UNFCCC

NATIONAL INVENTORY DOCUMENT (NID) FOR Nigeria's First Biennial Transparency Report _ UNFCCC

FEDERAL REPUBLIC OF NIGERIA

National Inventory Document

under the United Nations Framework Convention on Climate Change (UNFCCC)

24 December 2024

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- Federal Ministry of Environment
- Energy Commission of Nigeria

- Federal Ministry of Agriculture & Food Security
- Federal Ministry of Budget, Economic and National Planning
- Federal Ministry of Transport
- Federal Ministry of Water Resources & Sanitation
- Federal Ministry of Power
- Federal Ministry of Works & Housing
- Federal Ministry of Finance
- Federal Ministry of Health
- Federal Ministry of Science, Technology & Innovation
- Federal Ministry of Trade & Investment
- Federal Ministry of Steel and Mines Development
- Federal Ministry of Solid Minerals
- Federal Ministry of Industry Trade & Investment
- Federal Ministry of Marine and Blue Economy
- Federal Ministry of Women Affairs
- Ministries of Environment across 36 States of the Federation
- National Environmental Standard and Regulations Enforcement Agency
- Nigeria National Petroleum Company
- Nigerian Upstream Petroleum Regulatory Commission
- Nigeria Midstream and Downstream Regulatory Authority
- National Airspace Research & Development Agency
- National Oil Spill Detection and Response Agency
- National Bureau of Statistics
- National Emergency Management Agency
- National Planning Commission
- Nigerian Maritime Administration & Safety Agency
- Nigerian Meteorological Agency
- Rural Electrification Agency
- National Boundary Commission

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Abbreviations and acronyms

Abbreviation, Acronyms and Symbols	Definition
AD	Activity Data
AGO	Automotive Gas Oil
AR6	Sixth Assessment Report
AR	Assessment Report
ATK	Aviation Turbine Kerosene
BOD	Biological Oxygen Demand
BTR	Biennial Transparency Report
BUR	Biennial Update Report
C	Confidential
CFC	Chlorofluorocarbon
CH4	Methane
CMAN	Cement Manufacturer’s Association of Nigeria
CO	Carbon monoxide
CO2	Carbon dioxide
CO2 e	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
COP	Conference of Parties
COVID	Coronavirus disease
CRT	Common Reporting Table
CSO	Civil Society Organization
EF	Emission Factor
IEPCL	Indorama Eleme Petrochemicals Company Limited
EMEP / EEA	European Monitoring and Evaluation Program / European Environment Agency
ETF	Enhanced Transparency framework
FAO	Food and Agricultural Organisation
FMAFS	Federal Ministry of Agriculture and Food Security
FO	Fuel Oil
FRA	Global Forest Resources Assessment 2010
Fx	Flexibility
GDP	Gross Domestic Product

GHG	Greenhouse gas
GWP	Global Warming Potential
ha	Hectare
HFC	Hydrofluorocarbon
HHK	Household Kerosene
HWP	Harvested Wood Products
IE	Included Elsewhere
IEA	International Energy Agency
INDC	Initially Nationally Determined Contributions

Abbreviation, Acronyms and Symbols	Definition
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
JSON	JavaScript Object Notation
KCA	Key Category Analysis
kg	kilogram
Kt	kiloton
LULUCF	Land-Use, Land-Use Change and Forestry
LPG	Liquefied Petroleum Gas
M	Million
Mm	millimetre
MMS	Manure Management System
MPG	Modalities, Procedures and Guidelines
N	Nitrogen
N2O	Nitrous Oxide
NA	Not Applicable
NASRDA	National Space Research and Development Agency
NBS	Nigeria Bureau of Statistics
NC	National Communication
NCCC	National Council on Climate Change
NDC	Nationally Determined Contribution
NC3	Third national communication
NE	Not Estimated
NESREA	National Environmental Standards and Regulations Enforcement Agency
NF3	Nitrogen Trifluoride

NGO	Non-Governmental Organization
NF3	Nitrogen Fluoride
NID	National Inventory Document
NIR	National Inventory Report
NMVOC	Non-Methane Volatile Organic Compound
NNPC	Nigeria National Petroleum Company
NO	Not Occurring
NOx	Oxides of nitrogen
NPC	National Population Commission
NUPRC	Nigerian Upstream Petroleum Regulatory Commission
OPEC	Organization of Petroleum Exporting Countries
PA	Paris Agreement
PFC	PerFluoroCarbon
PRP	Pasture Range and Padlock
QA	Quality assurance
QC	Quality Control

Abbreviation, Acronyms and Symbols	Definition
RA	Reference Approach
RFO	Residual Fuel Oil
SA	Sectoral Approach
SF6	Sulphur hexafluoride
SO2	Sulphur dioxide
t	Tons
tdm	Tons dry matter
TJ	Tera joule
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
USGS	United States Geological Survey
X	Estimated
yr	year

Executive summary

ES 1. Background information on GHG inventories and climate change

Nigeria's national circumstances are such that the country has always been an emitter, which explains its initiatives to address emissions and be a net zero emitter in the longer term. Removals from the Land Use, Land Use Change and Forestry (LULUCF) sector are lower than total emissions from the Energy, Industrial Production and Product Use (IPPU), Agriculture, LULUCF and Waste sectors. The highest contributors in national emissions are the Oil and Gas sector and deforestation coupled with wood removals for use as fuelwood in LULUCF and emissions from the livestock sector.

Nigeria has so far compiled and submitted 5 GHG inventories. The country has progressed since the first submission but still faces serious challenges to fully comply with Article 13 of the Paris Agreement (PA) on the Enhanced Transparency Framework (ETF). The first 4 GHG inventories were submitted as chapters in the National Communications (NC), NC1, NC2 and NC3 in 2003, 2014 and 2020 and the First Biennial Update Report (BUR1) in 2018. The 5th GHG inventory was prepared and submitted as a stand-alone National Inventory Report (NIR1) document. Preparation of the GHG inventories over time aimed at conforming to decisions of the Conference of the Parties (COP) through adoption of the latest recommended methodologies and guidelines, enhancing transparency, accuracy and completeness while improving consistency and comparability. To-date, Nigeria's latest GHG inventory spanned over the time series 2000 to 2017, has been prepared using the IPCC 2006 guidelines, covered the direct GHGs carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Hydrofluorocarbons (HFCs) have not been estimated so far. Perfluorocarbons and nitrogen trifluoride (NF_3) have not been identified as GHGs being emitted up to now. The indirect gases nitrogen oxides (NO_x), carbon monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOCs) and sulphur dioxide (SO_2) have also been estimated in the last GHG inventory.

ES 2. Summary of trends related to national emissions and removals

The trend of national total emissions, removals and net emissions/removals are presented in Figure ES1. Nigeria is a net emitter over the full time series 2000 to 2022. Total emissions show a clear increasing trend over the period 2000 to 2019 of the time series after which it declined slightly due to land converted to Cropland and Settlements reaching 20 years when the balance of soil organic carbon (SOC) is accounted for in the software as from year 2020 for these 2 land classes. Total emissions increased from 374,312 kt CO_2 e in 2000 to 678,270 kt CO_2 e in 2022 resulting in an increase of 303,958 kt CO_2 e (81%). Net emissions increased from 368,499 kt CO_2 e in 2000 to 554,095 kt CO_2 e in 2022 which translates in an increase of 185,596 kt CO_2 e (51%). Removals increased from 5,813 kt CO_2 e in 2000 to 124,175 kt CO_2 e in 2022 resulting in an increase of 118,361 kt CO_2 e (2,036%).

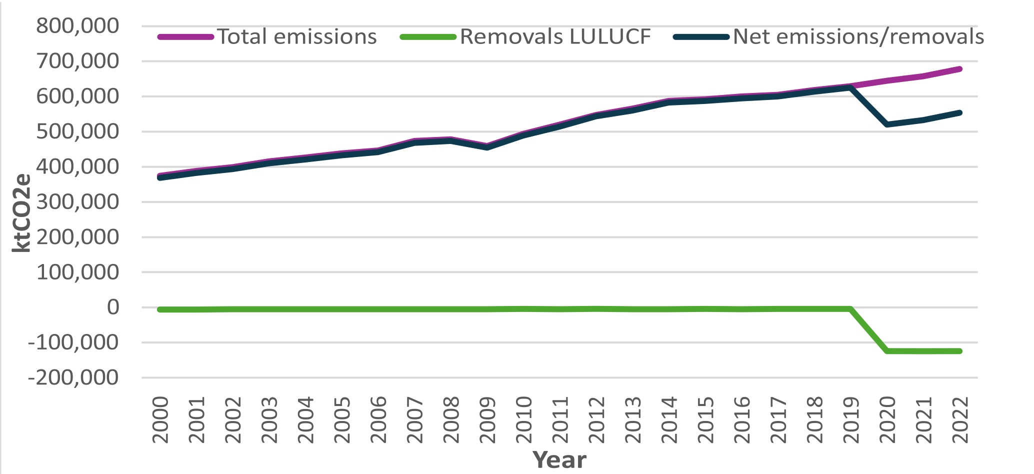

Figure ES1. Trend of total national emissions, removals and the resultant net emissions

ES 3. Overview of source and sink category emission estimates and trends

The trends of gross emissions by sector are provided in Figure ES2 for the full time series 2000 to 2022. The highest emitting sector remained LULUCF over the full time series followed by Energy, Agriculture, Waste and IPPU. Between 2000 and 2022, gross emissions increased by 63% in the LULUCF sector, 111% for Energy, 75% for Agriculture, 99% for Waste and 947% for IPPU. The removals accountable to the LULUCF sector increased by 2,036% between 2000 and 2022.

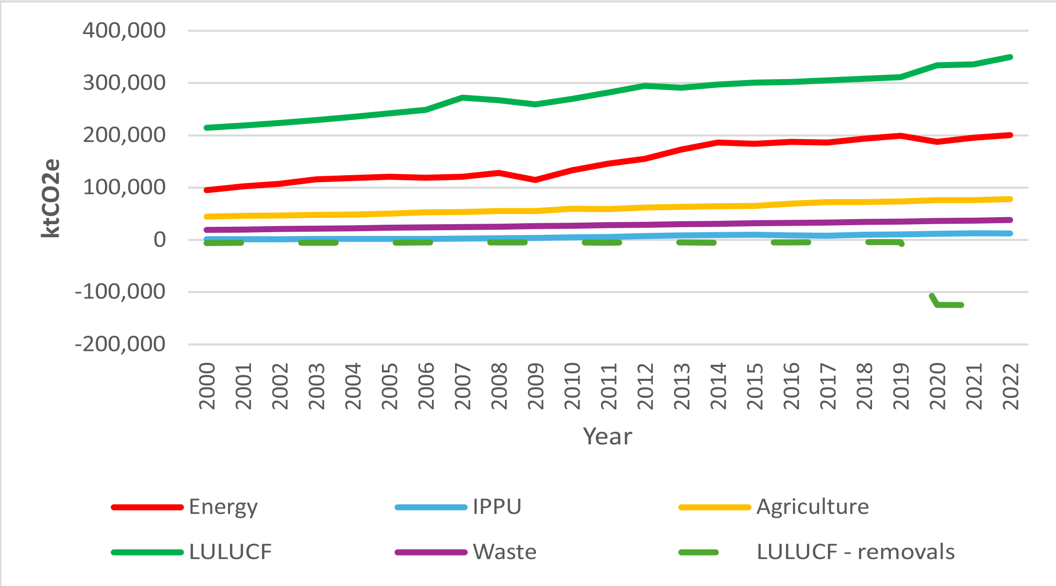

Figure ES2. Trend of aggregated gross emissions by sector

ES 4. Other information (e.g. indirect GHGs, precursor gases)

Regarding indirect GHGs, CO emissions increased by 87% from 12,499 kt in 2000 to 23,414 kt in 2022. Over the same period, NOx increased from 1,406 kt to 4,213 kt (200%), NMVOC from 1,998 kt to 3,460 kt (73%) while SO2 increased from 1,626 kt to 5,235 kt (222%).

ES 5. Key category analysis

When considering the summary of key categories for level (2022) and trend (2000 to 2022) assessments with LULUCF, there are 18 key categories in total, 16 common to both assessments. For the remaining 2, one each falls under the Level and the Trend assessment. When excluding LULUCF from the assessments for similar time periods, the number of key categories is still 18. This time 17 are common to both types of assessment, and the remaining 1 is under the level assessment only.

ES 6. Improvements introduced

Improvements introduced from the previous inventory submitted as NIR1 and this first National Inventory Document consist of widening of the scope of the inventory which enhances completeness, improving the accuracy of estimates through the estimation of emissions at the sub-category level instead of being treated in bulk as a category and recalculating estimates for all years of the previous inventory to keep consistency of the time series. Recalculations have been performed whenever there have been improved data sets available and new methodologies or emission factors available following the adoption of the 2019 Refinements to the IPCC 2006 guidelines. Explanations, including the justifications for recalculations and the implications for emissions or removals are provided under the individual categories as applicable.

Chapter 1. National circumstances, institutional arrangements and cross-cutting information

1.1. Background information on GHG inventories and climate change

The continued increase of the atmospheric level of greenhouse gases (GHGs) during the past five decades has caused global warming and the resulting climate change which is worsening and becoming a consequent burden to sustainable socio-economic development. The Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) clearly demonstrated that observed changes in weather extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, are due to human influence through its increasing GHG emissions. IPCC considers that the global surface temperature will continue to increase until at least the mid-century under all emissions scenarios and increases of 1.5°C and 2°C will be exceeded during the 21st century unless meaningful reductions in CO2 and other GHGs materialize in the coming decades. The average rate of global sea level rise has increased from 1.3 mm annually between 1901 and 1971, to 1.9 mm between 1971 and 2006, and further to 3.7 mm between 2006 and 2018 (AR6). Inadequate action would raise the global temperature by between 1.7 °C and 2.4 °C compared to pre-industrial levels and further impair the climate systems.

The global community is now addressing this most urgent situation through the Paris Agreement (PA), a new platform for enhanced collective commitments and actions. All signatory Parties to the PA committed themselves through their Initially Nationally Determined Contributions (INDCs). Furthermore, most signatory Parties have revised and updated their NDCs and will undertake future revisions every 5 years, making the PA a long-term dynamic agreement. The Agreement also called on Parties to report by 2020 on their long-term low emissions development strategies. Most Parties reviewed and updated their NDCs to make them more ambitious in view of tackling the cause of the problem, namely the continuing increase in the atmospheric level of GHGs.

The Republic of Nigeria ratified the Convention on 29 August 2004 as a Non-Annex 1 Party, its Kyoto Protocol on 10 December 2004 and the PA on 16 May 2017. To meet its obligations to these ratifications, Nigeria has submitted 3 National Communications (NCs) and 2 Biennial Update Reports (BURs), including 1 National Inventory Report (NIR) in association with the last BUR with the objective of being transparent. Nigeria is looking forward to be compliant and has thus prepared and submitted this second NIR (NIR2) within the framework of its first Biennial Transparency Report (BTR1) to honour its commitments in accordance with the Enhanced Transparency Framework (ETF) of the PA. Nigeria has also prepared and submitted its Intended Nationally determined Contributions (INDC) in 2015 to conform with Decisions 1/CP.19 and 1/CP.20 of the Conference of the Parties (COP). In line with Article 4 of the PA and Decision 1/CP.21 of the UNFCCC, Nigeria revised its INDC (to produce the first Nationally Determined Contribution (NDC) which was submitted in 2021 (https://unfccc.int/sites/default/files/NDC/202206/NDC_File%20Amended%20_11222.pdf).

Nigeria has so far compiled and submitted 5 GHG inventories. The country has progressed since the first submission but still faces serious challenges to fully comply with Article 13 of the PA on the ETF. The first 4 GHG inventories were submitted as chapters in the NC1, NC2 and NC3 in 2003, 2014 and 2020 and the BUR1 in 2018. The 5th GHG inventory was prepared as a stand-alone (NIR1) document https://unfccc.int/documents/307093. Preparation of the GHG inventories over time to conform to decisions of the COP through adoption of the latest recommended methodologies and guidelines, enhancing transparency, accuracy and completeness while improving consistency and comparability. To-date, Nigeria's latest GHG inventory spanned over the timeseries 2000 to 2017, has been prepared using the IPCC 2006 guidelines, covered the direct GHGs carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). Hydrofluorocarbons (HFCs) have not been estimated so far. Perfluorocarbons and nitrogen trifluoride (NF3) have not been identified as GHGs being emitted up to now. The indirect gases nitrogen oxides (NOx), carbon monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOCs) and sulphur dioxide (SO2) have also been estimated in the last GHG inventory.

1.2. Description of national circumstances and institutional arrangements

Nigeria's national circumstances are such that the country has always been an emitter which explains its initiatives to address emissions and be a net zero emitter in the longer term. Removals from the Land Use, Land Use Change and Forestry (LULUCF) sector are lower than total emissions from the Energy, Industrial Production and Product Use

(IPPU), Agriculture, LULUCF and Waste sectors. The highest contributors in national emissions are the Oil and Gas sector and deforestation coupled with wood removals for use as fuelwood in LULUCF and emissions from the livestock sector.

Nigeria is in the process of consolidating the in-house production of its GHG inventory to meet the ETF of the PA. However, due to lack of financial resources to maintain permanent staff for a full institutionalization of the process and insufficient capacity to implement the modalities, Procedures and Guidelines (MPGs), the country outsourced the computation of emissions and preparation of its NIR and the services of an independent international consultant for performing the Quality Assurance (QA) and capacity building of the GHG inventory working groups (Figure 1.1) to meet the enhanced transparency and higher standards of reporting.

The responsibilities within the institutional arrangements for the preparation of the NIR2 are:

- The National Council on Climate Change (NCCC) for inventory coordination, compilation and submission.
- The Federal Ministries and their Departments and Agencies for collection and provision of activity data (AD).
- The states through the States Desk Officers for data collection and submission as applicable.
- An external consultant for capacity building and QA.
- The NCCC for tracking capacity building needs, the IPCC process and COP decisions for implementation.

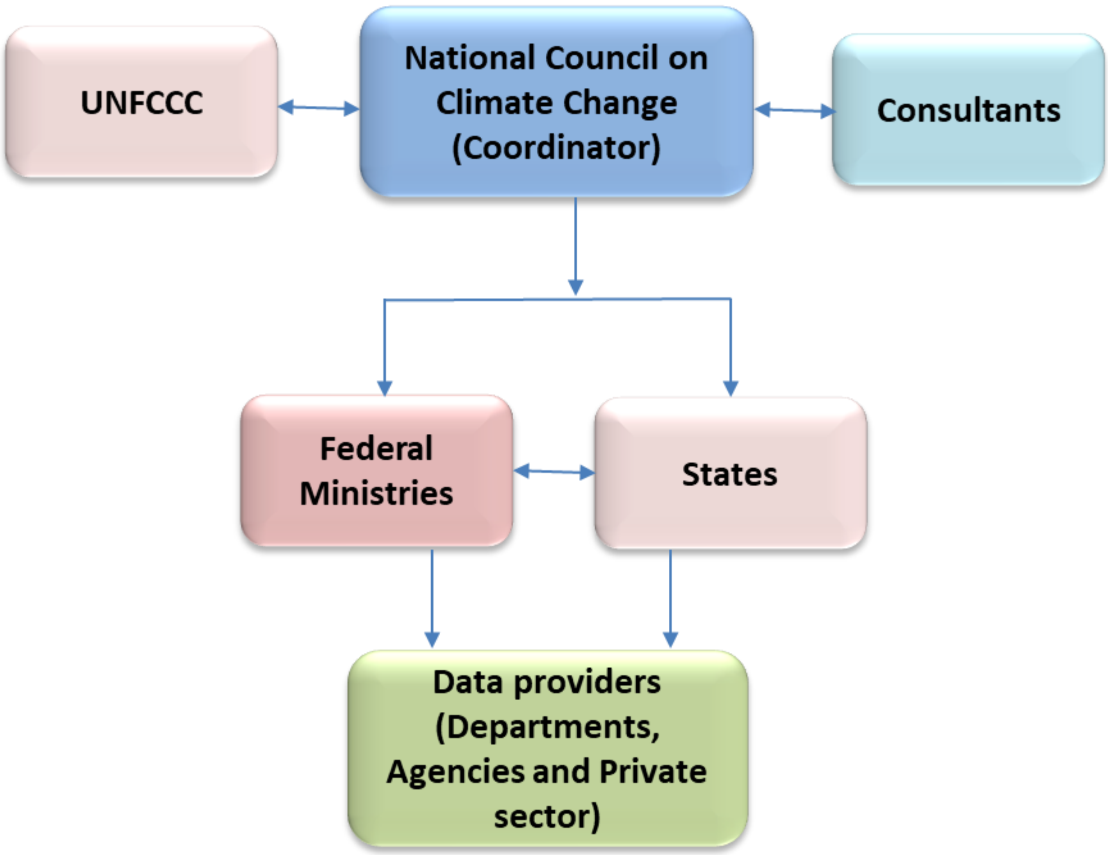

Figure 1.1. Institutional arrangements for compiling the GHG inventory

1.2.1. National entity or national focal point

The NCCC monitors and coordinates the production of the GHG inventories for Nigeria as National Focal Point of the Convention.

1.2.2. Inventory preparation process

The inventory cycle adopted for the compilation of the NID1 is presented in Figure 1.2. The different steps guiding the preparation of the inventory were:

- Drawing up of a work plan with timeline and deliverables.
- Allocation of tasks to NCCC staff.
- Collection, Quality Control (QC) and validation of AD.
- Selection of method and Tier level within each category and sub-category.
- Selection of EFs.
- Validation of AD and EFs during a workshop serving for capacity building concurrently.
- Computation of GHG emissions.
- Key Category Analysis.
- Uncertainty assessment.
- QA/QC of emissions, calculations and outputs.
- Assessment of completeness.
- Recalculations.
- Trend analysis.
- Identification of Gaps, constraints, needs and improvements.
- Preparation of the NID in accordance with Annex V of Decision 5/CMA.3 and the MPGs contained in the Annex to Decision 18/CMA.1.
- Circulation of final draft report to stakeholders for comments.
- Integration of stakeholders' comments.
- Validation of GHG inventory and chapter for inclusion in the BTR1.
- Generation of Common Reporting Tables (CRTs); and
- Submission to the UNFCCC as a stand-alone NIR2 as component of the BTR1.

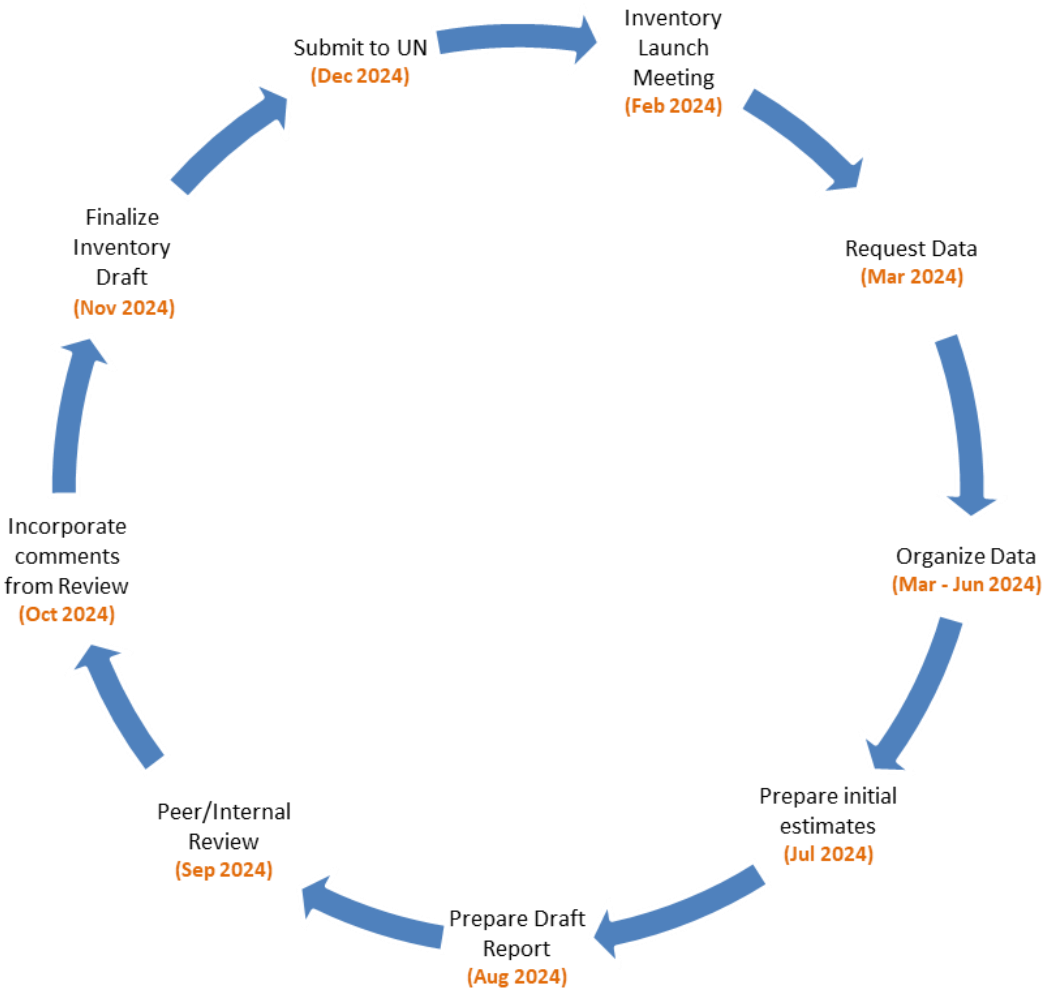

Figure 1.2. Inventory cycle of the NID1

1.2.3. Archiving of information

NCCC will be archiving all data, workings and other information on the compilation of the NID1 until an appropriate system is developed and operationalized.

1.2.4. Processes for official consideration and approval of inventory

The consideration and approval process involves officials from the Federal Ministries, their representatives from Departments and Agencies, Academicians, Non-Governmental Organizations (NGOs) and Civil Society Organizations (CSOs) which are members of the National Council on Climate Change (NCCC). The final draft of the NID1 is circulated to them for analysis and comments which are then integrated. The NCCC is then convened for a final discussion and approval of the NID1. Once the NID1 is validated and approved, the National Inventory Coordinator prepares a letter of submission to accompany the NID1 and CRTs, which are then submitted electronically to the UNFCCC by the NCCC.

1.3. Brief general description of methodologies (including tiers used) and data sources used

This section gives an overview of the methodological approach adopted for all sectors and sub-sectors covered in this inventory report. These procedures are extensively detailed in the respective sections covering the individual IPCC categories. Generally, the method adopted to compute emissions involved multiplying activity data (AD) by the relevant appropriate emission factor (EF), as shown below:

Emissions (E) = Activity Data (AD) x Emission Factor (EF)

All the methods and tools recommended by IPCC for the computation of emissions in an inventory have been used and followed to be in line with Decision 5/CMA.3 and the Modalities, Procedures and Guidelines contained in the Annex to Decision 18/CMA.1. The IPCC 2006 Guidelines, its Wetlands Supplement and 2019 Refinements, including the category-specific decision tree, were complemented with the European Monitoring and Evaluation Programme / European Environment Agency (EMEP/EEA) Guidebook 2023 for estimation of emissions of non-CO2 gases as applicable. Equations from the Guidebook were programmed in Excel worksheets, estimations made and entered manually in the sectoral tables generated by the IPCC 2006 Inventory Software, version 2.93 for reporting in the NID1.

The Tier 1 method has been adopted for estimating emissions in all sectors. The current inventory cycle has not enabled the country to collect and process quality national data to improve Tier levels based on the NIR1 key category analysis. The method and Tier level adopted are provided for under each individual category.

Default EFs were assessed for their appropriateness prior to their adoption, based on the conditions under which they have been developed and the extent to which these were representative of national circumstances.

Country-specific AD pertaining to most of the socio-economic sectors and categories are not readily available. Data which are collected, verified and processed to produce official national statistics reports were used when they were considered appropriate. Additional and/or missing data were sourced directly from both public and private sector operators by NCCC and inventory coordinator. Data gaps were filled by the national experts by personally contacting stakeholders and/or from results of surveys, scientific studies and by statistical modelling. All the data and information collected during the inventory process have been stored in the software database.

In some cases, due to the restricted timeframe and lack of a fully functional national framework for data collection and archiving to meet the requirements for preparing GHG inventories, derived data, international databases and estimates were used to fill in the gaps. These were considered reliable and sound since they were based on scientific findings and other observations. Due to significant changes and improvements applied to improve the GHG inventory, estimates for several categories were recalculated for the full time series 2000 to 2017 and the years 2018 to 2022 added to meet the mandatory year as per paragraph 58 of the Annex to the MPGs. All data are presented under the individual categories in this NID1. The data sources for estimated categories for the period 2000 to 2022 are given in Table 1.1.

Table 1.1. Summary of data sources for estimated categories

Greenhouse gas source and sink categories	**Data sources**
1 - Energy	
1.A - Fuel Combustion Activities	
1.A.1 - Energy Industries	
1.A.1.a – Public electricity and heat production	
1.A.1.a.i - Electricity generation	United Nations (UN) database (http://data.un.org/Explorer.aspx)
1.A.1.b – Petrol refining	UN database
1.A.1.c - Manufacture of solid fuels and other energy industries	
1.A.1.c.iii – Other energy industries	UN database
1.A.2 - Manufacturing Industries and	

Construction	
1.A.2.a – Iron and steel	UN database
1.A.2.c – Chemicals	UN database
1.A.2.f - Non-metallic minerals	UN database
1.A.2.g - Other	
1.A.2.g.viii – Other	UN database
1.A.3. Transport	
1.A.3.a. Domestic Aviation	UN database
1.A.3.b - Road transportation	UN database
1.A.3.c - Railways	UN database
1.A.3.d – Domestic navigation	(i) NIR1 Nigeria (https://unfccc.int/sites/default/files/resource/NIGERIA%20NIR1%20%20First%20National%20 GHG%20Inventory%20Report%20.pdf) (ii) UN database
1.A.4 - Other Sectors	
1.A.4.a – Commercial/institutional	(i) NIR1 Nigeria (ii) UN database
1.A.4.b - Residential	(i) NIR1 Nigeria (ii) UN database
1.A.4.c - Agriculture/Forestry/ Fishing	
1.A.4.c.i - Stationary	(i) NIR1 Nigeria (ii) UN database
1.A.4.c.ii – Off-road vehicles and other machinery	NIR1 Nigeria
1.B - Fugitive emissions from fuels	
1.B.1 - Solid Fuels	
1.B.1.a – Coal mining and handling	
1.B.1.a.ii – Surface mines	
1.B.1.a.ii.1 – Mining activities	UN database and was adjusted by over 20% to arrive at amount of raw charcoal produced
1.B.1.a.ii.2 – Post-mining activities	Same as for mining activities.
1.B.1.b - Fuel transformation	

1.B.1.b.i - Charcoal and biochar production	(i) UN database (ii) National data for exports of charcoal from FAO-Stat.
Greenhouse gas source and sink categories	**Data sources**
1.B.2 - Oil and natural gas and other emissions from energy production	
1.B.2.a - Oil	
1.B.2.a.ii - Production and upgrading	(i) Nigeria National Petroleum Company (NNPC) Annual Statistical Bulletins (ASB) (2000 -2017) (ii) NUPRC data for 2018 to 2022
1.B.2.a.iii - Transport	(i) NNPC Annual Statistical Bulletins (2000 – 2017) (ii) Nigerian Upstream Petroleum Regulatory Commission (NUPRC) data for 2018 to 2022
1.B.2.a.iv - Refining/storage	(i) NNPC Annual Statistical Bulletins (2000 -2017) (ii) Nigerian Oil and Gas Industry Annual Report 2018 (iii) UN data base (iv) Organization of Petroleum Exporting Countries (OPEC) Annual Statistical Bulletin 2023
1.B.2.a.v - Distribution of oil products	(i) NNPC Annual Statistical Bulletins (2000 -2017) (ii) UN data base (iii) Using IPCC splicing techniques for correction of outlier
1.B.2.b - Natural gas	
1.B.2.b.ii - Production and gathering	(i) NNPC Annual Statistical Bulletins (2000 -2017) (ii) NUPRC data for 2018 to 2022
1.B.2.b.iii - Processing	(i) NNPC Annual Statistical Bulletins (2000 -2017) (ii) NUPRC data for 2018 to 2022
1.B.2.b.iv – Transmission and storage	(i) NNPC Annual Statistical Bulletins (2000 -2017) (ii) NUPRC data for 2018 to 2022 (ii) UN data base
1.B.2.b.v - Distribution	(i) NNPC Annual Statistical Bulletins (2000 to 2017) (ii) NUPRC data for 2018 to 2022.
1.B.2.c - Venting and flaring	
1.B.2.c.i – Venting	
1.B.2.c.i.1 - Oil	(i) NNPC Annual Statistical Bulletins (2000 to 2017) (ii) UN database (iii) Organization of Petroleum Exporting Countries (OPEC) ASB 2023
1.B.2.c.i.2 - Gas	(i) NNPC Annual Statistical Bulletins (2000 to 2017) (ii) NUPRC data for 2018 to 2022
1.B.2.c.ii - Flaring	
1.B.2.c.ii.1 - Oil	(i) NNPC Annual Statistical Bulletins (2000 to 2017) (ii) NUPRC data for 2018 to 2022
1.B.2.c.ii.2 - Gas	(i) NNPC Annual Statistical Bulletins (2000 to 2017) (ii) NUPRC data for 2018 to 2022
2 - Industrial Processes and Product Use	
2.A - Mineral Industry	
2.A.1 - Cement production	(i) Cement Manufacturers Association of Nigeria (CMAN) (2000 to 2016) (ii) US Geological Survey (USGS) website (2017 to 2022) https://www.usgs.gov/centers/national-minerals-information-center/cementstatistics-and-information
2.A.4 – Other Process Uses of Carbonates (Ceramic production)	Ceramic producers through National Environmental Standards and Regulations Enforcement Agency (NESREA)

Greenhouse gas source and sink categories	Data sources
2.B – Chemical Industry	
2.B.1 – Ammonia Production	(i) National Bureau of Statistics (NBS) (2000 to 2013) (ii) USGS website (2014 to 2020) https://www.usgs.gov/centers/national-mineralsinformation-center/africa-and-middle-east#nga (ii) Ammonia producers through NESREA (2021 and 2022)
2.C – Metal Industry	
2.C.1 - Iron and Steel Production	(i) NBS (2000 to 2017) (ii) National Steel Raw Material exploration Agency (NSRMEA) https://nsrmea.gov.ng/blog/dr-hassan-calls-for-investment-in-primary-steelproduction-in-nigeria (2018 to 2022)
3 - Agriculture	
Greenhouse gas source and sink categories	**Data sources**
3.A - Enteric Fermentation	(i) Food and Agriculture Organization (FAO) of the United Nations - FAOSTATS (2000 to 2022) (ii) Federal Ministry of Agriculture and Food Security (FMAFS) (2003 to 2019, 2021 and 2022)
3.B - Manure Management	(i) Same as 3A (ii) NIR1 Nigeria
3.C – Rice cultivation	(i) FAOSTATS (2000 to 2020) (https://www.fao.org/faostat/en/#data/FS) (ii) FMAFS (2021 and 2022) (ii) Published literature on Rice Production Systems in Nigeria (https://cgspace.cgiar.org/bitstreams/80951ea8-333b-46b9-b38492c812ef4494/download)
3.D – Agricultural soils	FAOSTATS (2000 to 2022)
3.F. Field burning of agricultural residues	FAOSTATS (2000 to 2022)
3.H. Urea application	FAOSTATS (2000 to 2022)
4 - Land use and land use change and forestry	
4.A – Forest land **4.B – Cropland** **4.C – Grassland** **4.D – Wetlands** **4.E – Settlements** **4.F – Other land**	(i) FAO: FAOSTATS, FRA reports (https://www.fao.org/forest-resourcesassessment/past-assessments/fra-2015/en/) (ii) CILSS (Landscape of Africa, http://racines-sahel.org/bibliothequenumerique/files/original/25df9ccd73e05f7717d81e39e16034c0.pdf) (iii) NBS
4.G – Harvested wood products	FAOSTATS and UN database (2000 to 2022)
5 - Waste	
5.A - Solid Waste Disposal	(i) NBS (ii) National Population Commission (NPC) (iii) World Bank (https://data.worldbank.org/indicator/NY.GDP.MKTP.KD) (iv) NIR1 Nigeria
5.C - Incineration and Open Burning of Waste	Same as 5A
5.D - Wastewater Treatment and Discharge	(i) NPC (ii) NBS (iii) FAOSTATS
1.D. Memo items	
1.D.1. International bunkers	
1.D.1.a. Aviation	UN database
1.D.1.b. Navigation	UN database

1.4. Brief description of key categories

Since the software only generates results inclusive of LULUCF and the MPGs contained in Decision 18/CMA.1 require outputs with and without LULUCF, a tool has been developed to perform this task in accordance with the reporting requirements. The tool was tested by comparing the results obtained with it with those from the software for the level and trend assessment for a few years prior to adoption. It has been applied for the Key Category Analysis (KCA) analysis for this NID1.

The KCA was performed using the tool available within the IPCC Inventory Software and the results were exported in an excel file and saved. Excel worksheets were developed from the exported results for determining both the Level and Trend assessments. The Excel worksheets were programmed as per the equations of the IPCC 2006 guidelines to generate results with and without LULUCF. The KCA was truncated at the 95% level. The key categories for the level and trend assessments with and without LULUCF are provided in Annex 1 in detail. Tables 1.2 and 1.3 summarize the key categories for the level assessment for year 2022 and for the trend assessment from 2000 to 2022 with and without LULUCF respectively.

Table 1.2 provides a summary of key categories for level (2022) and trend (2000 to 2022) assessments with LULUCF. When considering both assessments with LULUCF (Table 1.2), there are 18 key categories in total, 16 common to both the level assessment of 2022 and the trend 2000 to 2022. For the remaining 2, 1 fall under the Level assessment and the other one under Trend.

Table 1.2. Summary of Key Categories for level (2022) and trend (2000-2022) assessments with LULUCF

Number	IPCC category code	IPCC category	GHG	Identification criteria	Comment
1	1.A.1	Energy Industries - Gaseous Fuels	CO2	L1,T1	Quantitative
2	1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CO2	L1,T1	Quantitative
3	1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO2	L1,T1	Quantitative
4	1.A.3.b	Road Transportation - Liquid Fuels	CO2	L1,T1	Quantitative
5	1.A.4	Other Sectors - Biomass - solid	CH4	L1,T1	Quantitative
6	1.A.4	Other Sectors - Liquid Fuels	CO2	L1,T1	Quantitative
7	1.B.1.b	Fuel transformation	CH4	T1	Quantitative
8	1.B.2.a	Oil	CH4	L1	Quantitative
9	1.B.2.b	Natural Gas	CH4	L1,T1	Quantitative
10	2.A.1	Cement production	CO2	L1,T1	Quantitative
11	3.A	Enteric Fermentation	CH4	L1,T1	Quantitative
12	3.C	Rice cultivation	CH4	L1,T1	Quantitative
13	3.D.1	Direct N2O Emissions from managed soils	N2O	L1,T1	Quantitative
14	4.A.1	Forest land Remaining Forest land	CO2	L1,T1	Quantitative
15	4.B.1	Cropland Remaining Cropland	CO2	L1,T1	Quantitative
16	4.E.1	Settlements Remaining Settlements	CO2	L1,T1	Quantitative
17	5.A	Solid Waste Disposal	CH4	L1,T1	Quantitative
18	5.D	Wastewater Treatment and Discharge	CH4	L1,T1	Quantitative

Notation keys: L = key category according to level assessment; T = key category according to trend assessment; and Q = key category according to qualitative criteria. The Approach used to identify the key category is included as L1, L2, T1 or T2

Table 1.3 provides a summary of key categories for level (2022) and trend (2000 to 2022) assessments without LULUCF. When excluding LULUCF from the assessments for similar time periods, the number of key categories is still 18. This time 17 are common to both types of assessment, and the remaining 1 is under the level assessment only.

Table 1.3. Summary of Key Categories for level (2022) and trend (2000-2022) assessments without LULUCF

Number	IPCC category code	IPCC category	GHG	Identification criteria	Comment
1	1.A.1	Energy Industries - Gaseous Fuels	CO2	L1,T1	Quantitative
2	1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CO2	L1,T1	Quantitative
3	1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO2	L1,T1	Quantitative
4	1.A.3.b	Road Transportation - Liquid Fuels	CO2	L1,T1	Quantitative
5	1.A.4	Other Sectors - Biomass - solid	CH4	L1,T1	Quantitative
6	1.A.4	Other Sectors - Biomass - solid	N2O	L1,T1	Quantitative
7	1.A.4	Other Sectors - Liquid Fuels	CO2	L1,T1	Quantitative
8	1.B.1.b	Fuel transformation	CH4	L1,T1	Quantitative
Number	**IPCC category code**	**IPCC category**	**GHG**	**Identification criteria**	**Comment**
9	1.B.2.a	Oil	CH4	L1,T1	Quantitative
10	1.B.2.b	Natural Gas	CH4	L1,T1	Quantitative
11	2.A.1	Cement production	CO2	L1,T1	Quantitative
12	3.A	Enteric Fermentation	CH4	L1,T1	Quantitative
13	3.C	Rice cultivation	CH4	L1,T1	Quantitative
14	3.D.1	Direct N2O Emissions from managed soils	N2O	L1,T1	Quantitative
15	3.D.2	Indirect N2O Emissions from managed soils	N2O	L1,T1	Quantitative
16	5.A	Solid Waste Disposal	CH4	L1,T1	Quantitative
17	5.C	Incineration and Open Burning of Waste	CH4	L1	Quantitative
18	5.D	Wastewater Treatment and Discharge	CH4	L1,T1	Quantitative

Notation keys: L = key category according to level assessment; T = key category according to trend assessment; and Q = key category according to qualitative criteria. The Approach used to identify the key category is included as L1, L2, T1 or T2

It must be highlighted that Nigeria has assessed key categories with and without LULUCF for the first time. The latter exercise has revealed additional key categories, but it has not been possible to move to Tier 2 due to lack of data. In fact, data for the years 2021 and 2022 were already collected when the inventory was compiled and this feature observed. They have all been considered for improvement and prioritized depending on their importance in contributing to emissions and the potential timeframe for their completion, including a preliminary assessment of resources needed. Details on those retained on a priority basis for improvement are provided in the improvement plan of the BTR1.

1.5. Brief general description of QA/QC plan and implementation

Nigeria has its own national system for Quality Control (QC) of data which are collected for national purposes by the different Federal Ministries through their Departments and Agencies. Data are also collected at the subnational level (States) as well at the regional levels. However, there exists no official QC procedures and framework, notably for

GHG inventory data. Nonetheless, all data are quality controlled to some point until the final QA is made by the National Bureau of Statistics (NBS) or other Federal institution before archiving. The private sector also implements its own QC within its data collection and archiving processes. Thus, the initial phases of the QC remained beyond the GHG inventory compiler and may not fit the QA/QC process of the IPCC exactly.

Conscious of the situation, the intent is to improve the QA/QC process. Nigeria has thus developed a QA/QC plan under this project and rolled it out during the data collection step of this inventory. The QA/QC plan follows all the steps earmarked in the 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019), including category-specific checklists. The QA/QC plan has been shared with all representatives of institutions responsible for data collection, NCCC members of the GHG inventory working group and States Desk Officers (SDOs) for adoption after a training session. The initial steps for quality controlling data collected have been integrated in the activity data collection template for each category which is monitored by the data collector and/or provider. There is no overall QA/QC coordinator yet within NCCC and this shortcoming will be corrected during the preparation of the BTR2/NC4. The rolling out of the QA/QC plan proved to be a very difficult exercise and did not work as expected for the GHG inventory of the BTR1. This is mainly due to delays in starting the inventory cycle coupled with insufficient availability of the stakeholders for implementing the QA/QC plan. Further strengthening of stakeholders on the QA/QC process will take place during the next data collection round for the next inventory.

Nonetheless, QC and QA procedures, as defined in the 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019), have been implemented as far as possible during the preparation of the inventory. Whenever there were inconsistencies or possible transcription errors, the institution responsible was queried, the problem discussed and solved. QC was implemented through:

- Routine and consistent checks to ensure data integrity, reliability and completeness.
- Routine and consistent checks to identify errors and omissions.
- Accuracy checks on data acquisition and calculations and the use of approved standardized procedures for emissions calculations; and
- Technical and scientific reviews of data used, methods adopted, and results obtained.

Furthermore, the AD were compared with those available on international databases such as those of the Food and Agriculture Organisation (FAO), the United Nations (UN) statistical database and the International Energy Agency (IEA) as applicable.

QA was undertaken by an independent reviewer who was not involved with the compilation of the inventory, the main objectives being to:

- Confirm the quality and reliability of data used for computing emissions.
- Review the AD and EFs adopted for each source category as a first step.
- Analyse the time series data to identify and correct outliers, ensure consistency; and
- Review and check the calculation steps in the software to ensure accuracy.

1.6. General uncertainty assessment

For this inventory, an Approach 1 uncertainty analysis of the aggregated figures as required by the 2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019) was performed. Based on the quality of the data and whether the EFs used were defaults or nationally derived, uncertainty levels were assigned for the two parameters and the combined uncertainty calculated. The uncertainty values assigned to AD and EFs were from the range recommended by the IPCC Guidelines for the specific gases of each source category. Thus, lower uncertainties were assigned to AD obtained from measurements made and recorded, intermediate values for interpolated and extrapolated AD and the highest ones in the range when the AD is subject to expert knowledge. Regarding the EFs, the average value recommended in the range from the IPCC Guidelines were adopted. Whenever there was a need to resort to expert judgement, the protocol was to consult with more than one expert from the typical sector or industry to ascertain the level of uncertainty to be adopted from within the range provided in the IPCC guidelines. In cases where IPCC has a particular recommended methodology, the uncertainty level was derived according to the procedure proposed in the IPCC Guidelines and used in the uncertainty analysis.

The uncertainty analysis could not be performed using the tool available within the IPCC Inventory Software – version 2.93. The results, obtained for the aggregated emissions for some categories particularly, were erroneous. This stemmed from wrong estimates being carried over within the tool of the software. Moreover, the MPGs contained in the Annex to Decision 18/CMA.1 require that Parties report uncertainties at category level for all sources and sinks. This is not generated by the software and must be calculated using other methods. To remedy this situation, the equations from the IPCC 2006 guidelines were programmed in an Excel worksheet and the uncertainties determined exactly as in the software. Uncertainties in total emissions were thus calculated in the Excel worksheet including emissions and removals from the LULUCF sector. The combined Uncertainty for the level assessment for the base year 2000 and year-t 2022 is 36.7% and 42.3% respectively while the uncertainty for the trend assessment between the base year 2000 and year-t 2022 is 35.5%. The uncertainties assigned to AD and EFs for each category and the combined uncertainty estimates are provided under the respective categories in this NID.

1.7. General assessment of completeness

An assessment of the completeness of the inventory was made by populating individual IPCC activity areas within each source category covering the 5 sectors. The methodology adopted was according to the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019). The notation keys from the list below have been used as appropriate:

Abbreviation	Meaning
X	Estimated
NA	Not Applicable
NO	Not Occurring
NE	Not Estimated
IE	Included Elsewhere
C	Confidential
Fx	Flexibility

The level of completeness depicting the scope of the inventory is provided in Table 1.4. It has not been possible to update the sectoral CRTs in Annex VI to this NID due to time constraints. The interoperability function of the IPCC Software 2.93 is generating JavaScript Object Notation (JSON) files with the notification keys of NO and NE assigned by default for those categories not estimated. These JSON files are the ones leaded on the UNFCCC tool to generate the CRTs.

1.7.1. Information on completeness

Estimates varied between categories depending on whether emissions occurred or not in the sub-categories. Categories have been assigned X when estimates from occurring sub-categories have been made even partially, NE when it has not been addressed at all and NO when it is not leading to emissions. The other notation keys have been used as applicable, including where Nigeria has resorted to the Flexibility provisions of the MPGs. Categories not estimated are provided in Table 1.4. Emissions have not been estimated because AD were not available in all cases.

Table 1.4. Completeness of the inventory

Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO2
Total National Emissions and Removals												
1 - Energy												
1.A - Fuel Combustion Activities	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.A.1 - Energy Industries	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.A.2 - Manufacturing Industries and Construction	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.A.3 - Transport	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.A.4 - Other Sectors	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.A.5 - Other	IE	IE	IE	NA	NA	NA	NA	NA	IE	IE	IE	IE
1.B - Fugitive emissions from fuels	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.B.1 - Solid fuels	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.B.2 - Oil and natural gas and other emissions from energy production	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.C - Carbon dioxide Transport and storage	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.C.1 - Transport of CO2	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.C.2 - Injection and storage	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.C.3 - Other	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2 - Industrial Processes and Product Use												
2.A - Mineral Industry	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.A.1 - Cement production	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.A.2 - Lime production	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

2.A.3 - Glass Production	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.A.4 - Other Process Uses of Carbonates	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.A.5 - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO2
2.B - Chemical Industry	X	NE	NO	NO	NO	NO	NO	NO	X	X	NO	NO
2.B.1 - Ammonia Production	X	NA	NA	NA	NA	NA	NA	NA	X	X	NO	NO
2.B.2 - Nitric Acid Production	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B.3 - Adipic Acid Production	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B.5 - Carbide Production	NO	NO	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B.6 - Titanium Dioxide Production	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B.7 - Soda Ash Production	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B.8 - Petrochemical and Carbon Black Production	NE	NE	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.B.9 - Fluorochemical Production	NA	NA	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.10 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	X	NO	NO	NO	NO	NO	NO	NO	NO	NO	X	NO
2.C.1 - Iron and Steel Production	X	NO	NA	NA	NA	NA	NA	NA	NO	NO	X	NO
2.C.2 - Ferroalloys Production	NO	NO	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.C.3 - Aluminium production	NO	NA	NA	NA	NO	NA	NA	NO	NO	NO	NO	NO
2.C.4 - Magnesium production	NO	NA	NA	NA	NA	NO	NA	NO	NO	NO	NO	NO

2.C.5 - Lead Production	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.C.6 - Zinc Production	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.C.7 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use	NE	NO	NO	NA	NA	NA	NA	NA	NO	NO	NE	NO
2.D.1 - Lubricant Use	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.2 - Paraffin Wax Use	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.3 - Solvent Use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NE	NA
2.D.4 - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO2
2.E - Electronics Industry	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.E.1 - Integrated Circuit or Semiconductor	NA	NA	NA	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.E.2 - TFT Flat Panel Display	NA	NA	NA	NA	NO	NO	NO	NO	NA	NA	NA	NA
2.E.3 - Photovoltaics	NA	NA	NA	NA	NO	NA	NA	NO	NA	NA	NA	NA
2.E.4 - Heat Transfer Fluid	NA	NA	NA	NA	NO	NA	NA	NO	NA	NA	NA	NA
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NA	NA	NA	Fx	Fx	NA	NA	NA	NA	NA	NA	NA
2.F.1 - Refrigeration and Air Conditioning	NA	NA	NA	Fx	NA	NA	NA	NA	NA	NA	NA	NA
2.F.2 - Foam Blowing Agents	NA	NA	NA	NO	NA	NA	NA	NA	NA	NA	NA	NA
2.F.3 - Fire Protection	NA	NA	NA	Fx	Fx	NA	NA	NA	NA	NA	NA	NA
2.F.4 - Aerosols	NA	NA	NA	Fx	NA	NA	NA	NA	NA	NA	NA	NA
2.F.5 - Solvents	NA	NA	NA	Fx	Fx	NA	NA	NA	NA	NA	NA	NA

2.F.6 - Other Applications (please specify)	NA	NA	NA	NO	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NE	NO	Fx	Fx	NO	NE	NA	NA	NA	NA
2.G.1 - Electrical Equipment	NA	NA	NA	NA	Fx	Fx	NA	NE	NA	NA	NA	NA
2.G.2 - SF6 and PFCs from Other Product Uses	NA	NA	NA	NA	Fx	Fx	NA	NE	NA	NA	NA	NA
2.G.3 - N2O from Product Uses	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.G.4 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NE	NE	NO	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.H.1 - Pulp and Paper Industry	NE	NE	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.H.2 - Food and Beverages Industry	NE	NE	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.H.3 - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture	X	X	X	NA	NA	NA	NA	NA	X	X	NE	NE
3.A - Enteric Fermentation	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO2
3.A.1 – Dairy cows	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.A.1.a – Other Cattle	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.A.2 – Sheep	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.A.1 – Swine	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.A.4 – All Other animals	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B – Manure Management	NA	X	X	NA	NA	NA	NA	NA	NA	NA	NE	NA
3.B.1 – Dairy cows	NA	X	X	NA	NA	NA	NA	NA	NA	NA	NE	NA
3.B.1.a – Other Cattle	NA	X	X	NA	NA	NA	NA	NA	NA	NA	NE	NA
3.B.2 – Sheep	NA	X	X	NA	NA	NA	NA	NA	NA	NA	NE	NA

3.B.1 – Swine	NA	X	X	NA	NA	NA	NA	NA	NA	NA	NE	NA
3.B.4 – All Other animals	NA	X	X	NA	NA	NA	NA	NA	NA	NA	NE	NA
3.B.5 – Indirect N2O emissions	NA	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C – Rice Cultivation	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D – Agricultural Soils	NA	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.1 - Direct N2O Emissions from managed soils	NA	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.D.2 - Indirect N2O Emissions from managed soils	NA	NA	X	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.E – Prescribed burning of savannahs	NA	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
3.F – Field burning of crop residues	NA	X	X	NA	NA	NA	NA	NA	X	X	NE	NE
3.G – Liming	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.H – Urea Application	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.I – Other carbon containing fertilizers	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.J – Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 – Land Use, Land Use Change and Forestry	X	X	X	NA	NA	NA	NA	NA	NE	NE	NE	NO
4.A - Forestland	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO2
4.A.1 - Forest land remaining Forestland	X	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NO
4.A.2 – Land converted to Forestland	NE	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.B - Cropland	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

4.B.1 - Cropland remaining Cropland	NE	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.B.2 – Land converted to Cropland	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.C - Grassland	NE	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.C.1 - Grassland remaining Grassland	NE	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NO
4.C.2 – Land converted to Grassland	NE	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.D - Wetland	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.D.1 - Wetland remaining Wetland	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.D.2 – Land converted to Wetland	NE	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.E - Settlements	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.E.1 - Settlements remaining Settlements	NE	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.E.2 – Land converted to Settlements	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.F – Other land	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.F.1 - Other land remaining Other land	X	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.A.2 – Land converted to Other land	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
4.G – Harvested Wood Products	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.H – Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
5 - Waste	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
5.A - Solid Waste Disposal	NA	X	NA	NA	NA	NA	NA	NA	NO	NO	X	NA

Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO2

5.A.1. Managed waste disposal sites	NA	NO	NA	NA	NA	NA	NA	NA	NO	NO	NO	NA
5.A.2. Unmanaged waste disposal sites	NA	X	NA	NA	NA	NA	NA	NA	NO	NO	X	NA
5.A.3. Uncategorized waste disposal sites	NA	NO	NA	NA	NA	NA	NA	NA	NO	NO	NO	NA
5.B - Biological Treatment of Solid Waste	NA	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5.B.1. Composting	NA	NE	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5.B.2. Anaerobic digestion at biogas facilities	NA	NE	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5.C - Incineration and Open Burning of Waste	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
5.B.1. Waste incineration	NE	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE
5.B.2. Open burning of waste	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
5.D - Wastewater Treatment and Discharge	NA	X	X	NA	NA	NA	NA	NA	NO	NO	X	NA
5.D.1. Domestic wastewater treatment and discharge	NA	X	NO	NA	NA	NA	NA	NA	NO	NO	NE	NA
5.D.2. Industrial wastewater treatment and discharge	NA	X	NE	NA	NA	NA	NA	NA	NO	NO	X	NA
5.B.3. Other	NA	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5.E - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
6 - Other	NE	NO	NE	NO	NO	NO	NO	NO	NO	NO	NO	NO
6.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.A - Indirect CO2 emissions from the atmospheric oxidation CH4, CO and NMVOC	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.B - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.D. Memo Items												
1.D.1. International bunkers	X	X	X	NA	NA	NA	NA	NA	X	X	X	X

Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors	Other halogenated gases without CO2 equivalent conversion factors	NOx	CO	NMVOCs	SO2
1.D.1.a. Aviation	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.D.1.b Navigation	X	X	X	NA	NA	NA	NA	NA	X	X	X	X
1.D.2. Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.D.3. CO2 emissions from biomass	X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.D.4. CO2 captured	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1.7.2. Description of insignificant categories

Nigeria is reporting on the emissions of all categories identified as sources and sinks with data available irrespective of any being insignificant as per para. 32 of the MPGs.

1.7.3. Total aggregate emissions considered insignificant

Not Applicable

1.8. Metrics

Each GHG has a unique atmospheric lifetime and heat-trapping potential. The radiative forcing, heat trapping potential, effect of a gas is a quantification of its ability to warm the atmosphere. Direct radiative forcing occurs when the gas itself is a GHG, whereas indirect forcing occurs when the oxidation of the original gas produces GHGs or when a gas influences the atmospheric lifetime of another gas.

Global warming potential (GWP) is defined as the time-integrated change in radiative forcing due to the instantaneous release of 1 kg of the gas, expressed relative to the radiative forcing caused by the release of 1 kg of CO2. The GWP concept has been developed to allow the comparison of the ability of each GHG to trap heat in the atmosphere relative to CO2, as well as the characterization of GHG emissions in terms of how much CO2 would be required to produce a similar warming effect over a given time period. This is called the carbon dioxide equivalent (CO2 e) value and is calculated by multiplying the amount of the gas by its associated GWP. This normalization to CO2 e enables the quantification of total national emissions expressed as CO2 e by signatory Parties of the Convention and facilitates the summing up for projecting global warming of the atmosphere and its impacts on the socio-economic development of the world in relation to anticipated climate change. It also enables parties to assess their efforts in mitigating national emissions within their development agenda.

The Intergovernmental Panel on Climate Change (IPCC) develops and updates the GWPs for all GHGs over time, based on scientific progress. Consistent with the MPGs of the ETF under the PA (Annex to Decision 18/CMA.1), the 100year GWP values provided by the IPCC in its Fifth Assessment Report (IPCC, 2014) and presented in Table 1.5 are used in this report. For example, the 100-year GWP for CH4 used in this inventory is 28, meaning that an emission of 10 kilotonnes (kt) of CH4 is equivalent to 28 x 10 kt = 280 kt CO2 e.

Table 1.5. Global Warming Potentials used in this inventory

Gas	Symbol	Global Warming Potential
Carbon Dioxide	CO_2	1
Methane	CH_4	28
Nitrous Oxide	N_2O	265

1.9. Summary of any flexibility applied

Nigeria has resorted to the flexibility provisions under paragraph 57 of the MPGS for extending the time series through the inclusion of estimates for the period 1990 to 1999 and paragraph 48 of the MPGS relative to widening the scope of coverage of direct GHGs, namely HydroFluoroCarbons (HFCs), PerFluoroCarbons (PFCs) and Sulphur hexaFluoride (SF)6 that are recognised as occurring but not Nitrogen Fluoride (NF3) that is not emitted in the country. More details are provided in Table 10.1.

Chapter 2. Trends in greenhouse gas emissions and removals

2.1. Description of emission and removal trends for aggregated GHG emissions and removals

The trend of national total emissions, removals and net emissions/removals are presented in Figure 2.1. Nigeria is a net emitter over the full time series 2000 to 2022. Total emissions show a clear increasing trend over the period 2000 to 2019 of the time series after which it declined slightly due to land converted to Cropland and Settlements reached 20 years when the balance of soil organic carbon (SOC) is accounted in the software as from Year 2020 for these 2 land classes. Total emissions increased from 374,312 kt CO2 e in 2000 to 678,270 kt CO2 e in 2022 resulting in an increase of 303,958 kt CO2 e (81%). Net emissions increased from 368,499 kt CO2 e in 2000 to 554,095 kt CO2 e in 2022 which translates in an increase of 185,596 kt CO2 e (51%). Removals increased from 5,813 kt CO2 e in 2000 to 124,175 kt CO2 e in 2022 resulting in an increase of 118,361 kt CO2 e (2,036%).

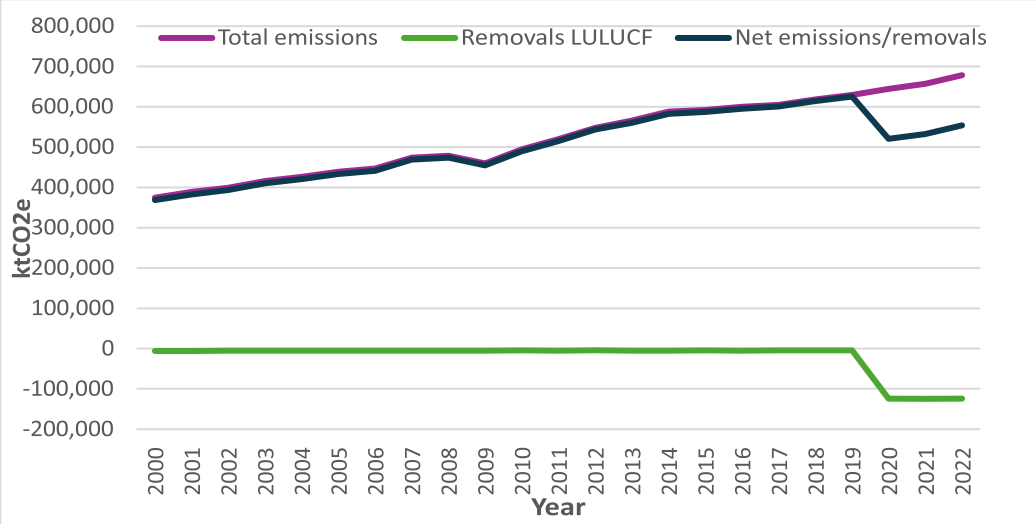

Figure 2.1. Trend of total national emissions, removals and the resultant net emissions

2.2. Description of emission and removal trends by sector and by gas

The trends of gross emissions by sector are provided in Figure 2.2 for the full time series 2000 to 2022 and Table 2.1 for selected years. The highest emitting sector remained LULUCF over the full time series followed by Energy, Agriculture, Waste and Industrial Production and product use (IPPU). Between 2000 and 2022, gross emissions increased by 63% in the LULUCF sector, 111% for Energy, 75% for Agriculture, 99% for Waste and 947% for IPPU. The removals accountable to the LULUCF sector increased by 2,036% between 2000 and 2022.

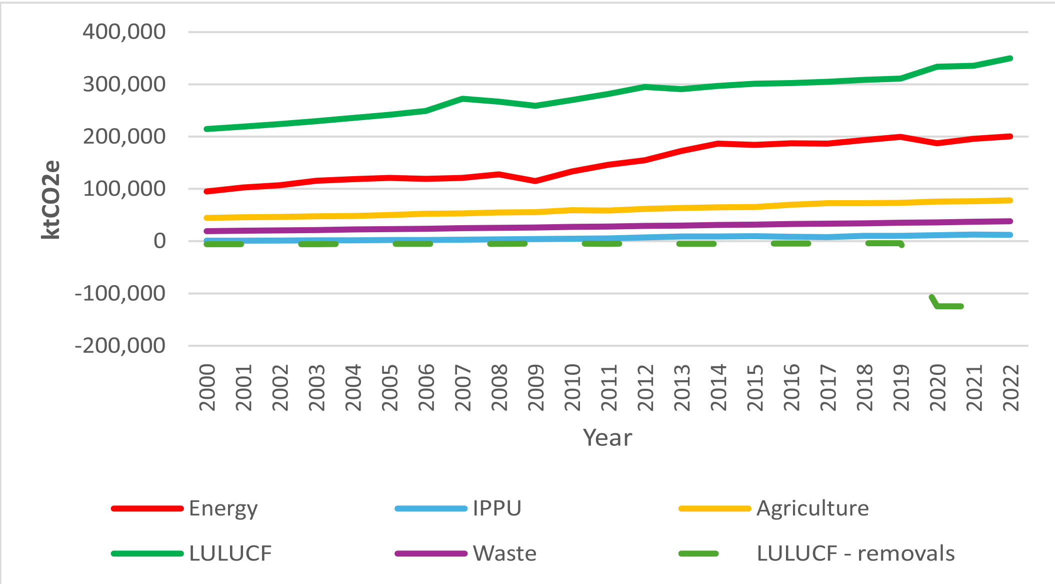

Figure 2.2. Trend of aggregated grossemissions by sector

Table 2.1. National emissions and removals (kt CO2 e) by sector for selected years

Year	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 to 2000 (% change)
Net emissions / removals	368,499	433,076	489,424	587,016	614,172	625,288	520,395	532,574	554,095	50%

Total Emissions	**374,312**	**438,306**	**494,123**	**591,704**	**618,388**	**629,459**	**644,701**	**657,254**	**678,270**	**81%**
Removals (LULUCF)	**-5,813**	**-5,230**	**-4,699**	**-4,688**	**-4,216**	**-4,171**	**-124,306**	**-124,681**	**-124,175**	**2036%**
Energy	95,092	120,975	133,222	184,062	193,347	199,402	187,325	195,685	200,422	111%
IPPU	1,150	2,000	4,775	9,791	9,977	10,183	11,410	12,619	12,044	947%
Agriculture	44,480	50,257	59,185	65,253	72,492	73,540	75,887	76,205	77,981	75%
LULUCF	214,488	242,045	269,853	300,965	308,357	311,167	333,955	335,669	349,774	63%
Waste	19,101	23,028	27,088	31,632	34,215	35,167	36,124	37,075	38,050	99%

The aggregated emissions by gas are given in Figure 2.3 while the share is provided in Figure 2.4. CO_2 dominated (around 70%) emissions throughout the full time series with 265,066 kt CO_2 e in 2000 and 486,458 kt CO_2e in 2022, representing an increase of 84%. CH_4increased by 75%, from 91,671 kt CO_2 e in 2000 to 160,368 kt CO_2 e in 2022. Similarly, N_2O emissions increased by 79% from 17,576 kt CO_2 e to 31,444 kt CO_2e.

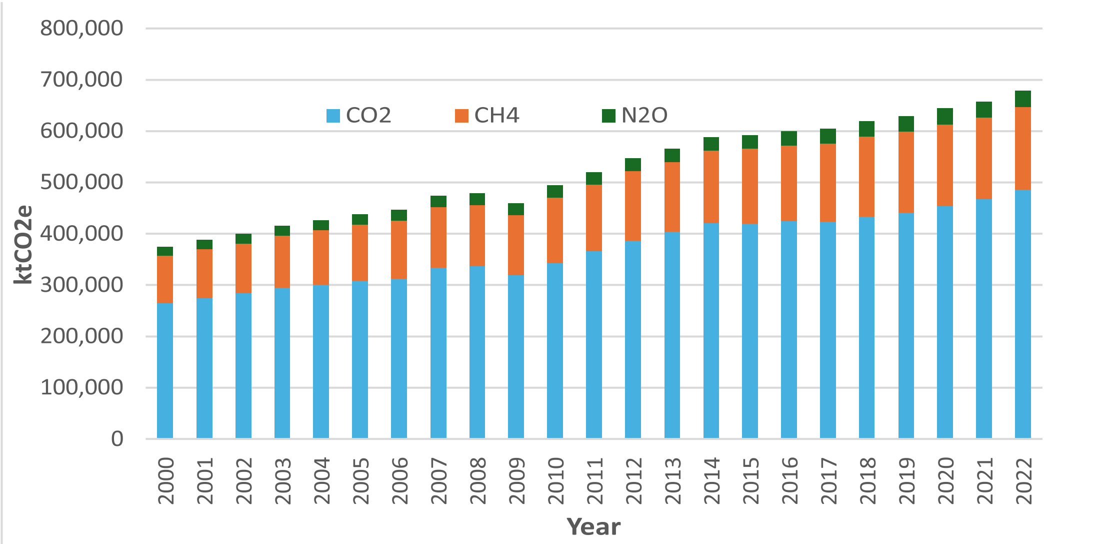

Figure 2.3. National aggregated emissions trends by gas

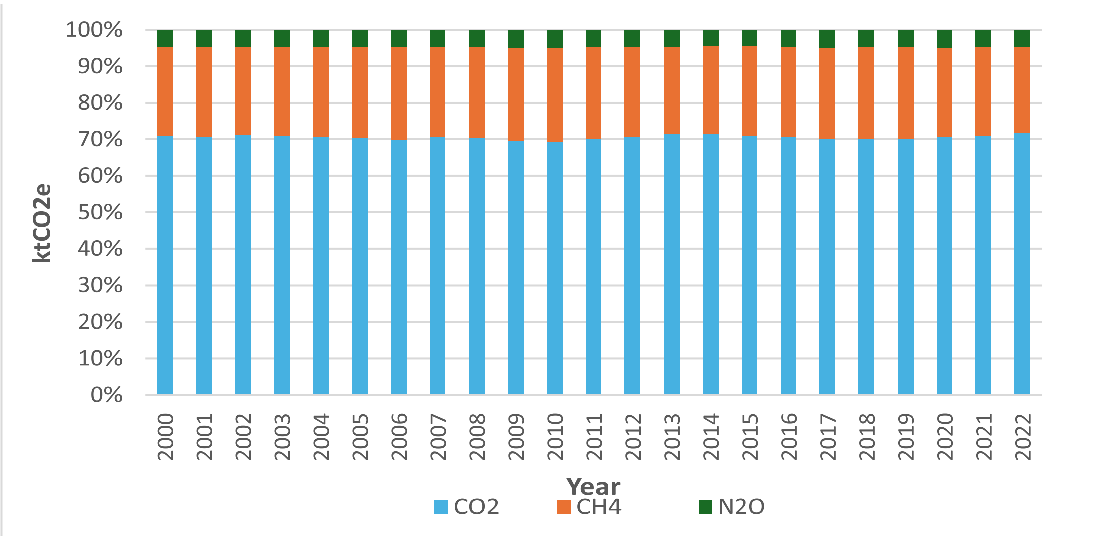

Figure 2.4. Share of aggregated emissions by gas

The absolute emissions by direct GHGs are provided in Figure 2.5. CO_2 emissions increased by 83% from 265,066 kt in 2000 to 486,458 kt in 2022. CH_4 increased from 3,274 kt in 2000 to 5,727 kt in 2022 and N_2O by 80% from 66 kt to 119 kt during the same period.

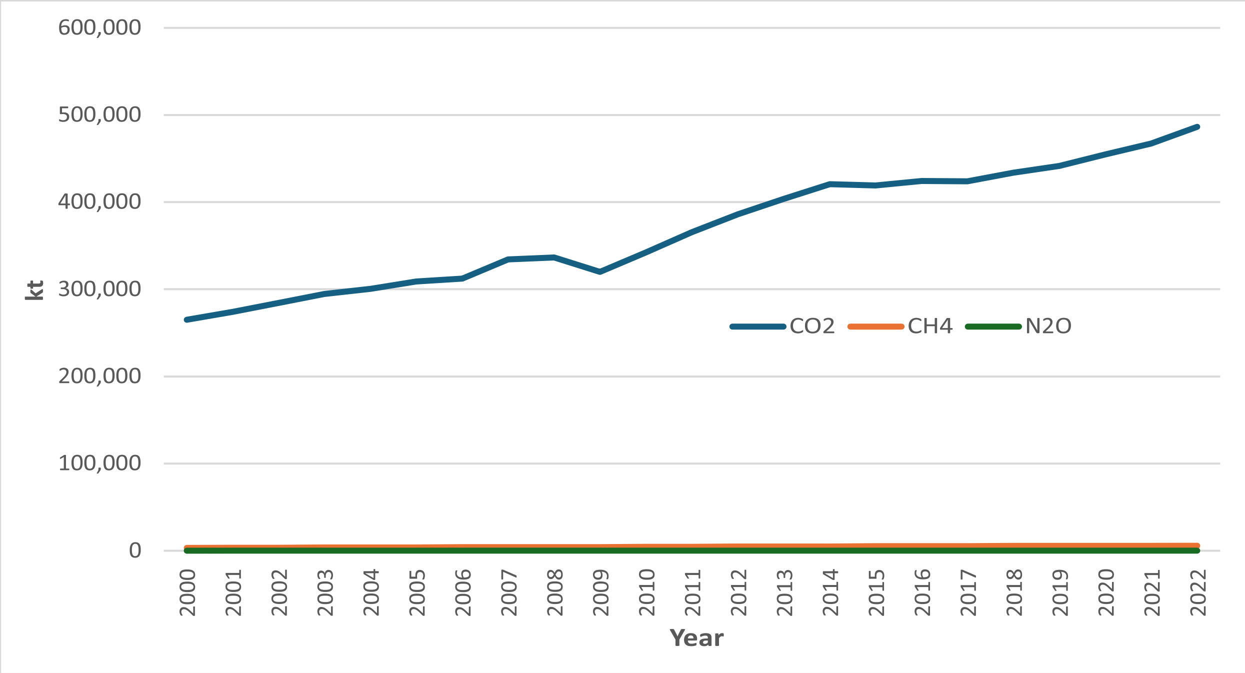

Figure 2.5. Trend of absolute emissions (kt) by gas

2.3. Indirect gases

Emissions of indirect GHGs are provided in Figure 2.6. Overall, CO emissions increased by 87% from 12,499 kt in 2000 to 23,414 kt in 2022. Over the same period, NOx increased from 1,406 kt to 4,213 kt (200%), NMVOC from 1,998 kt to 3,460 kt (73%) while SO2 increased from 1,626 kt to 5,235 kt (222%).

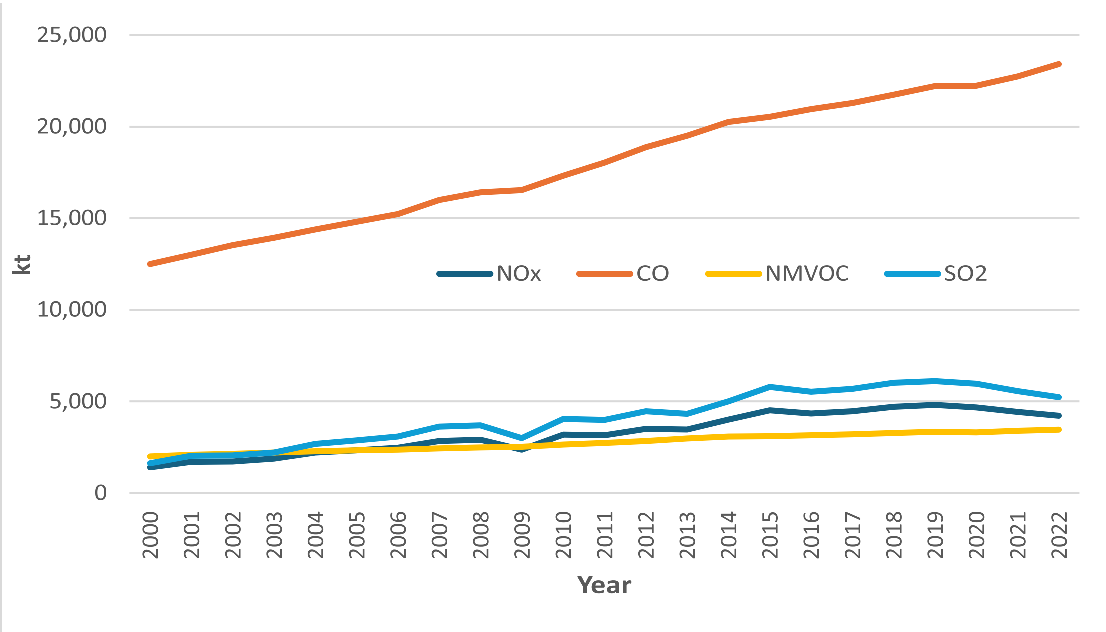

Figure 2.6. Trends of emissions of Indirect GHGs

Chapter 3. Energy (CRT sector 1)

3.1. Overview of the sector

The process of fuel combustion to generate heat used directly or to produce energy to drive mechanical and electrical systems releases the direct GHGs CO2, CH4 and N2O, the GHG precursors CO, NOx and NMVOCs, water and SO2. Extraction of hydrocarbons such as coal, oil and gas also releases the same direct GHGs, the precursors, water and SO2.

The activities within the Energy sector, leading to these emissions occur in the different segments of activities. Emissions are associated with energy production, processing for converting primary fuels into secondary fuels, transportation and storage as well as end products utilization. Fuel combustion activities is one of such end products utilization and involves both primary and secondary fuels. Upstream to these are extraction, refining, transportation and storage of primary and secondary hydrocarbons. The activities responsible for emissions are:

- Upstream exploration and exploitation of primary energy sources:
    - Emissions from exploration, mining and all related activities supporting the extraction processes, products storage and transportation.
    - Fugitive emissions resulting from processes such as flaring, venting and leakage from connecting and storage modules of crude oil and natural gas handling.
    - Fugitive emissions of methane during coal mining.
- Transformation of primary energy sources into more usable energy forms in refineries and power plants:
    - Emissions from flaring, cracking of crude oil into component fractions and any fuel combustion to support these activities. It also involves fuel combustions in power plants for steam, heat for use in electricity generation.
- Transmission and distribution of fuels:
    - Fuel combustion to generate electrical power for pipelines.
    - Fuel combustion in transport trucks / vessels.
    - Fugitive emissions during transmission and distribution.
- Use of fuels in stationary and mobile applications:
    - Fuel combustion in the transport sector. o On-site power generation plants.
    - Industrial use for heat generation and to power equipment.

Nigeria is a producer and exporter of crude oil, petroleum products and natural gas and produces coal for domestic use. Whenever local production cannot meet local demand, the country resort to importation to bridge the gap between demand and supply. The main secondary sources of liquid, biomass and gaseous fuels are diesel, gasoline, Liquefied Petroleum Gas (LPG), kerosene, Automotive Gas Oil (AGO) / Diesel, Aviation Turbine Kerosene (ATK), fuel wood, charcoal, bagasse, vegetable wastes, natural gas and household kerosene (HHK) amongst others. Natural gas is utilized for public power generation with diesel and Fuel Oil (FO) as back-up fuels as well as in industries for heat and own-use power generation. Transport fuels include gasoline and AGO / Diesel for road transportation, inland water navigation and railway, ATK for civil aviation and FO for international water navigation. Fuels consumed in the Commercial / Institutional and Residential sectors include HHK for cooking and lighting, LPG for cooking, gasoline and AGO / Diesel for auto-generation of electricity and biomass fuels (fuel wood and charcoal).

Emissions from the Energy Sector (CRT 1.A)

In 2022, the Energy sector emitted 200,422 kt CO2 e which represented 29.4% of Nigeria's total emissions (excluding removals from LULUCF). This represented more than a twofold increase from the Energy sector 2000 emissions of 95,092 kt CO2 e when the Energy sector contributed 25.3% of total emissions of the country. Except for 2009 and

2020 when a decrease in emissions were noted respectively, total emissions from the Energy Sector increased steadily during the period 2000 to 2022 period (Figure 3.1).

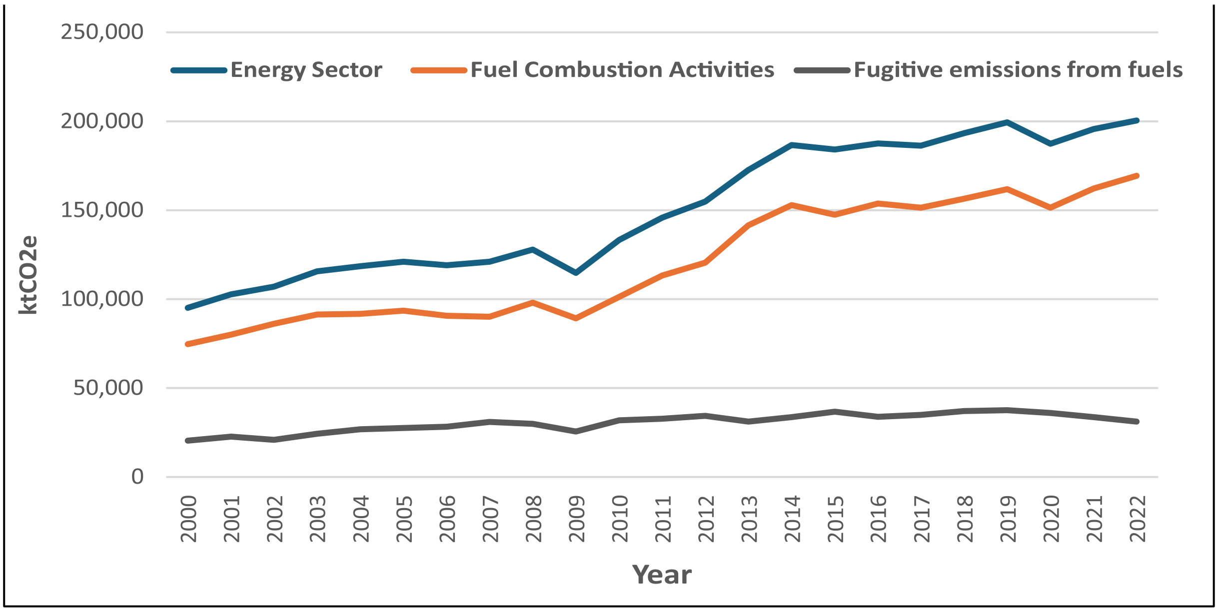

Figure 3.1. Trends of emissions (kt CO2 e) for the energy sector (2000-2022)

The trend of aggregated emissions by gas is given in Figure 3.2. CO2 and CH4 were the main contributors to emissions of the Energy sector. In 2000, they contributed 49,118 kt CO2 e and 42,667 kt CO2 e representing a share of 51.7% and 44.9% respectively. CO2 emissions plateaued between at an average of around 60,000 kt CO2 e up to 2009 and thereafter increased at a higher rate than CH4 to reach 123,840 kt CO2 e in 2022, representing an increase of 152.1% over the 2000 to 2022 period. On the other hand, CH4 emissions rose at a steadier, albeit lower rate, to reach 50,574 kt CO2 e in 2022, experiencing thus an increase of 65.4%.

Though N2O emissions increased from 3,307 kt CO2 e in 2000 to a level of 6,008 kt CO2 e in 2000, its contribution to total emissions decreased from 3.5% in 2000 to 3.0% in 2022.

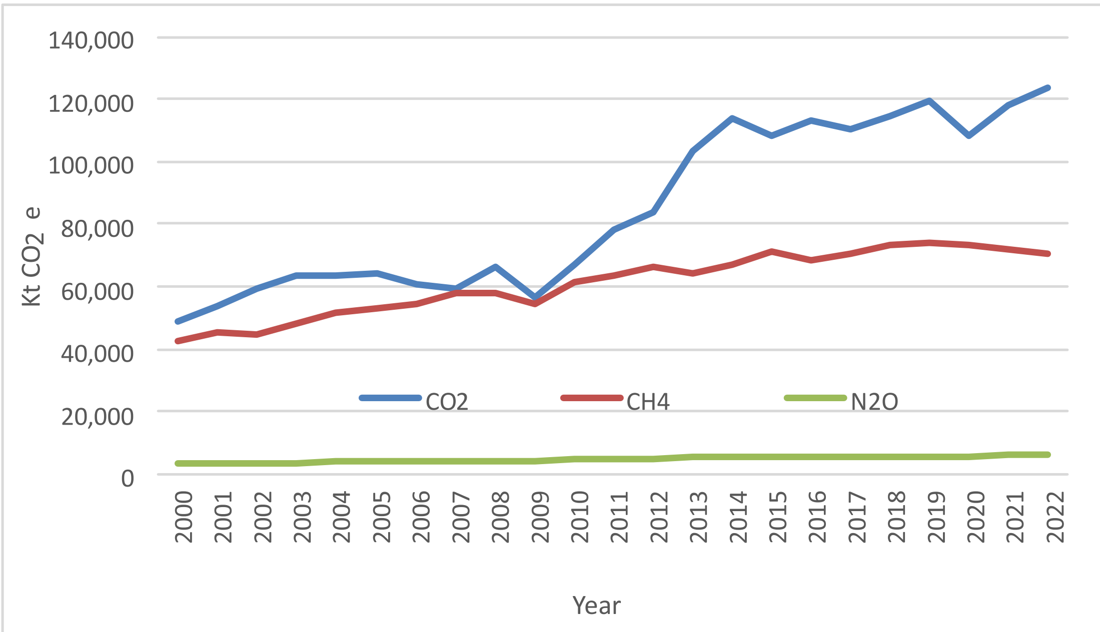

Figure 3.2. Aggregated emissions by gas for the Energy sector (2000-2022)

Emissions from the Energy sector originated from 2 subsectors, namely, Fuel Combustion Activities (CRT 1.A) and Fugitive emissions from fuels (CRT 1.B) (Table 3.1). Most of the emissions of the Energy sector occurred under Fuel Combustion Activities which emitted 169,326 kt CO2 e in 2022, accounting for 84.5% of emissions of the sector. This represented an increase in emission of 110.8% from the 2000 level of 74,679 kt CO2 e, when Fuel Combustion

Activities contributed 78.5% of emissions of the sector. The other subsector, Fugitive emissions, emitted 31,096 kt CO2 e in 2022, representing a 52.3% increase on the 20,413 kt CO2 e level of 2000.

Table 3.1. Emissions (kt CO2 e) of the Energy sector by sub sector for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1. Energy sector	95,092	120,975	133,222	184,062	193,347	199,402	187,325	195,685	200,422	111%
1.A Fuel Combustion Activities	74,679	93,514	101,290	147,391	156,336	161,859	151,360	162,122	169,326	127%
1.B - Fugitive emissions from fuels	20,413	27,461	31,932	36,672	37,011	37,543	35,964	33,563	31,096	52%

The methods and TIER levels adopted for all categories and sub-categories estimated in the Energy sector are given in Table 3.2. For the full time series, the IPCC Tier 1 methods of the 2006 Guidelines were adopted for all categories and supplemented with the EMEP/EEA version of 2023 for the indirect gases when IPCC guidelines did not provide a methodology. The basic equation used to estimate GHG emissions is given below:

Emissions GHG fuel = Fuel Consumption fuel x Emission Factor GHG fuel

Where

Emissions $_{GHG, fuel}$	= emissions of a given GHG by type of fuel (kg GHG)
Fuel Consumption $_{fuel}$	= amount of fuel combusted (TJ)
Emission Factor $_{GHG, fuel}$	= default emission factor of a given GHG by type of fuel (kg gas/TJ). For CO_2, it includes the carbon oxidation factor, assumed to be 1.

Table 3.2. Table Methodologies and TIER levels for Energy sector

Categories	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
1 - Energy							
1.A. Fuel combustion activities							
1.A.1. Energy industries							
1.A.1.a. Public electricity and heat production							
1.A.1.a.i. Electricity generation	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.1.b – Petrol refining	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.1.c - Manufacture of solid fuels and other energy industries							
1.A.1.c.iii – Other energy industries	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.2. Manufacturing Industries and construction							
1.A.2.a – Iron and steel	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.2.c – Chemicals	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.2.f - Non-metallic minerals	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1

1.A.2.g - Other							
1.A.2.g.viii - Other	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1

Categories	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
1.A.3. Transport							
1.A.3.a – Domestic aviation	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.3.b - Road transportation	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.3.c - Railways	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.3.d – Domestic navigation	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.3.e - Other transportation	NA	NA	NA	NA	NA	NA	NA
1.A.4. Other Sectors							
1.A.4.a - Commercial/institutional	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.4.b - Residential	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.4.c - Agriculture/forestry/fishing							
1.A.4.c.i - Stationary	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.4.c.ii - Off-road Vehicles and other machinery	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.A.5. Other							
1.A.5.a - Stationary	NA	NA	NA	NA	NA	NA	NA
1.A.5.b - Mobile	NA	NA	NA	NA	NA	NA	NA
1.B. Fugitive emissions from fuels							
1.B.1 - Solid Fuels							
1.B.1.a – Coal mining and handling							
1.B.1.a.ii – Surface mines							
1.B.1.a.ii.1 – Mining activities	DT1	DT1	NA	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.1.a.ii.2 – postmining activities	DT1	DT1	NA	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.1.b. Fuel transformation							
1.B.1.b.i -Charcoal and biochar production	NA	DT1	DT1	DT1	DT1	NE	NE
1.B.2. Oil and natural gas and other emissions from energy production							
1.B.2.a. Oil							
1.B.2.a.ii - Production and upgrading	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.a.iii - Transport	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.a.iv - Refining/ storage	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.a.v - Distribution of oil products	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.b - Natural gas							
1.B.2.b.ii - Production and gathering	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.b.iii - Processing	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1

1.B.2.b.iv – Transmission and storage	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.b.v - Distribution	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.c - Venting and flaring							
1.B.2.c.i - Venting							
Categories	**CO2**	**CH4**	**N2O**	**NOx**	**CO**	**NMVOCs**	**SO2**
1.B.2.c.i. 1 - Oil	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.c.i. 2 - Gas	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.c.ii - Flaring							
1.B.2.c.ii. 1 - Oil	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.B.2.c.ii. 2 - Gas	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
Categories	**CO2**	**CH4**	**N2O**	**NOx**	**CO**	**NMVOCs**	**SO2**
1.D. Memo Items							
1.D.1. International bunkers							
1.D.1.a. Aviation	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.D.1.b. Navigation	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
1.D.3. CO2 emissions from biomass	DT1	NA	NA	NA	NA	NA	NA

3.2. Fuel combustion activities (sectoral approach) (CRT 1.A)

Fuel combustion activities include emissions from the intentional oxidation of materials within an apparatus that is designed to raise heat and provide it either as heat or as mechanical work to a process or for use away from the apparatus.

Fuel combustion activities comprise 4 categories: Energy industries (CRT 1.A.1), Manufacturing industries & construction (CRT 1.A.2), Transport (CRT 1.A.3) and Other sectors (CRT 1.A.4).

Emissions from Fuel Combustion Activities (Table 3.3) increased by 127%, from 74,679 kt CO2 e in 2000 to 169,326 kt CO2 e in 2022.

The main contributors to the sub-sector Fuel Combustion Activities were Other sectors (CRT 1.A.4) and Transport (CRT 1.A.3). The contribution of the Other sectors category to the subsector decreased from 44.0% in 2000 to 36.3% in 2022, while the contribution of Transport increased from 28.7% to 34.9% during the same period.

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A - Fuel Combustion Activities	74,679	79,978	86,169	91,403	91,627	93,514	90,697	90,103	98,035
1.A.1 Energy industries	15,126	15,414	16,424	14,529	17,093	18,576	18,511	18,885	19,071
1.A.2 Manufacturing industries & construction	5,263	4,380	4,259	9,772	7,963	8,584	9,239	10,458	11,409
1.A.3 Transport	21,432	24,142	28,282	30,519	30,987	27,424	24,606	22,340	26,687
1.A.4 Other sectors	32,858	36,042	37,204	36,582	35,585	38,929	38,341	38,420	40,868

Category	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.A - Fuel Combustion Activities	89,263	101,290	113,219	120,434	141,425	152,896	147,391	153,683	151,354
1.A.1 Energy industries	16,993	21,033	24,338	26,166	26,630	29,524	29,921	31,386	29,464
1.A.2 Manufacturing industries & construction	6,618	9,879	15,079	16,044	18,769	20,594	19,660	15,303	14,130
1.A.3 Transport	24,975	30,509	32,535	35,875	46,467	51,022	46,390	53,172	53,212
1.A.4 Other sectors	40,678	39,869	41,266	42,349	49,559	51,756	51,419	53,823	54,548

Category	2018	2019	2020	2021	2022	2022 to 2000 (% change)
1.A - Fuel Combustion Activities	156,336	161,859	151,360	162,122	169,326	126.7%
1.A.1 Energy industries	29,864	29,363	29,989	29,498	33,792	123.4%
1.A.2 Manufacturing industries & construction	15,168	15,432	14,519	16,076	15,066	186.3%
1.A.3 Transport	56,818	60,761	52,009	58,948	59,045	175.5%
1.A.4 Other sectors	54,486	56,303	54,843	57,601	61,423	86.9%

Table 3.3. Emissions (kt CO2 e) Fuel Combustion Activities for period 2000 - 2022

3.2.1. Comparison of the sectoral approach with the reference approach

The Sectoral Approach (SA) is a bottom-up one where emissions are estimated for the different activities at the subcategory levels to be then aggregated to bring it to category, sub-sector and sector. It uses more granular data and is expected to better reflect emissions of the Energy sector. On the other hand, the top-down Reference Approach (RA) gives an overall estimate of CO_2 estimated for the different fuels before they are distributed and consumed in the different sectors.

Emissions under the RA and SA approaches for selected years are given in Table 3.4. Emissions increased over time under both approaches. The % difference varied between -40.9% and 37.7% for the selected years with lower differences noted for years 2005, 2019 and 2022.

Table 3.4. Comparison of emissions (kt CO2) from the RA and SA Approaches for selected years

Approach	2000	2005	2010	2019	2020	2021	2022		
Reference	28,357	66,853	85,602	133,170	132,997	128,119	147,754	160,147	118,462
Sectoral	48,011	63,089	66,036	106,829	113,573	118,311	107,307	117,188	122,988
Difference	-40.9%	6.0%	29.6%	24.7%	17.1%	8.3%	37.7%	36.7%	-3.7%

The difference (%) in fuels consumed and CO2 emissions from the RA has been estimated and compared with those of the SA (Figures 3.3 and 3.4). Positive as well as negative differences have been noted between the RA and SA approaches both for fuel consumption and CO2 emissions during the time series 1990 to 2022.

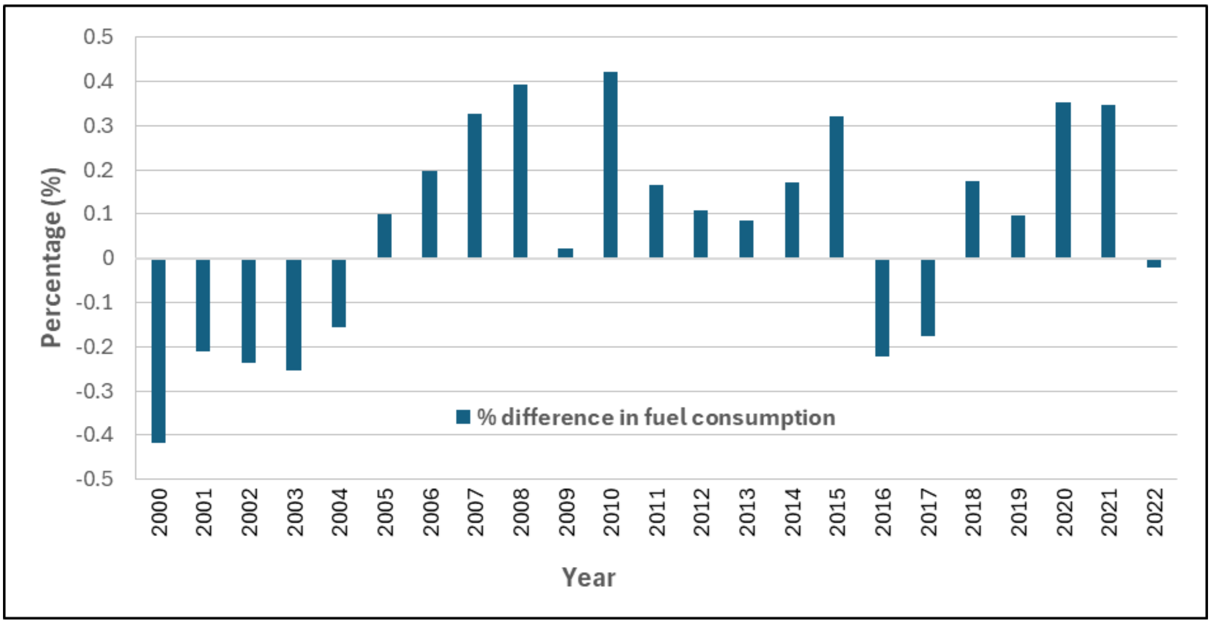

Figure 3.3. % difference between the RA and SA for fuel consumption

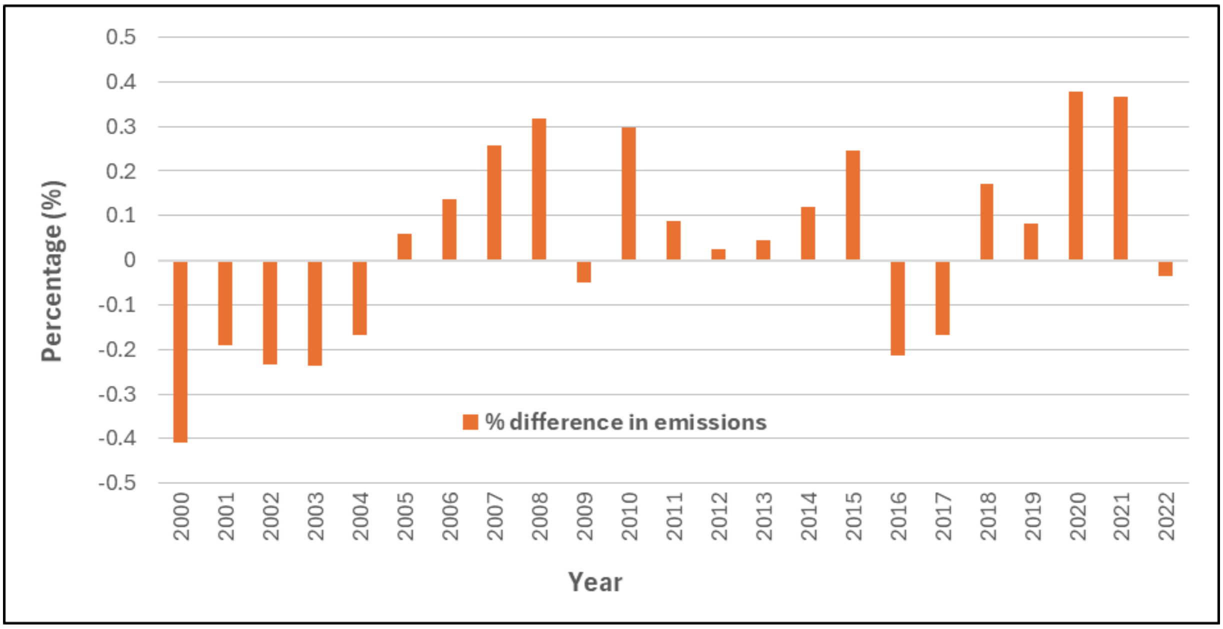

Figure 3.4. % difference between the RA and SA for CO2 emissions

3.2.2. International bunker fuels

Emissions from International bunkers increased from 1,807 kt CO2 e in 2000 to 2,803 in 2022 (+55%), with a peak at 3,118 kt CO2 e in 2018 (Figure 3.5). International aviation and International navigation were the two contributors to International bunkers.

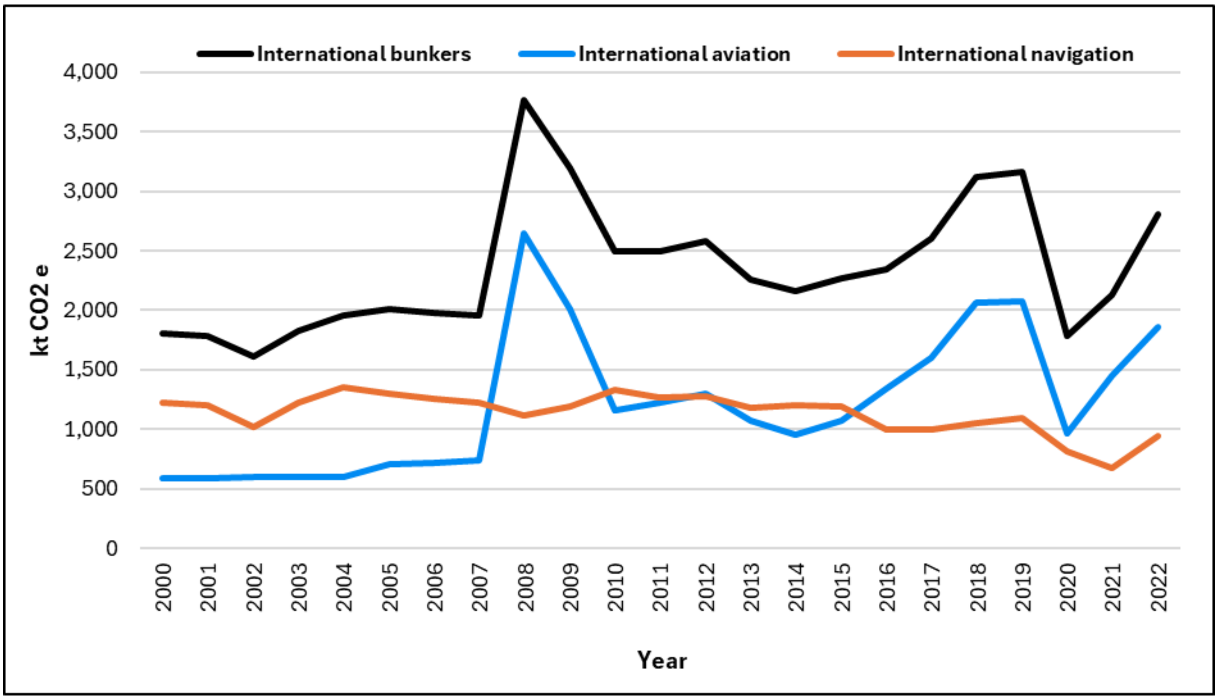

Figure 3.5. Emissions (kt CO2 e) of international bunkers (2001-2022)

The share of emissions of International aviation increased from 33% (588 kt CO2 e) in 2000 to 66% (1,863 kt CO2 e) in 2022, while the share of International navigation decreased from 67% (1,219 kt CO2 e) in 2000 to 34% (940 kt CO2 e) in 2022 (Table 3.5).

Table 3.5. Emissions (kt CO2 e) of international aviation and navigation bunkering (2000-2022)

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
International bunkers	1,807	1,788	1,617	1,826	1,953	2,010	1,975	1,956	3,764
Aviation	588	591	594	597	600	709	715	734	2,647
Navigation	1,219	1,197	1,022	1,229	1,353	1,302	1,261	1,222	1,118
Category	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
International bunkers	3,196	2,490	2,490	2,579	2,255	2,157	2,268	2,341	2,605
Aviation	2,008	1,156	1,220	1,296	1,077	959	1,077	1,347	1,604
Navigation	1,188	1,334	1,270	1,283	1,178	1,197	1,191	994	1,001
Category	**2018**	**2019**	**2020**	**2021**	**2022**	**2022 to 2000 (% change)**			
International bunkers	3,118	3,162	1,781	2,128	2,803	55.1%			
Aviation	2,066	2,073	964	1,450	1,863	217.0%			
Navigation	1,051	1,089	817	678	940	-22.9%			

Activity Data used for International bunkers are provided at Table 3.6.

Table 3.6. Activity Data used for International bunkers (2000-2022)

Category	Fuel (kt)	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.D.1 - International bunkers										

Category	Fuel (kt)									
1.D.1.a - Aviation Jet kerosene		185	186	187	188	189	223	225	231	833
1.D.1.b - Navigation	Diesel	119	117	100	120	132	127	123	119	109
	RFO	265	260	222	267	294	283	274	266	243

Category	Fuel (kt)	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.D.1 - International bunkers										
1.D.1.a - Aviation Jet kerosene		632	364	384	408	339	302	339	424	505
1.D.1.b - Navigation	Diesel	116	130	124	125	115	117	116	97	98
	RFO	258	290	276	279	256	260	259	216	218

Category	Fuel (kt)	2018	2019	2020	2021	2022	2022 to 2000 (% change)
1.D.1 - International bunkers							
1.D.1.a - Aviation Jet kerosene		505	650	652	303	456	146.7%
1.D.1.b - Navigation	Diesel	98	103	106	80	66	-44.4%
	RFO	218	228	237	177	147	-44.4%

EFs used for direct and indirect gases for estimating emissions from International bunkering are provided at Table 3.7.

Table 3.7. Emission Factors used for estimating international bunkering emissions Direct gases

Sub-category - International bunkers	Fuel type	Emission Factor (kg/TJ)			Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2/Chapter 3 - Mobile Combustion
		CO_2	CH_4	N_2O	
Aviation	Jet Kerosene	71,500	0.5	2	Tables 3.6.4 and 3.6.5
	Diesel	74,100	7	2	Tables 3.5.2 and 3.5.3
	RFO	77,400	7	2	" "

Indirect gases

Sub-category - International bunkers	Fuel type	Emission Factor (kg/ton fuel)				Source: EMEP/EEA emission inventory guidebook 2013 and 2023
		NOx	CO	NMVOC	SO_2	
Aviation	Jet Kerosene[1]	12.8	1.1	0.5	1	1.A.3. a, 1.A.5.b - Aviation, Table 3-3
Navigation	Diesel	72.2	3.84	1.75	1.82	1.A.3. d - Navigation Shipping, Table 3-2
	RFO	69.1	3.67	1.67	19.2	1.A.3. d - Navigation Shipping, Table 3-1

Note 1: EF for jet kerosene obtained from EMEP/EEA Guidebook 2013

3.2.3. Feedstocks and non-energy use of fuels

Natural gas was by far the predominant fuel among the products accounted as Feedstocks and non-energy use of fuels. The amount of natural gas used as Feedstocks and non-energy use of fuels decreased by 13% from 100,139 kt in 2018 to 86,809 in 2022 (Table 3.8).

Table 3.8. Amount of products (kt) accounted as Feedstocks and non-energy use of fuels (2000-2022)

Fuel (kt)	2000	2001	2002	2003	2004	2005	2006	2007	2008
Diesel	0	0	0	0	0	19	1	11	9
Naphta	357	357	413	403	0	509	130	220	408

Bitumen	0	0	0	3	0	42	0	0	22
Refinery gas	58	58	111	28	15	98	28	13	49
Natural gas	30,821	53,049	57,991	45,964	58,195	57,783	53,358	45,265	31,465
Fuel (kt)	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Diesel	1	55	56	47	47	1	80	11	11
Naphta	200	937	780	375	375	559	310	475	475
Bitumen	0	11	33	23	23	5	15	7	7
Refinery gas	19	12	18	0	0	68	0	0	61
Natural gas	51,474	31,678	48,980	63,775	53,853	50,773	53,853	133,240	108,904

Fuel (kt)	**2018**	**2019**	**2020**	**2021**	**2022**
Diesel	38	38	38	38	38
Naphta	535	535	535	535	535
Bitumen	15	15	15	15	15
Refinery gas	40	40	40	40	40
Natural gas	100,139	101,816	99,622	92,724	86,809

3.2.4. Energy industries (CRT 1.A.1.)

3.2.4.1. Category description

The Energy Industries category (CRT 1.A.1) comprises emissions from fuels combusted by the fuel extraction or energy-producing industries.

Energy industries comprise 3 subcategories, namely, Public electricity and heat production (CRT 1.A.1.a), Petroleum refining (CRT 1.A.1.b) and Manufacture of solid fuels and other energy industries (CRT 1.A.1.c).

Public electricity and heat production and Manufacture of solid fuels and other energy industries together contributed 90.9 % of emissions in 2000 and 97 % in 2022 (Figure 3.6).

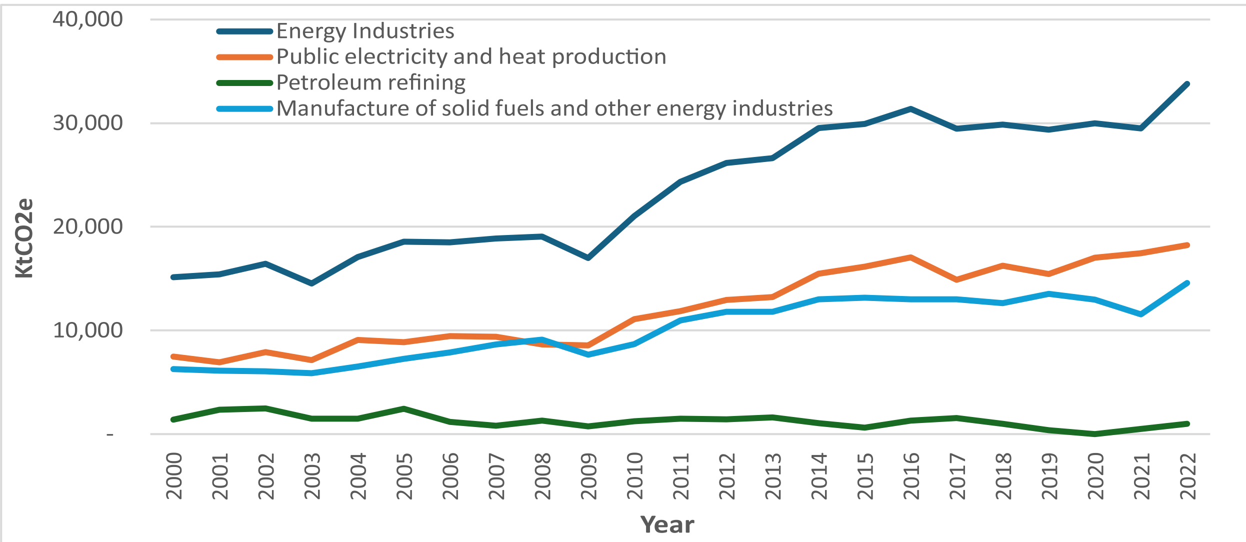

Figure 3.6. Trend of emissions (kt CO2 e) by sub-category for Energy Industries (2000-2022)

Emissions from Energy Industries increased by 123% during the review period, that is, from 15,126 kt CO2 e in 2000 to 33,792 kt CO2 e in 2022 (Table 3.9).

Emissions from Energy consisted almost totally of CO2, which represented a share of 99.9% of aggregated emissions during the period under review (Figure 3.7).

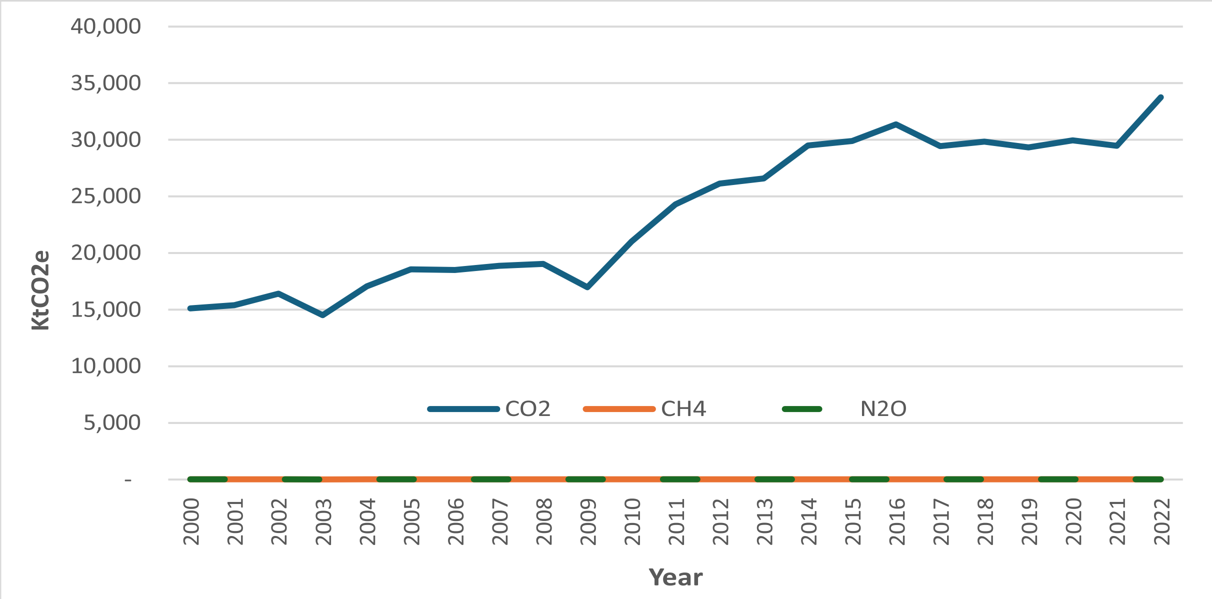

Figure 3.7. Trend of emissions (kt CO2 e) by gas for Energy Industries (2000-2022)

Public electricity and heat production (CRT 1.A.1.a)

Public electricity and heat production (CRT 1.A.1.a) sums up emissions from electricity generation, combined heat and power generation, and heat plants.

Emissions from Public electricity and heat production increased by 144 %, from 7,467 kt CO2 e in 2000 to 18,231 kt CO2 e in 2022 (Table 3.9).

Petroleum refining (CRT 1.A.1.b)

Petroleum refining includes all combustion activities supporting the refining of petroleum products including on-site combustion for the generation of electricity and heat for own use. Does not include evaporative emissions occurring at the refinery.

Emissions from Petroleum refining decreased by 29.0%, from 1,380 kt CO2 e in 2000 to 979 kt CO2 e in 2022 (Table 3.9).

Manufacture of solid fuels and other energy industries (CRT 1.A.1.c)

Manufacture of solid fuels and other energy industries includes combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal.

Emissions from Manufacture of solid fuels and other energy industries increased by 132.2%, from 6,279 kt CO2 e in 2000 to 14,581 kt CO2 e in 2022 (Table 3.9).

Table 3.9. Emissions (kt CO2 e) for Energy Industries (2000-2022)

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.A.1 - Energy Industries	15,126	15,414	16,424	14,529	17,093	18,576	18,511	18,885	19,071
1.A.1.a - Public electricity and heat production	7,467	6,928	7,901	7,152	9,078	8,856	9,460	9,406	8,642
1.A.1.b - Petroleum refining	1,380	2,359	2,477	1,503	1,489	2,459	1,186	815	1,317

1.A.1.c - Manufacture of solid fuels and other energy industries	6,279	6,126	6,045	5,875	6,525	7,261	7,865	8,664	9,113

Category	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.A.1 - Energy Industries	16,993	21,033	24,338	26,166	26,630	29,524	29,921	31,386	29,464
1.A.1.a - Public electricity and heat production	8,562	11,089	11,877	12,942	13,228	15,480	16,141	17,062	14,890
1.A.1.b - Petroleum refining	754	1,252	1,479	1,418	1,609	1,044	624	1,305	1,563
1.A.1.c - Manufacture of solid fuels and other energy industries	7,676	8,693	10,982	11,806	11,792	12,999	13,157	13,019	13,011

Category	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1.A.1 - Energy Industries	29,864	29,363	29,989	29,498	33,792	123.4%
1.A.1.a - Public electricity and heat production	16,234	15,459	17,025	17,441	18,231	144.1%
1.A.1.b - Petroleum refining	990	385	0	513	979	-29.0%
1.A.1.c - Manufacture of solid fuels and other energy industries	12,640	13,519	12,963	11,543	14,581	132.2%

3.2.4.2. Methodological issues

The chosen method is Tier 1 level based on the applicable decision tree from the IPCC 2006 guidelines using national AD from international databases and default EFs from the 2006 IPCC guidelines for all sub-categories falling under Energy Industries.

Activity Data

Public electricity and heat production (CRT 1.A.1.a)

Activity Data used for Electricity Generation are provided at Table 3.10.

Table 3.10. Activity Data used for Electricity Generation (2000-2022)

Natural gas (TJ)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	44,821	69,315	128,799	136,052	210,122	354,138	423,645	511,894
BTR1 - NID1	132,977	123,382	140,704	127,360	161,670	157,710	168,470	167,510

Year	2008	2009	2010	2011	2012	2013	2014	2015
BUR2 - NIR1	553,522	572,294	591,066	597,788	637,641	495,530	599,366	774,318

BTR1 - NID1	153,890	152,480	197,470	211,510	230,470	235,570	275,672	287,437
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	803,360	848,606	-	-	-	-	-	-
BTR1 - NID1	303,833	265,166	289,095	275,293	303,189	310,597	324,659	-

Petroleum refining (CRT 1.A.1.b)

Activity Data used for Petrol Refining are provided at Table 3.11.

Table 3.11. Activity Data used for Petrol Refining (2000-2022)

Diesel (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	63	80	88	27	16	19	22	27
BTR1 - NID1	63	80	88	27	3	19	22	27
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	30	11	27	46	20	44	25	14
BTR1 - NID1	30	11	27	46	20	44	25	14
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	27	35	-	-	-	-	-	-
BTR1 - NID1	27	35	20	4	0	12	20	-

Residual fuel oil (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	218	350	336	262	144	439	226	137
BTR1 - NID1	218	350	336	262	289	439	226	137
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	256	161	289	298	317	326	226	123
BTR1 - NID1	256	161	289	298	317	326	226	123
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	227	300						-
BTR1 - NID1	227	300	169	34	0	102	168	-

LPG (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	22	34	31	10	6	22	3	2
BTR1 - NID1	22	34	31	10	17	22	10	2
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	35	5	12	22	19	33	11	7
BTR1 - NID1	39	5	12	22	19	33	11	7
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	20	26	-	-	-	-	-	-

BTR1 - NID1	20	26	15	3	0	9	15	-

Petroleum coke (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	11	66	90	36	34	43	5	0
BTR1 - NID1	11	66	90	36	19	43	5	0
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	7	6	3	1	1	2	10	8
BTR1 - NID1	7	6	3	1	1	2	10	8
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	9	12	-	-	-	-	-	-
BTR1 - NID1	9	12	7	1	0	4	7	-

Refinery gas (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	125	214	239	135	201	258	100	76
BTR1 - NID1	125	214	239	135	137	258	100	76
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	69	35	50	79	65	72	34	16
BTR1 - NID1	69	35	50	79	65	72	34	16
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	36	48	-	-	-	-	-	-
BTR1 - NID1	36	48	27	5	0	16	27	-

Natural gas (TJ)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	661	1,485	1,450	1,157	1,262	1,472	1,349	1,349
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	1,472	1,419	1,261	1,839	2,032	2,415	1,671	1,805
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BTR1 - NID1	5,628	4,600	4,511	4,191	0	1,257	4,434	-

Manufacture of solid fuels and other energy industries (CRT 1.A.1.c)

Activity Data used for Manufacture of solid fuels and other energy industries are provided at Table 3.12.

Table 3.12. Activity Data used for other energy industries (2000-2022))

Natural gas (TJ)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	79,941	95,874	73,299	67,527	72,930	85,780	78,296	78,018
BTR1 - NID1	111,819	109,095	107,658	104,617	116,198	129,305	140,058	154,285
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	81,973	82,147	73,644	106,582	117,935	131,032	157,384	162,298
BTR1 - NID1	162,277	136,702	154,802	195,564	210,247	209,996	231,495	234,292
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	150,319	145,156	-	-	-	-	-	-

BTR1 - NID1	231,835	231,694	225,096	240,744	230,852	205,555	259,666	-

<u>Emission Factors</u>

Emission Factors used for direct gases in the Energy Industries category are provided at Table 3.13.

Table 3.13. Emission Factors used for direct gases in the Energy Industries category

Sub-category	Fuel type	Emission Factor (kg/TJ)			Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/Volume 2/Chapter 2 - Stationary Combustion
		CO2	CH4	N2O	
Electricity generation Petroleum refining Other energy industries	Diesel	74,100	3	0.6	Table 2.2
	LPG	63,100	1	0.1	" "
	RFO	77,400	3	0.6	" "
	Petroleum coke	97,500	3	0.6	" "
	Refinery gas	57,600	1	0.1	" "
	Natural gas	56,100	1	0.1	" "

Emission Factors used for indirect gases in the Energy Industries category are provided at Table 3.14.

Table 3.14. Emission Factors used for indirect gases in the Energy Industries category

Sub-category	Fuel type	Emission Factor (g/GJ)				Source: EMEP/EEA air pollutant emission inventory guidebook 2023, 1.A.1 - Energy Industries
		NOx	CO	NMVOC	SO2	
Electricity generation	Natural gas	89	39	2.6	0.281	Table 3.4
Petroleum refining	All fuels	5.24	1.29	NA	8.87	Table 4.2
Other energy industries	Natural gas	89	39	2.6	0.281	Table 3.4

No CO2 was captured and stored.

3.2.4.3. Description of any flexibility applied

Not Applicable

3.2.4.4. Uncertainty assessment and time-series consistency

The uncertainties assigned to the AD (Table 3.15) are ±0.2% and the ranges, -5.33% to +6.14% for CO2, -70% to +200% for CH4 and N2O, from the IPCC 2006 guidelines for the EFs, given that they are the default values that have been used.

Table 3.15. Uncertainty levels assigned for the Energy Industries

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
1.A.1 - Energy Industries			
1.A.1.a.i - Electricity generation - Gaseous fuels	CO2	±2	-3.21 to +3.92
	CH4	±2	-70 to +200
	N2O	±2	-70 to +200
1.A.1.b - Petroleum refining - Liquid fuels	CO2	±2	-5.33 to +6.14
	CH4	±2	-67.12 to +228.79
	N2O	±2	-67.12 to +228.79

1.A.1.b - Petroleum refining - Gaseous fuel	CO2	±2	-3.21 to +3.92
	CH4	±2	-70 to +200
	N2O	±2	-70 to +200
1.A.1.c.iii -Other energy industries - Gaseous fuels	CO2	±2	-3.21 to +3.92
	CH4	±2	-70 to +200
	N2O	±2	-70 to +200

1: Source - 2006 Guidelines, Table 2.15, Page 2.41, Chapter 2, Volume 2.

2: Source - Tier 1 default values which are in line with 2006 Guidelines are taken from the IPCC GHG inventory software, version 2.93.

The combined uncertainties determined using the tool developed in Excel worksheet in line with the methods contained in the IPCC 2006 guidelines are provided in Table 3.16 for this category. The level assessment uncertainties for the base year 2000 and year-t (2022) are 2.9% and 3.0% while the trend assessment with 2000 as base year and 2022 as year-t is 4.5%.

Table 3.16. Uncertainty assessment for the Energy Industries

A	B	C	D	E	F	H	H	M
2006 IPCC Categories	**Gas**	**Base Year (2000) emissions or removals (Gg CO2 equivalent)**	**Year T (2022) emissions or removals (Gg CO2 equivalent)**	**Activity Data Uncertainty (%)**	**Emission Factor Uncertainty (%)**	**Contribution to Variance by Category in Year 2000**	**Contribution to Variance by Category in Year 2022**	**Uncertainty introduced into the trend in total national emissions (%)**
1.A.1 - Energy Industries								
1.A.1.a.i - Electricity Generation - Gaseous Fuels	CO2	7,460.0	18,213.4	2.0	3.9	4.7	5.6	11.8
1.A.1.a.i - Electricity Generation - Gaseous Fuels	CH4	3.7	9.1	2.0	200.0	0.0	0.0	0.0
1.A.1.a.i - Electricity Generation - Gaseous Fuels	N2O	3.5	8.6	2.0	200.0	0.0	0.0	0.0
1.A.1.b - Petroleum Refining - Gaseous Fuels	CO2	37.1	248.7	2.0	6.1	0.0	0.0	0.0
1.A.1.b - Petroleum Refining - Gaseous Fuels	CH4	0.0	0.1	2.0	228.8	0.0	0.0	0.0
1.A.1.b - Petroleum Refining - Gaseous Fuels	N2O	0.0	1.2	2.0	228.8	0.0	0.0	0.0
1.A.1.b - Petroleum Refining - Liquid Fuels	CO2	1,339.3	728.5	2.0	3.9	0.3	0.0	0.9
1.A.1.b - Petroleum Refining - Liquid Fuels	CH4	1.2	0.7	2.0	200.0	0.0	0.0	0.0
A	**B**	**C**	**D**	**E**	**F**	**H**	**H**	**M**
2006 IPCC Categories	**Gas**	**Base Year (2000) emissions or removals (Gg CO2 equivalent)**	**Year T (2022) emissions or removals (Gg CO2 equivalent)**	**Activity Data Uncertainty (%)**	**Emission Factor Uncertainty (%)**	**Contribution to Variance by Category in Year 2000**	**Contribution to Variance by Category in Year 2022**	**Uncertainty introduced into the trend in total national emissions (%)**
1.A.1.b - Petroleum Refining - Liquid Fuels	N2O	2.1	1.3	2.0	200.0	0.0	0.0	0.0
1.A.1.c.iii - Other Energy Industries - Gaseous Fuels	CO2	6,273.0	14,567.3	2.0	3.9	3.3	3.6	7.4
1.A.1.c.iii - Other Energy Industries - Gaseous Fuels	CH4	3.1	7.3	2.0	200.0	0.0	0.0	0.0
1.A.1.c.iii - Other Energy Industries - Gaseous Fuels	N2O	3.0	6.9	2.0	200.0	0.0	0.0	0.0

Sum	15,126.1	33,793.0	Sum	8.4	9.3	20.1
Uncertainty in level (L) and trend (T) assessment				**L - 2.9**	**L - 3.0**	**T - 4.5**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series

3.2.4.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, AD from the energy balance, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations, reference material and conversion factors. Quality Assurance during the estimation steps was done by independent international experts

3.2.4.6. Category-specific recalculations

Recalculations were performed for all years of the period 2000 to 2017 because of changes in the datasets for subcategories as applicable (Refer to AD provided above) and in methodology when considering the 2019 Refinements, namely transfer of charcoal production from Energy industries to Fuel transformation under the Fugitive emissions subsector. This resulted in either an increase or decrease in the emissions, within the range -49% to +72% (Table 3.17).

Table 3.17. Comparison of previous and recalculated emissions (kt CO2 e) for Energy Industries

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	8,811	12,022	14,227	13,367	17,613	27,595	29,820	34,409	37,454	38,008	39,087	41,530
BTR1 - NID1	15,126	15,414	16,424	14,529	17,093	18,576	18,511	18,885	19,071	16,993	21,033	24,338
% change	72	28	15	9	-3	-33	-38	-45	-49	-55	-46	-41

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	-
BUR2 - NIR1	44,344	37,304	44,099	53,789	55,231	57,813	-	-	-	-	-	-
BTR1 - NID1	26,166	26,630	29,524	29,921	31,386	29,464	29,864	29,363	29,989	29,498	33,792	-
% change	-41	-29	-33	-44	-43	-49	-	-	-	-	-	-

3.2.4.7. Category-specific planned improvements

Electricity generation under Energy Industries (Gaseous Fuels) is a key category and need to be addressed at the Tier 2 level. However, there are 3 sub-categories contributing to the category being a key one. It is felt that an in-depth analysis of results must be done to guide which sub-category is responsible for making the category a key one before addressing it. Hence, due to limited resources, the improvement will consist in conducting the deeper analysis by 2026 and then addressing the particular sub-category by 2028.

3.2.5. Manufacturing industries and construction (CRT 1.A.2)

3.2.5.1. Category description

Emissions from Manufacturing industries and construction originate from combustion of fuels in industry and also includes combustion for the generation of electricity and heat for own use in these industries.

In Nigeria, the activities contributing to emissions from Manufacturing industries and construction are Iron and steel (CRT 1.A.2.a), Chemicals (CRT 1.A.2.c), Non-metallic minerals (CRT 1.A.2.f) and Other (CRT 1.A.2.g.viii).

The trend of emissions from Manufacturing industries and construction is given in Figure 3.8. Generally, emissions increased over the time series with ups and downs, especially in the Other sub-category.

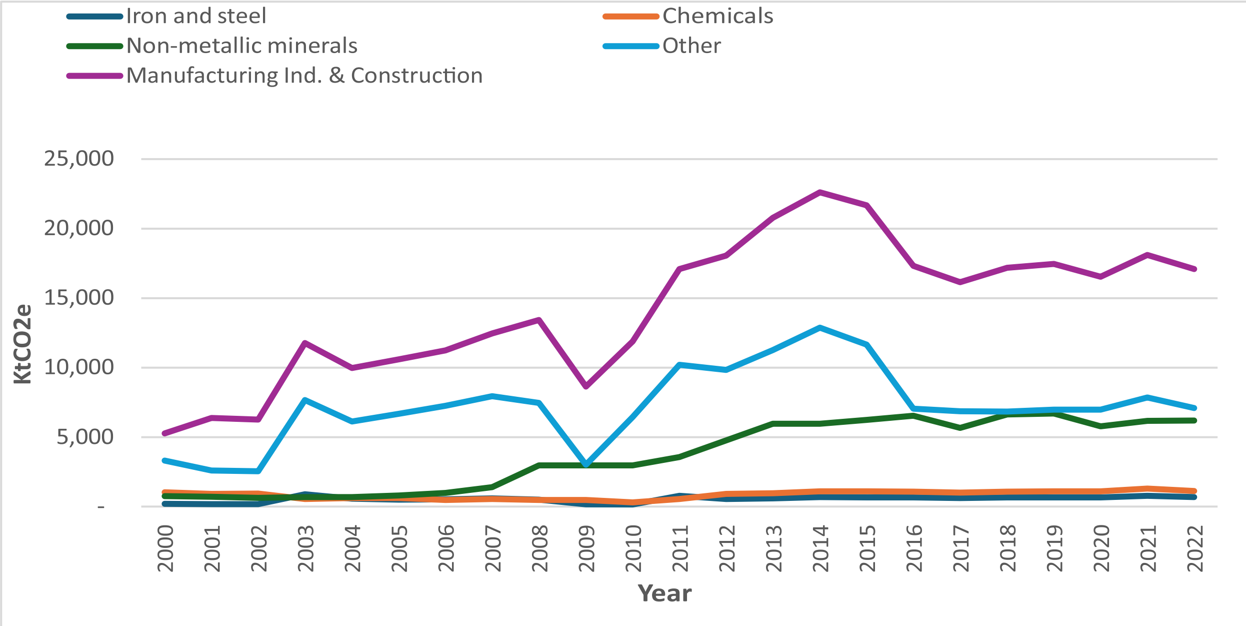

Figure 3.8. Trend of emissions (kt CO2 e) by sub-category from Manufacturing Industries and Construction (20002022)

Emissions increased by 186.3%, rising from 5,263 kt CO2 e in 2000 to 16,076 kt CO2 e in 2022 (Table 3.18). In 2000, Chemicals, Non-metallic minerals and Other accounted for 96.6% emissions from Manufacturing industries and construction. However, with the share of Chemicals falling from 19.5% in 2000 to 7.4% in 2022, emissions for the category originated mainly from Non-metallic minerals and Other in 2022. These 2 subcategories accounted together for 88.1% of emissions (Figure 3.8 and Table 3.18) in 2022.

Table 3.18. Emissions (kt CO2 e) for Manufacturing Industries and Construction for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1.A.2 - Manufacturing industries and construction	5,263	8,584	9,879	19,660	15,168	15,432	14,519	16,076	15,066	186%
1.A.2.a - Iron and	190	501	162	667	651	665	669	784	677	256% steel
1.A.2.c - Chemicals	1,024	604	300	1,101	1,074	1,098	1,104	1,294	1,117	9%
1.A.2.f - Nonmetallic minerals	742	804	2,972	6,244	6,617	6,693	5,780	6,160	6,180	732%
1.A.1.g.viii - Other	3,306	6,676	6,445	11,649	6,827	6,976	6,966	7,837	7,093	115%

CO2 was by far the gas which contributed most in aggregated emissions, though its share decreased from 96.7% in 2000 to 85.8% in 2022 (Figure 3.9).

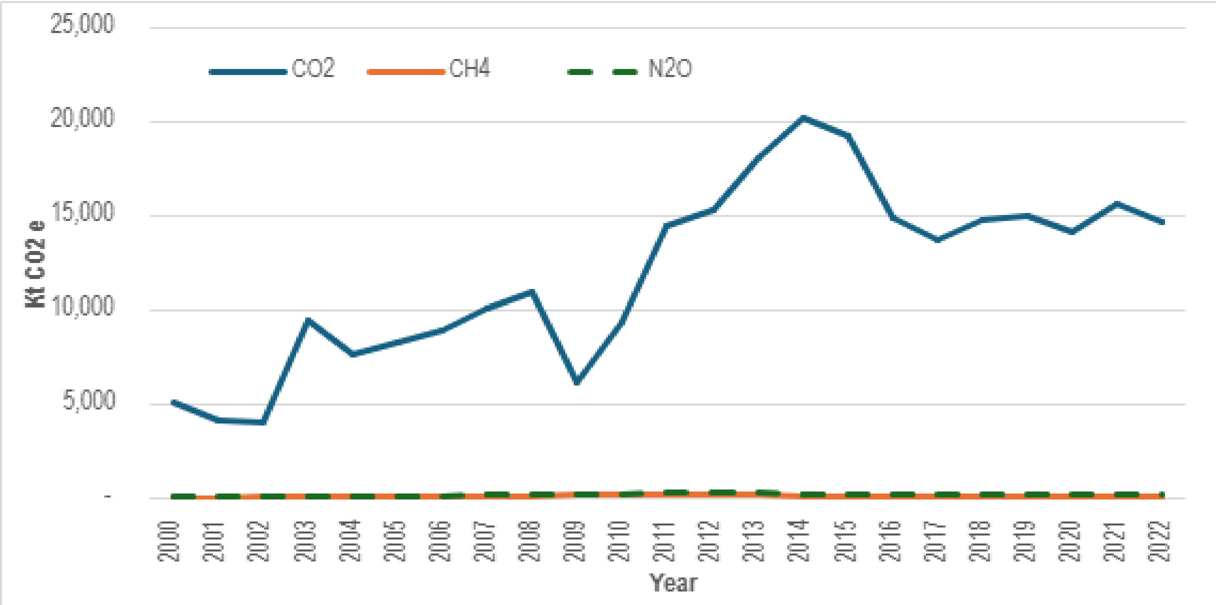

Figure 3.9. Trend of emissions (kt CO2 e) by gas for Manufacturing Industries and Construction (2000-2022)

Iron and steel (CRT 1.A.2.a)

Emissions from Iron and steel increased from 190 kt CO2 e in 2000 to 677 kt CO2 e in 2022, representing a 256% increase (Table 3.18). The emissions exhibited some ups and downs with a peak at 885 kt CO2 e in 2003 and a trough at around 160 kt CO2 e in 2010 and 2011 (Figure 3.8).

Non-ferrous metals (CRT 1.A.2.b)

Included Elsewhere. Fuels under this sub-category are allocated to Manufacturing industries and construction and burned under Other-Non specified.

Chemicals (CRT 1.A.2.c)

In absolute terms, emissions from Chemicals increased slightly by 9.0%, from 1,024 kt CO2 e in 2000 to 1,117 kt CO2 e in 2022 (Table 3.18). However, there was an initial tendency for a decrease from 2000 to 2010 and thereafter, emissions were on an increasing trend (Figure 3.8).

Emissions from Non-metallic minerals increased 8.3-fold, from 742 kt CO2 e in 2000 to 6,180 kt CO2 e in 2022 (Table 3.18). Except for 2017 and 2020 when there was a drop, emissions increased steadily during the period under review (Figure 3.8).

Pulp, paper and print (CRT 1.A.2.d)

Included Elsewhere. Fuels under this sub-category are allocated to Manufacturing industries and construction and burned under Other-Non specified.

Food processing, beverages and tobacco (CRT 1.A.2.e)

Included Elsewhere. Fuels under this sub-category are allocated to Manufacturing industries and construction and burned under Other-Non specified.

Non-metallic minerals (CRT 1.A.2.f)

Emissions from Non-metallic minerals increased 8.3-fold, from 742 kt CO2 e in 2000 to 6,180 kt CO2 e in 2022 (Table 3.18). Except for 2017 and 2020 when there was a drop, emissions increased steadily during the period under review (Figure 3.8).

Other – Non specified (CRT 1.A.2.g.viii)

Other emitted 3,306 kt CO2 e in 2000 and 7,093 kt CO2 e in 2022, representing a 14.6% increase (Table 3.18). It is to be noted that much variability was noted in the yearly change in emission from that subcategory (Figure 3.8).

3.2.5.2. Methodological issues

The chosen method is Tier 1 level based on the applicable decision tree from the IPCC 2006 guidelines using national AD from international databases and default EFs from the IPCC 2006 guidelines for all sub-categories falling under Manufacturing industries and construction.

Activity data for Manufacturing industries and construction are presented at Table 3.19.

Table 3.19. Activity Data used for Manufacturing industries and construction (2000-2022)

Diesel (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	68	70	74	70	51	63	52	44
BTR1 - NID1	8	9	10	10	11	13	14	6
1.A.2.g.viii - Other	8	9	10	10	11	13	14	6
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	48	36	28	31	22	90	102	90
BTR1 - NID1	11	6	12	6	5	6	5	0
1.A.2.g.viii - Other	11	6	12	6	5	6	5	0
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	124	124	-	-	-	-	-	-
BTR1 - NID1	5	5	5	5	5	5	5	-
1.A.2.g.viii - Other	5	5	5	5	5	5	5	

Residual fuel oil (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	238	232	252	1,689	558	289	156	121
BTR1 - NID1	206	177	177	212	455	300	162	123
1.A.2.g.viii - Other	206	177	177	212	455	300	162	123
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	483	367	248	291	378	467	577	53
BTR1 - NID1	379	176	258	302	392	413	439	451
1.A.2.g.viii - Other	379	176	258	302	392	413	439	451
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	93	453	-	-	-	-	-	-
BTR1 - NID1	444	448	456	466	458	475	508	-
1.A.2.g.viii - Other	444	448	456	466	458	475	508	-

LPG (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	2	2	3	3	3	2	3	3
BTR1 - NID1	1	2	2	2	2	2	2	1
1.A.2.g.viii - Other	1	2	2	2	2	2	2	1
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	4	5	6	6	7	8	10	15
BTR1 - NID1	0	1	1	1	1	1	1	1
1.A.2.g.viii - Other	0	1	1	1	1	1	1	1
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**

BUR2 - NIR1	20	21	-	-	-	-	-	-
BTR1 - NID1	2	2	1	3	3	3	3	-
1.A.2.g.viii - Other	2	2	1	3	3	3	3	-

Other kerosene (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	NE	NE	NE	NE	NE	NE	NE	NE
BTR1 - NID1	366	213	178	195	175	617	879	1,009
1.A.2.g.viii - Other	366	213	178	195	175	617	879	1,009
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	NE	NE	NE	NE	NE	NE	NE	NE
BTR1 - NID1	782	279	1,261	1,042	1,322	1,682	2,060	1,671
1.A.2.g.viii - Other	782	279	1,261	1,042	1,322	1,682	2,060	1,671
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	NE	NE	-	-	-	-	-	-
BTR1 - NID1	242	264	167	171	168	174	189	-
1.A.2.g.viii - Other	242	264	167	171	168	174	189	-

Other bituminous coal (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	3	3	43	23	8	8	8	23
BTR1 - NID1	302	290	254	278	278	327	399	568
1.A.2.g.viii - Other	302	290	254	278	278	327	399	568
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	32	34	38	32	48	44	46	48
BTR1 - NID1	1,209	1,209	1,209	1,451	1,935	2,419	2,419	2,540
1.A.2.g.viii - Other	1,209	1,209	1,209	1,451	1,935	2,419	2,419	2,540
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	50	46	-	-	-	-	-	-
BTR1 - NID1	2,660	2,298	2,692	2,723	2,351	2,506	3,133	-
1.A.2.g.viii - Other	2,660	2,298	2,692	2,723	2,351	2,506	3,133	-

Natural gas (TJ)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	30,400	45,046	75,690	79,302	118,419	192,976	226,322	273,304
BTR1 - NID1	45,084	39,712	40,673	134,505	89,310	81,399	82,216	91,185
Iron and steel	3,388	2,984	3,056	15,753	9,913	8,915	9,290	10,286
Chemicals	18,241	16,068	16,458	9,684	10,760	10,760	8,608	9,684
1.A.2.g.viii - Other	23,455	20,660	21,159	109,068	68,637	61,724	64,318	71,215
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	292,937	168,378	309,795	317,570	344,149	264,673	319,985	410,012
BTR1 - NID1	77,474	31,205	28,234	119,439	93,615	100,018	114,151	113,669
Iron and steel	8,691	2,852	2,889	13,851	9,777	10,446	11,922	11,872

Chemicals	8,608	8,608	5,342	9,684	16,141	17,245	19,682	19,599
1.A.2.g.viii - Other	60,175	19,745	20,003	95,904	67,697	72,327	82,547	82,198
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	190,329	227,652	-	-	-	-	-	-
BTR1 - NID1	111,253	104,730	110,951	113,427	114,031	133,661	125,370	-
Iron and steel	11,620	10,939	11,588	11,847	11,910	13,960	12,049	-
Chemicals	19,182	18,057	19,130	19,557	19,661	23,045	19,890	-
1.A.2.g.viii - Other	80,451	75,734	80,233	82,023	82,460	96,655	83,421	-

Other primary solid biomass (Bagasse) (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	117	22	22	0	0	0	98	179
BTR1 - NID1	117	22	22	0	0	0	98	179
1.A.2.g.viii - Other	117	22	22	0	0	0	98	179
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	68	122	98	98	35	35	20	49
BTR1 - NID1	68	122	98	98	35	35	20	49
1.A.2.g.viii - Other	68	122	98	98	35	35	20	49
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	50	66	-	-	-	-	-	-
BTR1 - NID1	65	82	98	70	71	71	71	-
1.A.2.g.viii - Other	65	82	98	70	71	71	71	-

Charcoal (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	15	16	17	16	16	18	17	17
BTR1 - NID1	6	7	8	8	9	10	11	15
1.A.2.g.viii - Other	6	7	8	8	9	10	11	15
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	16	18	17	18	18	19	18	19
BTR1 - NID1	13	12	13	15	17	16	17	17
1.A.2.g.viii - Other	13	12	13	15	17	16	17	17
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	19	20	-	-	-	-	-	-
BTR1 - NID1	16	16	17	17	17	17	17	-
1.A.2.g.viii - Other	16	16	17	17	17	17	17	-

Wood/wood waste (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	5,639	6,179	6,784	7,393	8,128	8,860	9,634	10,501
BTR1 - NID1	5,186	5,806	6,505	7,264	8,139	9,088	10,146	11,418
1.A.2.g.viii - Other	5,186	5,806	6,505	7,264	8,139	9,088	10,146	11,418
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**

BUR2 - NIR1	11,632	12,562	13,409	14,423	15,159	14,466	8,739	8,799
BTR1 - NID1	13,064	14,596	16,254	18,162	20,264	19,213	11,093	11,169
1.A.2.g.viii - Other	13,064	14,596	16,254	18,162	20,264	19,213	11,093	11,169
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	8,839	8,881	-	-	-	-	-	-
BTR1 - NID1	11,220	11,272	11,327	11,383	11,442	11,503	11,443	-
1.A.2.g.viii - Other	11,220	11,272	11,327	11,383	11,442	11,503	11,443	-

Emission Factors used for direct and indirect gases are provided in Tables 3.20 and 3.21 respectively.

Table 3.20. Emission Factors used for direct gases in the Manufacturing Industries and Construction category

Sub-category	Fuel type	Emission Factor (kg/TJ)			Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume2/Chapter 2 - Stationary Combustion
		CO2	CH4	N2O	
Iron and Steel Chemicals Non-metallic minerals Other	Diesel	74,100	3	0.6	Table 2.3
	Other kerosene	71,900	3	0.6	" "
	RFO	77,400	3	0.6	" "
	LPG	63,100	1	0.1	" "
	Other bituminous coal	94,600	10	1.5	" "
	Natural gas	56,100	1	0.1	" "
	Wood/wood waste	112,000	30	4	" "
	Other primary solid biomass (Bagasse)	100,000	30	4	" "
	Charcoal	112,000	200	4	" "

Table 3.21. Emission Factors used for indirect gases in the Manufacturing Industries and Construction category

Sub-category	Fuel type	Emission Factor (g/GJ)				Source: EMEP/EEA air pollutant emission inventory guidebook 2023, 1.A.2 - Manufacturing industries and construction Industries
		NOx	CO	NMVOC	SO2	
Iron and Steel Chemicals Non-metallic minerals Other	Diesel	513	66	25	47	Table 3.4
	Other kerosene	513	66	25	47	" "
	RFO	513	66	25	47	" "
	LPG	513	66	25	47	" "
	Oth. bitum. coal	173	931	88.8	900	Table 3.2
	Natural gas	74	29	23	0.67	Table 3.3
	Wood/wood waste	91	570	300	11	Table 3.5
	Oth. primary solid biomass (Bagasse)	91	570	300	11	Table 3.5
	Charcoal	91	570	300	11	" "

No CO2 was captured and stored.

3.2.5.3. Description of any flexibility applied Not

Applicable.

3.2.5.4. Uncertainty assessment and time-series consistency

The uncertainties assigned to the AD (Table 3.22) varied from ±3% to ±15% depending on the subcategory and the quality of the data collected and those for the default EFs from -3.21 to +17.57 for CO2, -66.11% to +222.22% for CH4 and -62.50 +275.00 for N2O depending on activity area. The ranges adopted are from the IPCC 2006 guidelines.

Table 3.22. Uncertainty levels assigned for Manufacturing Industries and Construction

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
1.A.2 -Manufacturing Industries and Construction			
1.A.2.a - Iron and steel - Gaseous fuels	CO2	±3	-3.21 to +3.92
	CH4	±3	-70 to +200
	N2O	±3	-70 to +200
1.A.2.c - Chemicals - Gaseous fuels	CO2	±3	-3.21 to +3.92
	CH4	±3	-70 to +200
	N2O	±3	-70 to +200
1.A.2.f - Non-metallic minerals - Solid Fuel	CO2	±15	-11.44 to +12.46
	CH4	±15	-70 to +200
	N2O	±15	-67.78 to +222
1.A.2.g.viii – Other - Liquid fuels	CO2	±9	-5.33 to +6.14
	CH4	±9	-67.12 to +228.79
	N2O	±9	-67.12 to +228.80
1.A.2.g.viii - Other - Gaseous fuels	CO2	±9	-3.21 to +3.92
	CH4	±9	-70 to +200
	N2O	±9	-70 to +200
1.A.2.g.viii - Other - Biomass - Solid	CO2	±9	-15.22 to +17.57
	CH4	±9	-66.11 to +222.22
	N2O	±9	-62.50 +275.00

1: Source - 2006 Guidelines, Table 2.15, Page 2.41, Chapter 2, Volume 2.

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]

2: Source - Tier 1 default values which are in line with 2006 Guidelines are taken from the IPCC GHG inventory software, version 2.93.

The combined uncertainties determined using the generated tool in line with the methods contained in the IPCC 2006 guidelines are provided in Table 3.23 for this category. The uncertainties for the level assessment for the base year 2000 is 7.7% and 9.7% for year-t (2022) and for the trend assessment with 2000 as base year and 2022 as yeart, it is 30%.

Table 3.23. Uncertainty assessment for the Manufacturing Industries and Construction

A	B	C	D	E	F	H	H	M
2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Gg CO2	Year T (2022) emissions or removals (Gg CO2	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Contribution to Variance by Category in Year 2000	Contribution to Variance by Category in Year 2022	Uncertainty introduced into the trend in total national

		equivalent)	equivalent)					emissions (%)
1.A.2 - Manufacturing Industries and Construction								
1.A.2.a - Iron and Steel - Gaseous Fuels	CO2	190.1	675.9	3.0	3.9	0.0	0.0	0.3
1.A.2.a - Iron and Steel - Gaseous Fuels	CH4	0.1	0.3	3.0	200.0	0.0	0.0	0.0
1.A.2.a - Iron and Steel - Gaseous Fuels	N2O	0.1	0.3	3.0	200.0	0.0	0.0	0.0
1.A.2.c - Chemicals - Gaseous Fuels	CO2	1023.3	1115.8	3.0	3.9	0.9	0.1	2.6
1.A.2.c - Chemicals - Gaseous Fuels	CH4	0.5	0.6	3.0	200.0	0.0	0.0	0.0
1.A.2.c - Chemicals - Gaseous Fuels	N2O	0.5	0.5	3.0	200.0	0.0	0.0	0.0
1.A.2.f - Non-Metallic Minerals - Solid Fuels	CO2	737.1	6135.6	15.0	12.5	7.5	63.1	702.2
1.A.2.f - Non-Metallic Minerals - Solid Fuels	CH4	2.2	18.2	15.0	200.0	0.0	0.1	0.2
1.A.2.f - Non-Metallic Minerals - Solid Fuels	N2O	3.1	25.8	15.0	222.2	0.0	0.1	0.5
1.A.2.g.viii - Other - Liquid Fuels	CO2	1825.2	2058.3	9.0	6.1	14.3	2.2	38.3
1.A.2.g.viii - Other - Liquid Fuels	CH4	2.1	2.3	9.0	228.8	0.0	0.0	0.0
1.A.2.g.viii - Other - Liquid Fuels	N2O	3.9	4.3	9.0	228.8	0.0	0.0	0.1
1.A.2.g.viii - Other - Gaseous Fuels	CO2	1315.8	4679.9	9.0	3.9	6.0	9.3	128.6
1.A.2.g.viii - Other - Gaseous Fuels	CH4	0.7	2.3	9.0	200.0	0.0	0.0	0.0
1.A.2.g.viii - Other - Gaseous Fuels	N2O	0.6	2.2	9.0	200.0	0.0	0.0	0.0
1.A.2.g.viii - Other – Biomass solid	CO2	0.0	0.0	60.0	17.6	0.0	0.0	0.0
1.A.2.g.viii - Other – Biomass solid	CH4	70.1	153.4	60.0	222.2	9.4	5.5	10.1
1.A.2.g.viii - Other – Biomass solid	N2O	87.4	190.6	60.0	275.0	21.8	12.7	19.1
Sum		**5262.8**	**15066.5**	**Sum**		**60.0**	**93.1**	**902.1**
Uncertainty in level (L) and trend (T) assessment						**L - 7.7**	**L - 9.7**	**T - 30.0**

The time series is consistent as the AD have always been obtained from the same sources, the default EFs of IPCC used as well as the same methodology for all the years of the time series.

3.2.5.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations, reference material and conversion factors. Quality Assurance during the estimation steps was done by independent international experts.

3.2.5.6. Category-specific recalculations

Following changes in the emissions being made at the level of 3 sub-categories (iron and steel, Chemicals and Nonmetallic minerals) and Other instead of being combined under only the Other sub-category previously, recalculations were undertaken for all years of the time-series. Emissions differed by -39% to +84% (Table 3.24).

Table 3.24. Manufacturing industries and construction – recalculations

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	2,857	3,682	5,595	10,263	8,833	12,235	13,684	16,258	18,565	11,198	18,777	19,374
BTR1 - NID1	5,263	4,380	4,259	9,772	7,963	8,584	9,239	10,458	11,409	6,618	9,879	15,079
% change	84	19	-24	-5	-10	-30	-32	-36	-39	-41	-47	-22

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	-
BUR2 - NIR1	21,173	17,180	20,509	23,906	11,825	15,046	-	-	-	-	-	-
BTR1 - NID1	16,044	18,769	20,594	19,660	15,303	14,130	15,168	15,432	14,519	16,076	15,066	-
% change	-24	9	0	-18	29	-6	-	-	-	-	-	-

3.2.5.7. Category-specific planned improvements

The planned improvement is firstly to make a study for identifying the activities by 2026 and collect AD and estimate sub-categories assessed under Other-Non specified separately by 2028. Manufacturing Industries and Construction - Gaseous and Solid fuels are key categories and need to be addressed at Tier 2 level to be in accordance with the MPGs of the Annex to Decision 2018/CMA.1. However, this is difficult to achieve since the category comprises numerous sub-categories and which one is responsible is not known, unless some deeper assessments are undertaken. The planned improvement consists of undertaking an in-depth exercise by 2026 to identify the responsible sub-category for further action by 2028.

3.2.6. Transport (CRT 1.A.3)

3.2.6.1. Category description

The Transport category comprises emissions from the combustion and evaporation of fuel for all transport activity (excluding military transport), regardless of the sector.

Transport comprises the following subcategories: Domestic aviation (CRT 1.A.3.a), Road transportation (CRT 1.A.3.b), Railways (CRT 1.A.3.c) and Domestic navigation (CRT 1.A.3.d).

Road transportation was the main contributor to emissions with an average share of 96.0 %, with a trough at 94.9% in 2007 and a peak of 97.5% in 2020 (Figure 3.10 and Table 3.25).

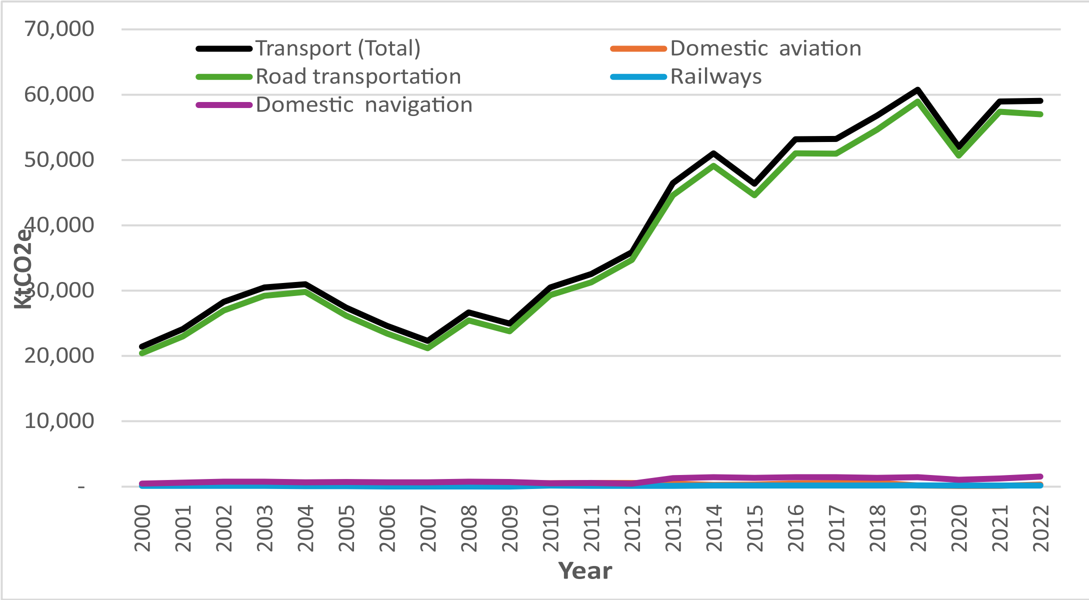

Figure 3.10. Trend of emissions (kt CO2 e) by sub-category for Transport (2000-2022)

Emissions from Transport (CRT 1.A.3) increased by 175%, from 21,432 kt CO_2 e in 2000, to 59,045 kt CO_2 e in 2022 (Table 3.25).

Table 3.25. Emissions (kt CO2 e) by sub-category for Transport for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1.A.3 - Transport	21,432	27,424	30,509	46,390	56,818	60,761	52,009	58,948	59,045	175%
1.A.3.a - Domestic aviation	415	440	499	299	625	188	115	135	316	-24%
1.A.3.b - Road transportation	20,422	26,180	29,324	44,588	54,638	58,947	50,684	57,414	57,000	179%
1.A.3.c - Railways	127	84	151	169	190	196	161	160	182	44%
1.A.3.d - Domestic navigation	469	719	535	1,335	1,365	1,431	1,050	1,238	1,547	230%

Emissions from Transport originated almost totally from CO_2, the share of which to aggregated emissions varied from 97.7% to 97.9% during the period under review (Figure 3.2).

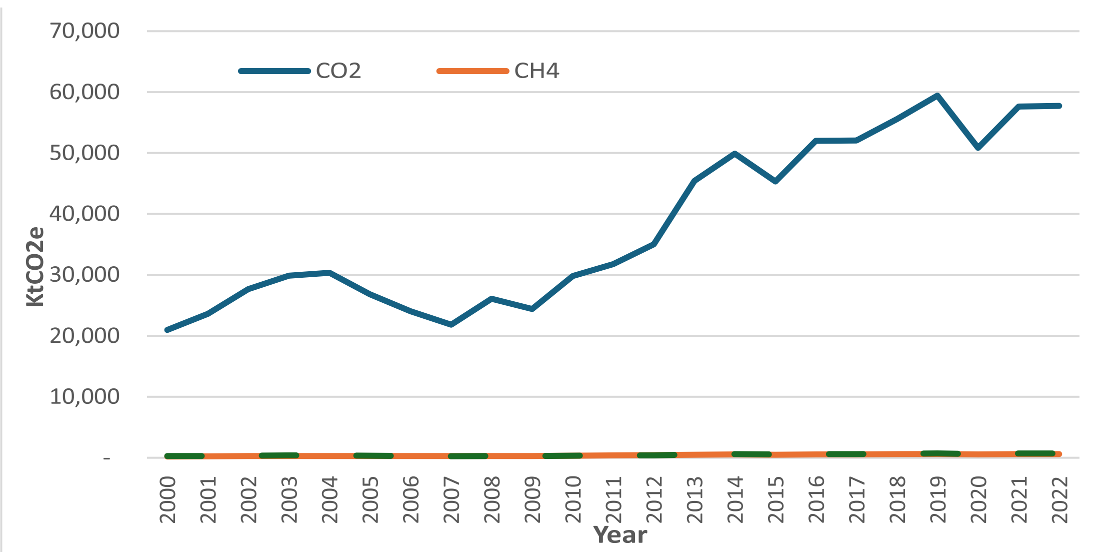

Figure 3.11. Trend of emissions (kt CO2 e) by gas for Transport (2000-2022)

Domestic aviation (CRT 1.A.3.a)

Emissions from Domestic aviation (Table 3.26) varied from 115 KT CO2 e in 2020 because of COVID-19 and 625 kt CO2 e in 2018. It rose gradually from 415 kt CO2 e in 2000 to 569 kt CO2 e in 2012 (Table 3.26). Emissions then dropped from 2013 to 2015 and thereafter rose again to peak at 625 kt CO2 e in 2018. In 2019 and 2022, emissions dropped again to reach its lowest levels for the period under review due to the COVID-19 pandemic, before rising again to 316 kt CO2 e in 2022. Emissions in 2022 were 23.8% lower than those of 2000.

Table 3.26. Emissions (kt CO2 e) for Domestic Aviation (2000-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
415	420	425	430	435	440	446	451	456	461	499	546
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
569	477	283	299	496	589	625	188	115	135	316	

Road transportation (CRT 1.A.3.b)

Emissions from Road transportation rose by 179.1%, from 20,422 kt CO2 e in 2000 to 57,000 in 2022. It is to be noted that emissions peaked at 58,947 kt CO2 e in 2019.

Emissions from Road transportation (Table 3.27) increased from 20,422 kt CO2 e in 2000 to 57,000 kt CO2 e in 2022.

Table 3.27. Emissions (kt CO2 e) for Road Transportation (2000-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
20,422	22,983	26,996	29,239	29,834	26,180	23,450	21,190	25,438	23,781	29,324	31,302
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
34,729	44,588	49,138	44,588	51,020	50,968	54,638	58,947	50,684	57,414	57,000	-

Railways (CRT 1.A.3.c)

Emissions from railways (Table 3.28) increased from 127 kt CO2 e in 2000 to 182 kt CO2 e in 2022, with its lowest at 14 kt CO2 e in 2009. They subsequently rose to reach 182 kt CO2 e in 2022, peaking at 196 kt CO2 e in 2019. The net increase during the period 2000 to 2022 was 43.7%.

Table 3.28. Emissions (kt CO2 e) for Railways (2000-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
127	109	113	106	56	84	49	21	46	14	151	130
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
116	116	162	169	190	187	190	196	161	160	182	-

Domestic navigation (CRT 1.A.3.d)

Emissions from Road transportation (Table 3.29) increased from 469 kt CO2 e in 2000 to 1,547 kt CO2 e in 2022. From 2000 to 2012, emissions from Domestic navigation fluctuated at levels between 462 kt CO2 e and 719 kt CO2 e. Emissions made a sharp increase to 1,286 kt CO2 e in 2013 and reached 1,547 kt CO2 e in 2022. The net increase during the period under review is 229.6%.

Table 3.29. Emissions (kt CO2 e) for Domestic Navigation (2000-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
469	630	748	745	661	719	662	677	747	719	535	557
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
462	1,286	1,440	1,335	1,466	1,468	1,365	1,431	1,050	1,238	1,547	-

Other transportation (CRT 1.A.3.e)

Emissions from Other Transportation have been included elsewhere as the fuel is accounted for under the Transport category in the energy balance.

3.2.6.2. Methodological issues

The chosen method is Tier 1 level based on the applicable decision tree from the IPCC 2006 guidelines using national AD from international databases and default EFs from the IPCC 2006 guidelines for all transport sub-categories.

Domestic aviation (CRT 1.A.3.a)

Table 3.30 provides AD used for Domestic aviation for the period 2000 to 2017 for the BUR2-NIR1 inventory and for the period 2000 to 2022 for this NID.

Table 3.30. Activity Data used for Domestic aviation (2000-2022)

Jet kerosene (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	13	23	25	29	25	21	21	25
BTR1 - NID1	130	132	134	135	137	139	140	142
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	22	23	15	17	24	31	28	31
BTR1 - NID1	143	145	157	172	179	150	89	94
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	39	37	-	-	-	-	-	
BTR1 - NID1	156	186	197	59	36	43	99	

Table 3.31 provides Emission Factors for Direct and Indirect gases used for Domestic aviation for the period 2000 to 2022 for this NID.

Table 3.31. Emission Factors used for Domestic Aviation category

Emission Factors of direct gases					
Sub-category	**Fuel type**	**Emission Factor (kg/TJ)**			**Source**
		CO2	**CH4**	**N2O**	
Domestic Aviation	Jet kerosene	71,500	0.5	2	2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2/Chapter 3 - Mobile Combustion Tables 3.6.4 and 3.6.5

Emission Factors of indirect gases						
Sub-category	**Fuel type**	**Emission Factor**				**Source**
		NOx (kg/TJ)	**CO (kg/ton)**	**NMVOC (kg/ton)**	**SO2 (kg/ton)**	
						(i) 2006 Guidelines, Vol. 3, page 3.64, Table 3.6.5 for NOx (ii) EFDB for CO (Emission factor ID= 110541)

Domestic Aviation	Jet kerosene	250	7	0.1	100	(iii) EMEP/EEA air pollutant emission inventory guidebook 2013, 1.A.3.a Aviation, Page 19, Table 3.3 for NMVOC (iv) Sulphur content of 0.05% is assumed, see https://archive.ipcc.ch/ipccreports/sres/aviation/111.htm

Road transportation (CRT 1.A.3.b)

Table 3.32 provides AD used for Domestic aviation for the period 2000 to 2017 for the BUR2-NIR1 inventory and for the period 2000 to 2022 for this NID.

Table 3.32. Activity Data used for Road transportation (2000-2022)

Cars

Gasoline (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	1,957	2,937	3,572	3,588	3,373	3,554	3,415	3,643
BTR1 - NID1	3,496	3,966	4,824	4,845	4,818	4,800	4,612	4,672
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	3,906	3,908	2,195	2,423	1,968	6,535	7,154	6,535
BTR1 - NID1	5,275	5,278	6,165	7,052	7,938	8,825	9,661	8,825
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	7,157	7,127	-	-	-	-	-	-
BTR1 - NID1	9,666	9,655	10,166	10,870	9,613	10,792	10,609	-

Diesel (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	62	64	67	64	46	57	28	23
BTR1 - NID1	54	59	63	83	90	57	39	16
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	25	19	15	16	11	47	54	47
BTR1 - NID1	32	16	33	17	15	72	81	72
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	65	65	-	-	-	-	-	-
BTR1 - NID1	99	99	113	126	98	114	118	-

Light duty trucks

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	424	636	773	777	730	769	739	789
BTR1 - NID1	757	859	1,044	1,049	1,043	1,039	998	1,011
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	846	846	565	506	447	1,415	1,549	1,415
BTR1 - NID1	1,142	1,142	1,334	1,526	1,718	1,910	2,091	1,910
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	1,549	1,543	-	-	-	-	-	-
BTR1 - NID1	2,092	2,090	2,201	2,353	2,081	2,336	2,297	-

Gasoline (kt) *Diesel (kt*

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	591	612	642	611	440	544	265	222
BTR1 - NID1	521	575	614	807	870	550	375	150
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	244	182	141	157	109	455	517	455
BTR1 - NID1	305	155	320	165	141	692	787	692
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	627	627	-	-	-	-	-	-
BTR1 - NID1	954	953	1,091	1,214	944	1,105	1,137	-

Heavy duty trucks and buses

Gasoline (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	10	16	19	19	18	19	18	19
BTR1 - NID1	19	21	26	26	26	25	25	25
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	21	21	14	12	11	35	38	35
BTR1 - NID1	28	28	33	37	42	47	51	47
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	38	38	-	-	-	-	-	-
BTR1 - NID1	51	51	54	58	51	57	56	-

Diesel (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	1,399	1,449	1,520	1,447	1,042	1,288	627	527
BTR1 - NID1	1,223	1,348	1,439	1,892	2,041	1,289	879	352
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	577	430	334	372	257	1,076	1,224	1,076
BTR1 - NID1	715	364	751	388	330	1,623	1,846	1,623
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	1,484	1,486	-	-	-	-	-	-
BTR1 - NID1	2,237	2,235	2,558	2,846	2,213	2,592	2,665	-

Motorcycles

Gasoline (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	208	312	379	381	358	378	363	387
BTR1 - NID1	371	421	512	515	512	510	490	496
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	415	415	278	248	219	694	760	694
BTR1 - NID1	560	561	655	749	843	938	1,026	938
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	760	757	-	-	-	-	-	-

BTR1 - NID1	1,027	1,026	1,080	1,155	1,021	1,147	1,127	-

Table 3.33 provides Emission Factors for Direct and Indirect gases used for Road transportation for the period 2000 to 2022 for this NID.

Table 3.33. Emission Factors used for Road Transportation category

Direct gases					
Sub-category - Road Transportation	**Fuel type**	**Emission Factor (kg/TJ)**			**Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2/Chapter 3 - Mobile Combustion**
		CO2	**CH4**	**N2O**	
Cars	Gasoline	69,300	33	3.2	Tables 3.2.1 and 3.2.2
	Diesel	74,100	3.9	3.9	
Light-duty trucks	Gasoline	69,300	33	3.2	" "
	Diesel	74,100	3.9	3.9	
Heavy-duty trucks and buses	Diesel	74,100	3.9	3.9	" "
Motorcycles	Gasoline	69,300	33	3.2	" "

Indirect gases						
Sub-category - Road Transportation	**Fuel type**	**Emission Factor (g/kg fuel)**				**Source: EMEP/EEA air pollutant emission inventory guidebook 2023, 1.A.3.b - Road Transport.**
		NOx	**CO**	**NMVOC**	**SO2 (Yr 2022)**	
	Gasoline	8.73	84.7	10.05	0.010	Gasoline 13.22 152.3 14.59 0.010
	Diesel	12.96	3.33	0.70	0.006	(i) Table 3-5 for CO and NMVOC (ii) Table 3-6 for NOx
Light-duty trucks	Gasoline	13.22	152.3	14.59	0.010	(iii) EF on gasoline for heavy duty trucks and buses not provided in the guidelines. Therefore, as proxy, EF for light duty trucks have been used
	Diesel	14.91	7.4	1.54	0.006	(iv) Emissions of SO2 per fuel type based on formula
Cars						(2) as shown on page 22 of GB 2023 (v) Sulphur content for gasoline and diesel based on values provided in Table 3.14
Heavy-duty trucks and buses	Diesel	33.37	7.58	1.92	0.006	(vi) EF (SO2) (g/kg)
Motorcycles	Gasoline	6.64	497.7	131.40	0.010	

Year	2000-04	2005-08	2009-22
Gasoline	0.26	0.08	0.010
Diesel	0.60	0.08	0.006

Railways (CRT 1.A.3.c)

Table 3.34 provides Activity Data used for Railways for the period 2000 to 2017 for the BUR2-NIR1 inventory and for the period 2000 to 2022 for this NID.

Table 3.34. Activity Data used for Railways (2000-2022) *Diesel (kt)*

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	35	36	38	36	26	32	10	8

BTR1 - NID1	36	31	32	30	16	24	14	6
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	9	7	5	6	4	17	19	17
BTR1 - NID1	13	4	43	37	33	33	46	48
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
BUR2 - NIR1	23	24	-	-	-	-	-	-
BTR1 - NID1	54	53	54	56	46	46	52	-

Table 3.35 provides Emission Factors used for Railways for the period 2000 to 2022.

Table 3.35. Emission Factors used for Railways category

Direct gases						
Sub-category	**Fuel type**	**Emission Factor (kg/TJ)**				**Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2/Chapter 3 - Mobile Combustion**
		CO2	**CH4**	**N2O**		
Railways	Diesel	74,100	4.15	28.6		Table 3.4.1
Indirect gases						
Sub-category	**Fuel type**	**Emission Factor (kg/Ton fuel)**				**Source: EMEP/EEA air pollutant emission inventory guidebook 2023, 1.A.3.c**
		NOx	**CO**	**NMVOC**	**SO2**	
Railways	Diesel	52.4	10.7	4.65	10	Table 3.1 and paragraph 3.2.2

Domestic navigation (CRT 1.A.3.d)

Table 3.36 provides Activity Data used for Domestic navigation for the period 2000 to 2017 for the BUR2-NIR1 inventory and for the period 2000 to 2022 for this NID.

Table 3.36. Activity Data used for Domestic navigation (2000-2022)

Gasoline (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BTR1 - NID1	114	171	208	209	196	207	199	212
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	227	228	128	141	115	380	417	380
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BTR1 - NID1	417	415	374	388	281	333	430	-

Diesel (kt)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BUR2 - NIR1	38	40	42	40	29	35	24	20
BTR1 - NID1	36	31	32	30	16	24	14	6
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	22	17	13	14	28	41	47	41

BTR1 - NID1	13	4	43	37	33	33	46	48
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	57	57	-	-	-	-	-	-
BTR1 - NID1	54	56	64	71	55	64	66	-

Table 3.37 provides Emission Factors used for Domestic aviation for the period 2000 to 2022.

Table 3.37. Emission Factors used for Domestic Navigation category

Direct gases					
Sub-category	**Fuel type**	**Emission Factor (kg/TJ)**			**Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume**
		CO2	**CH4**	**N2O**	**2/Chapter 3 - Mobile Combustion**
Domestic Navigation	Diesel	74,100	7	2	
	Gasoline	69,300	7	2	" "
					Tables 3.5.2 and 3.5.3

Indirect gases						
Sub-category	**Fuel type**	**Emission Factor (kg/Ton fuel)**				**Source: EMEP/EEA air pollutant emission inventory guidebook 2023, 1.A.3.d, 1.A.3.d.ii, 1.A.4.c.iii - International maritime and inland navigation, etc.**
		NOx	**CO**	**NMVOC**	**SO2**	
Domestic Navigation		9.4	573.9	181.5	20	Table 3.4
		72.2	3.84	1.75	1.82	Table 3.2

Gasoline

Diesel

Other transportation (CRT 1.A.3.e)

Included Elsewhere since fuel for the Other transportation sub-category is accounted for under the allocation for the Transport category in the energy balance

3.2.6.3. Description of any flexibility applied

Not resorted to for all sub-categories of the transport category

3.2.6.4. Uncertainty assessment and time-series consistency

The uncertainty levels assigned to the AD and EFs (Table 3.38) are the default ranges from the IPCC 2006 guidelines. The uncertainty for AD is in the range of ±5% to ±25 while for the EFs, values of -2.02% to 4.3% has been adopted for CO2, the range of -60 to +244.69for CH4 and -40 to +209.94 for N2O

Table 3.38. Uncertainty levels assigned for Transport

2006 IPCC Categories	**Gas**	**Uncertainty assigned (%)**	
		AD[1]	EF[2]
1.A.3.a - Domestic Aviation			
1.A.3.a - Domestic aviation - Liquid Fuels	CO2	±20	-3.17 to +4.21
	CH4	±20	-60.00 to +100.00
	N2O	±20	-70.00 to +150.00
1.A.3.b - Road Transportation			
1.A.3.b.i - Cars - Liquid Fuels	CO2	±5	-2.09 to + 3.07

	CH4	±5	-61.52 to +244.69
	N2O	±5	-67.83 to +209.94
1.A.3.b.ii - Light-duty trucks - Liquid Fuels	CO2	±5	-2.09 to + 3.07
	CH4	±5	-61.52 to +244.69
	N2O	±5	-67.83 to +209.94
1.A.3.b.iii - Heavy-duty trucks and buses - Liquid Fuels	CO2	±5	-2.09 to + 3.07
	CH4	±5	-61.52 to +244.69
	N2O	±5	-67.83 to +209.94
1.A.3.b.iv - Motorcycles - Liquid Fuels	CO2	±5	-2.09 to + 3.07
	CH4	±5	-61.52 to +244.69
	N2O	±5	-67.83 to +209.94
1.A.3.c - Railways			
1.A.3.c - Railways - Liquid Fuels	CO2	±5	-2.02 to + 0.94
	CH4	±5	-59.76 to + 150.60
	N2O	±5	-50.00 to +200.00
1.A.3.d - Domestic waterborne navigation			
1.A.3.d - Domestic waterborne navigation - Liquid Fuels	CO2	±25	-3.53 to + 4.30
	CH4	±25	-50.00 to + 50.00
	N2O	±25	-40.00 to +140.00

1: Source - 2006 Guidelines, Volume 2, Chapter 3, (i) Page 3.69, p.3.6.1.7 (ii) Page 3.30, p. 3.2.2 (iii) Page 3.46, p.3.4.1.6 (iv) Page 3.54, p.3.5.1.7

2: Source - Tier 1 default values which are in line with the 2006 Guidelines are taken from IPCC GHG inventory software, version 2.93.

The estimated combined uncertainties are 4.1% and 4.4% % for the level assessment for the base year 2000 and year-t 2022 respectively, and 12.1% for the trend between base year 2000 and year-t 2022 (Table 3.39).

Table 3.39. Uncertainty assessment for Transport

A	B	C	D	E	F	H	H	M
2006 IPCC Categories	**Gas**	**Base Year (2000) emissions or removals (Gg CO2 equivalent)**	**Year T (2022) emissions or removals (Gg CO2 equivalent)**	**Activity Data Uncertainty (%)**	**Emission Factor Uncertainty (%)**	**Contribution to Variance by Category in Year 2000**	**Contribution to Variance by Category in Year 2022**	**Uncertainty introduced into the trend in total national emissions (%)**
1.A.3 - Transport								
1.A.3.a - Domestic Aviation - Liquid Fuels	CO2	411.4	313.7	20.0	4.2	0.2	0.0	0.2
1.A.3.a - Domestic Aviation - Liquid Fuels	CH4	0.1	0.1	20.0	100.0	0.0	0.0	0.0
1.A.3.a - Domestic Aviation - Liquid Fuels	N2O	3.0	2.3	20.0	150.0	0.0	0.0	0.0
1.A.3.b.i - Cars - Liquid Fuels	CH4			5.0	244.7	2.7	3.2	0.2
1.A.3.b.i - Cars - Liquid Fuels	N2O	133.7	403.8	5.0	209.9	1.7	2.1	0.1
1.A.3.b.ii - Light-duty trucks - Liquid Fuels	CO2	3984.8	10672.3	5.0	3.1	1.2	1.1	12.4
1.A.3.b.ii - Light-duty trucks - Liquid Fuels	CH4	33.4	99.3	5.0	244.7	0.1	0.2	0.0
1.A.3.b.ii - Light-duty trucks - Liquid Fuels	N2O	51.6	136.8	5.0	209.9	0.3	0.2	0.0

1.A.3.b.iii - Heavy-duty trucks and buses - Liquid Fuels	CO2	3952.7	8665.8	5.0	3.4	1.2	0.8	8.3
1.A.3.b.iii - Heavy-duty trucks and buses - Liquid Fuels	CH4	6.5	14.8	5.0	244.7	0.0	0.0	0.0
		10905.1	32945.0					
1.A.3.b.i - Cars - Liquid Fuels	CO2	143.4	434.8	5.0	3.1	8.9	10.7	118.3
A	**B**	**C**	**D**	**E**	**F**	**H**	**H**	**M**
2006 IPCC Categories	**Gas**	**Base Year (2000) emissions or removals (Gg CO2 equivalent)**	**Year T (2022) emissions or removals (Gg CO2 equivalent)**	**Activity Data Uncertainty (%)**	**Emission Factor Uncertainty (%)**	**Contribution to Variance by Category in Year 2000**	**Contribution to Variance by Category in Year 2022**	**Uncertainty introduced into the trend in total national emissions (%)**
1.A.3.b.iii - Heavy-duty trucks and buses - Liquid Fuels	N2O	55.0	120.6	5.0	209.9	0.3	0.2	0.1
1.A.3.b.iv - Motorcycles - Liquid Fuels	CO2	1140.3	3460.3	5.0	3.1	0.1	0.1	1.3
1.A.3.b.iv - Motorcycles - Liquid Fuels	CH4	15.2	46.1	5.0	244.7	0.0	0.0	0.0
1.A.3.b.iv - Motorcycles - Liquid Fuels	N2O	0.0	0.0	5.0	209.9	0.0	0.0	0.0
1.A.3.c - Railways - Liquid Fuels	CO2	114.7	164.8	5.0	2.0	0.0	0.0	0.0
1.A.3.c - Railways - Liquid Fuels	CH4	0.2	0.3	5.0	150.6	0.0	0.0	0.0
1.A.3.c - Railways - Liquid Fuels	N2O	11.7	16.9	5.0	200.0	0.0	0.0	0.0
1.A.3.d - Domestic Navigation - Liquid Fuels	CO2	464.6	1531.2	25.0	4.3	0.3	0.4	6.4
1.A.3.d - Domestic Navigation - Liquid Fuels	CH4	1.3	4.3	25.0	50.0	0.0	0.0	0.0
1.A.3.d - Domestic Navigation - Liquid Fuels	N2O	3.5	11.6	25.0	140.0	0.0	0.0	0.0
Sum		**21432.3**	**59044.8**	**Sum**		**17.0**	**19.1**	**147.4**
Uncertainty in level (L) and trend (T) assessment						**L - 4.1**	**L - 4.4**	**T - 12.1**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

3.2.6.5. Category-specific QA/QC and verification

The quality control checks for all sub-categories of the Transport category were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, AD in terms of fuel used by trains, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations, reference material and conversion factors. Quality Assurance during the estimation steps was done by independent international experts.

3.2.6.6. Category-specific recalculations

Following the availability of improved data sets, all years of the previous time series were recalculated with the updated AD. This recalculation resulted in an increase varying between 20% to 80% (Table 3.40).

Table 3.40. Transport – recalculations

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
BUR2 - NIR1	15,425	19,968	23,094	22,817	19,887	21,867	18,034	18,545	19,954	19,246	19,262	19,923
BTR1 - NID1	21,432	24,142	28,282	30,519	30,987	27,424	24,606	22,340	26,687	24,975	30,509	32,535

% change	39	21	22	34	56	25	36	20	34	30	58	63
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	19,916	33,870	37,281	33,870	38,604	38,477	-	-	-	-	-	
BTR1 - NID1	35,875	46,467	51,022	46,390	53,172	53,212	56,818	60,761	52,009	58,948	59,045	
% change	80	37	37	37	38	38	-	-	-	-	-	

3.2.6.7. Category-specific planned improvements

Domestic aviation (CRT 1.A.3.a) No
planned improvement

Road transportation (CRT 1.A.3.b)

Road transportation is a key category and need to be estimated at Tier 2 level. The improvement will consist in undertaking the necessary surveys for disaggregating the national vehicle fleet, determining km run by each vehicle calls and any other applicable information or data required to meet the Tier 2 standard. Due to the size and other problems inherent to Nigeria, the plan is to complete that exercise within the next 6 years by 2030, inclusive of training data collectors to complete the process.

Railways (CRT 1.A.3.c)

No planned improvement

Domestic navigation (CRT 1.A.3.d) No
planned improvement

Other transportation (CRT 1.A.3.e) No
planned improvement

3.2.7. Other sectors (CRT 1.A.4)

3.2.7.1. Category description

Other sectors comprise the following subcategories: Commercial/institutional (CRT 1.A.4.a), Residential (CRT 1.A.4.b) and Agriculture / forestry / fishing (CRT 1.A.4.c).

The subcategory Residential was by far the largest contributor to emissions though that share decreased slightly from 98.0% in 2000 to 93.7% in 2022 (Figure 3.12).

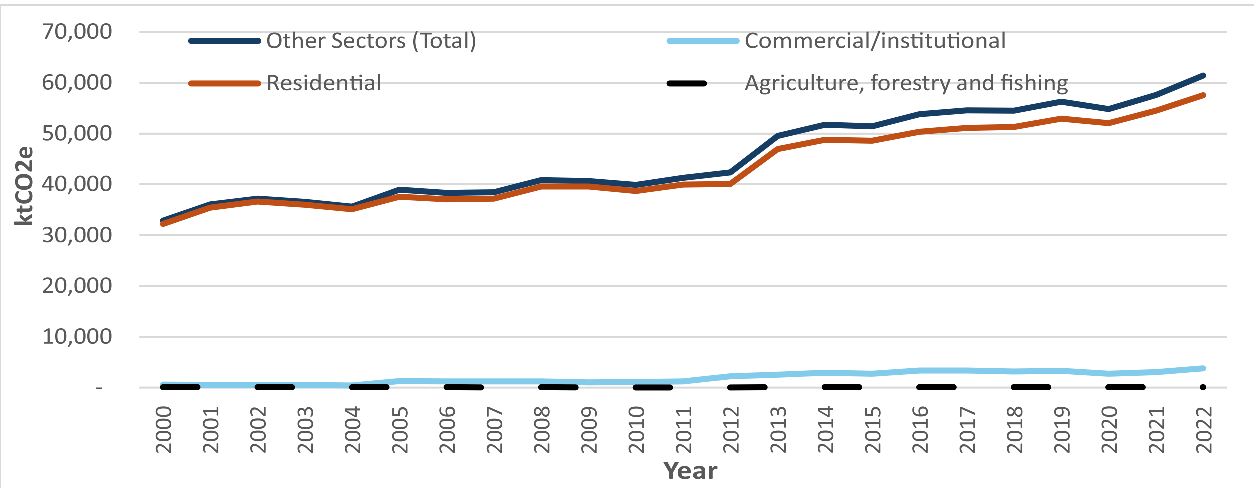

Figure 3.12. Trend of emissions (kt CO2 e) by sub-category for Other Sectors (2000-2022)

Emissions from Other sectors increased by 87%, from 32,858 kt CO_2 e in 2000, representing a share of 44.0%, to 61,423 kt CO_2 e in 2022, representing a share of 36.3% (Table 3.41).

Table 3.41. Emissions (kt CO2 e) by sub-category for Other Sectors for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1.A.4 Other sectors	32,858	38,929	39,869	51,419	54,486	56,303	54,843	57,601	61,423	87%
1.A.4.a Commercial / institutional	587	1,308	1,114	2,731	3,143	3,278	2,705	3,052	3,794	547%
1.A.4.b Residential	32,208	37,542	38,708	48,600	51,271	52,951	52,082	54,485	57,550	79%
1.A.4.c Agriculture / forestry / fishing	64	79	47	88	72	73	57	64	79	47%

CH4 remained the major contributor to emissions of Other Sectors. Emissions increased gradually from 23,106 kt CO_2 e in 2000 to 39,643 kt CO_2 e in 2022 (+71.6%). However, the share of CH_4 to aggregated emissions decreased from 70.3% in 2022 to 64.5% in 2022 (Figure 3.13).

CO2 was the second contributor to aggregated emissions with 6,837 kt CO_2 e in 2000 and 16,814 kt CO_2 e in 2022, that is a 145.9% increase during the period under review. The share of CO_2 increased from 20.8% in 2000 to 25.0% in 2022. The change in emissions occurred in a jagged manner during the period under review (Figure 3.13).

Emissions of N2O rose from 2,915 kt CO_2 e in 2000 to 4,969 kt CO_2 e in 2022, equivalent to an increase of 70.5% (Figure 3.13).

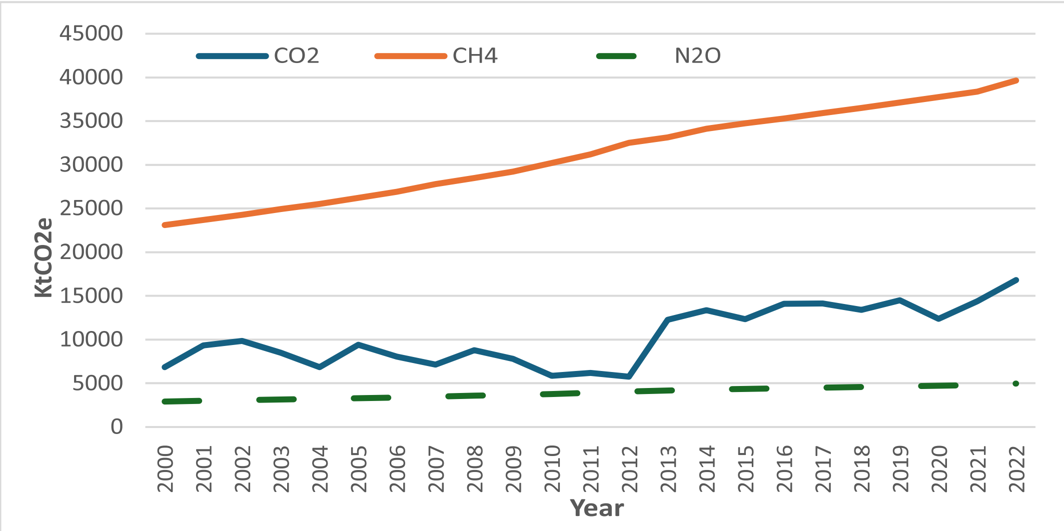

Figure 3.13. Aggregated emissions by gas for the Other sectors category

Commercial/institutional (CRT 1.A.4.a)

Emissions (Table 3.42) increased from 587 kt CO_2 e in 2000 to 3,794 in 2022.

Table 3.42. Emissions (kt CO2 e) for Commercial/Institutional (2001-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
587	557	509	501	419	1,308	1,197	1,190	1,246	1,060	1,114	1,248
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	-
2,259	2,552	2,905	2,731	3,368	3,387	3,143	3,278	2,705	3,052	3,794	-

Residential (CRT 1.A.4.b)

Emissions (Table 3.43) increased from 32,208 kt CO2 e in 2000 to 57,550 in 2022.

Table 3.43. Emissions (kt CO2 e) for Residential (2001-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
32,208	35,406	36,633	36,003	35,092	37,542	37,078	37,192	39,563	39,581	38,708	39,980
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	-
40,059	46,919	48,754	48,600	50,381	51,079	51,271	52,951	52,082	54,485	57,550	-

Agriculture/forestry/fishing (CRT 1.A.4.c)

Emissions (Table 3.44) increased from 64 kt CO2 e in 2000 to 79 in 2022.

Table 3.44. Emissions (kt CO2 e) for Agriculture/Forestry/Fishing (2001-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
64	79	62	79	73	79	66	38	59	37	47	39
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	-
31	88	96	88	74	82	72	73	57	64	79	-

3.2.7.2. Methodological issues

The chosen method is Tier 1 level based on the applicable decision tree from the IPCC 2006 guidelines using national AD from international databases and default EFs from the IPCC 2006 guidelines for all Other sectors sub-categories.

Commercial/institutional (CRT 1.A.4.a)

Table 3.45 provides Activity Data used for the Commercial / Institutional sub-category.

Table 3.45. Activity Data used for Commercial / Institutional (2000-2022)

Diesel (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	5	6	6	6	4	292	264	245
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	269	200	156	173	337	501	570	501
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	691	692	624	663	491	591	777	

LPG (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	5	5	6	6	6	4	6	7
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	8	10	12	13	15	18	21	33
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	43	46	35	37	27	33	43	

Wood/Wood waste (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	3,791	3,493	3,024	2,898	2,215	1,946	1,676	1,761
BTR1 - NID1	3,486	3,282	2,899	2,848	2,218	1,996	1,765	1,914
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	1,604	1,774	2,656	2,968	5,140	3,993	4,796	4,829
BTR1 - NID1	1,801	2,061	3,219	3,737	6,871	5,304	6,088	6,130
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	4,851	4,874	-	-	-	-	-	
BTR1 - NID1	6,157	6,186	6,216	6,247	6,279	6,313	6,969	

Charcoal (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	475	464	481	451	533	546	568	585
BTR1 - NID1	186	198	224	228	292	325	367	518
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	599	626	653	685	707	722	734	754
BTR1 - NID1	483	416	491	575	668	621	660	678
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	770	788	-	-	-	-	-	
BTR1 - NID1	658	669	680	692	703	715	822	

Other kerosene (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	2	2	2	2	3	3	3	4
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	4	4	6	1	1	1	1	1
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	1	1	1	1	1	1	1	

Table 3.46 provides Emission Factors used for direct gases for the Commercial / Institutional sub-category.

Table 3.46. Emission Factors used for direct gases in Commercial / institutional

Sub-category	Fuel type	Emission Factor (kg/TJ)			Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2
		CO2	CH4	N2O	
Commercial/ institutional	Diesel	74,100	10	0.6	Chapter 2, page 2.21, Table 2.4
	LPG	63,100	5	0.1	" "
	Oth. Kerosene	71,900	10	0.6	" "
	Wood/ wood waste	112,000	300	4	" "
	Charcoal	112,000	200	1	" "

Table 3.47 provides Emission Factors used for indirect gases for the Commercial / Institutional sub-category.

Table 3.47. Emission Factors used for indirect gases for Commercial / Institutional sources

Sub-category	Fuel type	Emission Factor (g/GJ)				Source: EMEP/EEA air pollutant emission inventory guidebook 2023, 1.A.4 -Small combustion
		NOx	CO	NMVOC	SO2	
Commercial/ Institutional	Diesel	306	93	20	94	Table 3-9
	LPG	74	29	23	0.67	Table 3-8
	Oth. Kerosene	306	93	20	94	Table 3-9
	Wood/ wood waste	91	570	300	11	Table 3-10
	Charcoal	91	570	300	11	Table 3-10

Residential (CRT 1.A.4.b)

Table 3.48 provides Activity Data used for the Residential sub-category.

Table 3.48. Acti ity Data used for Residential (2000- 022)

Gasoline (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	811	1,216	1,479	1,486	1,397	1,472	1,414	1,508
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	1,617	1,618	1,082	968	854	2,706	2,962	2,706
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	2,964	2,951	2,702	2,804	2,034	2,406	3,110	

Other kerosene (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	865	1,618	152	1,087	1,107	1,101	735	424
BTR1 - NID1	1,263	1,658	1,554	1,114	680	1,129	753	414
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	777	560	530	714	500	2,112	2,287	2,112
BTR1 - NID1	796	573	543	732	478	482	480	493
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	729	1,150	-	-	-	-	-	
BTR1 - NID1	504	517	530	543	557	570	557	

Diesel (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	3	3	4	3	2	3	113	95
BTR1 - NID1	73	75	77	80	82	84	113	95
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	104	78	60	67	131	195	221	195
BTR1 - NID1	104	78	60	67	131	195	221	195
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	268	269	-	-	-	-	-	
BTR1 - NID1	268	269	244	259	192	232	306	

LPG (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	41	36	42	42	49	30	42	50
BTR1 - NID1	13	13	22	21	13	13	12	15
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	59	76	92	101	118	136	161	255
BTR1 - NID1	16	18	13	17	20	22	21	22
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	328	353	-	-	-	-	-	
BTR1 - NID1	47	56	164	361	689	814	621	

Wood/wood waste (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	76,032	76,293	76,685	76,756	77,284	77,429	77,436	77,019
BTR1 - NID1	69,915	71,695	73,527	75,419	77,381	79,422	81,544	83,747
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	76,604	76,087	74,964	74,192	71,860	74,296	79,838	80,386
BTR1 - NID1	86,035	88,409	90,871	93,423	96,064	98,690	101,318	102,013
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1			103,454	103,971				

Other primary solid waste (vegetable waste) (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
	80,750	81,129						
	102,475	102,955			BUR2 - NIR1	-	-	
		-	-	-				
		104,506	105,063	111,850				
BTR1 - NID1			143,551	147,469				
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
	36,734	38,227						
	136,094	139,751			BUR2 - NIR1	39,661	41,363	
		42,953	44,859	46,822	51,509			
		151,498	155,634	159,887	164,278			
BTR1 - NID1			178,302	183,299				
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
	52,270	52,486						
	168,808	173,475			BUR2 - NIR1	56,092	59,696	
		64,802	63,916	62,323	64,322			
		188,408	193,559	198,714	203,829			
BTR1 - NID1			219,772	225,218				

Charcoal (kt)

Year	2000	2001	2002	2003	2004	2005	2006	2007
	66,385	70,114						
	209,003	214,353			BUR2 - NIR1		- -	
		-	-	-				
		230,782	236,403	238,168				
BUR2 - NIR1	2,622	2,708	2,768	2,893	2,913	2,998	3,079	3,165
BTR1 - NID1	1,026	1,156	1,289	1,462	1,596	1,785	1,989	2,800
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	3,172	3,294	3,358	3,446	3,514	3,610	3,670	3,770
BTR1 - NID1	2,558	2,191	2,525	2,893	3,320	3,106	3,190	3,276
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	3,850	3,939	-	-	-	-	-	
BTR1 - NID1	3,292	3,347	3,403	3,461	3,519	3,576	4,039	

Table 3.49 provides Emission Factors used direct gases for the Residential sub-category.

Table 3.49. Emission Factors used for direct gases in Residential

Sub-category	Fuel type	Emission Factor (kg/TJ)			Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2
		CO2	CH4	N2O	
Residential	Gasoline	69,300	10	0.6	Chapter 2, page 2.22, Table 2.5
	Diesel	74,100	10	0.6	" "
	Other kerosene	71,900	10	0.6	" "
	LPG	63,100	5	0.1	" "
	Wood/ wood waste	112,000	300	4	" "
	Other primary solid biomass	100,000	300	4	" "
	Charcoal	112,000	200	1	" "

Table 3.50 provides Emission Factors used for indirect gases in the Residential sub-category.

Table 3.50. Emission Factors used for indirect gases in Residential

Sub-category	Fuel type	Emission Factor (g/GJ)				Source: EMEP/EEA air pollutant emission inventory guidebook 2023, 1.A.4 -Small combustion
		NOx	CO	NMVOC	SO2	
Residential	Gasoline	51	57	0.69	70	Table 3-5
	Diesel	51	57	0.69	70	Table 3-5
	Other kerosene	51	57	0.69	70	Table 3-5
	LPG	51	26	1.9	0.3	Table 3-4
	Wood/ wood waste	50	4,000	600	11	Table 3-6
	Oth primary solid biomass	50	4,000	600	11	Table 3-6
	Charcoal	50	4,000	600	11	Table 3-6

Agriculture/forestry/fishing (CRT 1.A.4.c)

Table 3.51 provides Activity data used for the Agriculture / forestry / fishing (Stationary) sub-category.

Table 3.51. Activity Data used for Agriculture / forestry / fishing: (2000-2022)

Stationary - Diesel (000 tons)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	5	5	8	8	9	9	10	4
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	8	4	8	4	4	4	4	4
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	4	4	4	4	4	5	5	

Stationary - Other kerosene (000 tons)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	5	10	1	7	7	7	5	3
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	5	3	3	4	3	13	14	13
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	4	7	8	9	6	7	9	

Off-road vehicle - Diesel (000 tons)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	9	9	10	9	7	8	6	5
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	5	4	3	3	2	10	11	10
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	-
BTR1 - NID1	13	13	9	9	6	8	10	-

Table 3.52 provides Emission Factors used direct gases for the Agriculture / forestry / fishing sub-category.

Table 3.52. Emission Factors used for direct gases in Agriculture / forestry / fishing: Stationary and Off-road vehicle

Sub-category	Fuel type	Emission Factor (kg/TJ)			Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2
		CO2	CH4	N2O	
Agriculture, forestry and fishing: Stationary	Other kerosene	71,900	10	0.6	Chapter 2, page 2.22, Table 2.5
	Diesel	74,100	10	0.6	Chapter 2, page 2.22, Table 2.5
Agriculture, forestry and fishing: Off-road vehicles and other machinery	Diesel	74,100	4.15	28.6	Chapter 3, page 3.36, Table 3.3.1

Table 3.53 provides Emission Factors used for indirect gases for the Agriculture / forestry / fishing sub-category.

Table 3.53. Emission Factors used for indirect gases in category Agriculture / forestry / fishing: Stationary and Offroad vehicle

Sub-category	Fuel type	Emission Factor (g/GJ)	Source: EMEP/EEA air pollutant emission inventory guidebook

		NOx	CO	NMVOC	SO2	2023, 1.A.4 -Small combustion
Agriculture, forestry and fishing: Stationary	Gasoline	306	93	20	94	Table 3-9
	Diesel	306	93	20	94	Table 3-9
Agriculture, forestry and fishing: Off-road vehicles and other machinery	Diesel	34,457 g/t fuel	11,469 g/t	3,542 g/t fuel	Not available	(i) 1.A.4 - Non-road mobile machinery, Table 3.1

No CO2 was captured and stored

3.2.7.3. Description of any flexibility applied

Not resorted to for all sub-categories

3.2.7.4. Uncertainty assessment and time-series consistency

The uncertainty levels assigned to the AD (Table 3.60) and to the EFs are the default ranges from the IPCC 2006 guidelines. They are ±15% and ±60% for Liquid Fuels and ±60% for solid Biomass respectively for AD for Commercial/institutional, residential and Stationary respectively as applicable. It is ±100 for Liquid fuels for Off-road vehicles and other machinery AD. The uncertainty level assigned for EFs is between ±2.41% and 6.14 for CO2, the range is -59.91 to + 150.22 for CH4 and the range -50.00 to +240, as depicted in Table 3.54.

Table 3.54. Uncertainty levels assigned for the category Other Sectors

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
1.A.4.a - Commercial/Institutional			
	CO2	±15	-5.33 to + 6.14
			-70.00 to + 200.00
	N2O	±60	
1.A.4.b -Residential			
1.A.4.c.i - Stationary - Liquid Fuels	CH4	±15	
	N2O	±15	-67.12 to +236.36
1.A.4.c.ii -Off-road vehicles and other machinery			
	N2O	±60	
1.A.4.c.i - Stationary			
1.A.4.a - Commercial/institutional - Liquid Fuels 1.A.4.b - Residential - Liquid Fuels	CO2	±15	-5.33 to + 6.14
	CH4	±15	-70.00 to + 200.00
	N2O	±15	-67.12 to +236.36
1.A.4.a - Commercial/institutional - Biomass - Solid 1.A.4.b - Residential - Biomass - solid	CO2	±60	-15.22 to +17.57
	CH4	±60	-66.10 to +200.00
			-60.00 to +240.00
1.A.4.c.ii - Off-road vehicles and other machinery - Liquid Fuels	CO2	±100	-2.41 to + 3.87
	CH4	±100	-59.91 to + 150.22
	N2O	±100	-50.00 to +200.00

1: Source - 2006 Guidelines, Volume 2, (a) Chapter 2, Page 2.41, Table 2.15
(b) Chapter 3, Page 3.38, p. 3.3.2.1
2: Source - Tier 1 default values which are in line with IPCC 2006 Guidelines are taken from IPCC GHG inventory software, version 2.93.

The estimated combined uncertainties are 145.3% and 132.6% for the level assessment for base year 2000 and yeart 2022 respectively and 103.3% for the trend between base year 2000 and year-t 2022 (Table 3.55)

Table 3.55. Uncertainty assessment for the category Other Sectors

A	B	C	D	E	F	H	H	M
2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Gg CO2 equivalent)	Year T (2022) emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Contribution to Variance by Category in Year 2000	Contribution to Variance by Category in Year 2022	Uncertainty introduced into the trend in total national emissions (%)
1.A.4 - Other sectors								
1.A.4.a - Commercial/Institutional - Liquid Fuels	CO2	39.7	2608.2	15.0	6.1	0.0	0.5	3.1
1.A.4.a - Commercial/Institutional - Liquid Fuels	CH4	0.1	9.7	15.0	200.0	0.0	0.0	0.0
1.A.4.a - Commercial/Institutional - Liquid Fuels	N2O	0.1	5.4	15.0	228.8	0.0	0.0	0.0

A	B	C	D	E	F	H	H	M
2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Gg CO2 equivalent)	Year T (2022) emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Contribution to Variance by Category in Year 2000	Contribution to Variance by Category in Year 2022	Uncertainty introduced into the trend in total national emissions (%)
1.A.4.a - Commercial/Institutional - Biomass - solid	CO2	0.0	0.0	60.0	17.6	0.0	0.0	0.0
1.A.4.a - Commercial/Institutional - Biomass - solid	CH4	487.5	1049.1	60.0	200.0	9.6	12.7	8.0
1.A.4.a - Commercial/Institutional - Biomass - solid	N2O	59.1	121.7	60.0	250.0	0.2	0.3	0.1
1.A.4.b - Residential - Liquid Fuels	CO2	6736.3	14127.7	15.0	6.1	11.0	13.9	83.3
1.A.4.b - Residential - Liquid Fuels	CH4	26.5	53.2	15.0	200.0	0.0	0.0	0.0
1.A.4.b - Residential - Liquid Fuels	N2O	15.0	28.6	15.0	236.4	0.0	0.0	0.0
1.A.4.b - Residential - Biomass - solid	CO2	0.0	0.0	60.0	17.6	0.0	0.0	0.0
1.A.4.b - Residential - Biomass - solid	CH4	22592.1	38531.1	60.0	200.0	20612.2	17157.1	10401.8
1.A.4.b - Residential - Biomass - solid	N2O	2837.5	4809.6	60.0	250.0	493.0	405.3	168.4
1.A.4.c.i - Stationary - Liquid Fuels	CO2	32.7	45.2	15.0	6.1	0.0	0.0	0.0
1.A.4.c.i - Stationary - Liquid Fuels	CH4	0.1	0.2	15.0	200.0	0.0	0.0	0.0
1.A.4.c.i - Stationary - Liquid Fuels	N2O	0.1	0.1	15.0	236.4	0.0	0.0	0.0

1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CO2	28.0	30.3	100.0	3.9	0.0	0.0	0.0
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CH4	0.0	0.0	100.0	150.2	0.0	0.0	0.0
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	N2O	2.9	3.1	100.0	200.0	0.0	0.0	0.0
Sum		**32857.8**	**61423.2**			**21126.0**	**17589.8**	**10664.7**
Uncertainty in level (L) and trend (T) assessment						**L - 145.3**	**L -132.6**	**T - 103.3**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

3.2.7.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, AD in terms of fuel by type combusted for Residential, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations, reference material and conversion factors. Quality Assurance during the estimation steps was done by independent international experts

3.2.7.6. Category-specific recalculations

New sets of improved AD for the period 2000 to 2017 (Table 3.56) became available and hence recalculations were undertaken along with AD for the period 2018 to 2022 to complete the full time series. The recalculations led to an increase in emissions varying between 31% and 74%.

Table 3.56. Other sectors – recalculations

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	21,804	25,613	21,931	25,129	25,093	26,381	25,526	25,216	26,813	25,870	24,351	25,044
BTR1 - NID1	32,858	36,042	37,204	36,582	35,585	38,929	38,341	38,420	40,868	40,678	39,869	41,266
% change	51	41	70	46	42	48	50	52	52	57	64	65
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	24,377	37,132	39,650	38,635	36,422	38,301	-	-	-	-	-	
BTR1 - NID1	42,349	49,559	51,756	51,419	53,823	54,548	54,486	56,303	54,843	57,601	61,423	
% change	74	33	31	33	48	42	-	-	-	-	-	

3.2.7.7. Category-specific planned improvements

Liquid fuels under Other sectors, Agriculture/Forestry/Fishing is a key category based on this NID and need to be addressed at the Tier 2 level. A deeper analysis will be performed to identify which economic sector is responsible so as to guide collection of disaggregated data and/or generate country-specific EFs for moving to Tier 2. This exercise is planned for completion and adoption in the next inventory in 2028.

3.2.8. Other (CRT 1.A.5)

Included Elsewhere as it has not been possible to track fuels combusted in this category for confidentiality purposes such as for defence.

3.2.8.1. Category description

Not Applicable as Included Elsewhere

3.2.8.2. Methodological issues

Not Applicable as Included Elsewhere

3.2.8.3. Description of any flexibility applied

Not Applicable as Included Elsewhere

3.2.8.4. Uncertainty assessment and time-series consistency

Not Applicable as Included Elsewhere

3.2.8.5. Category-specific QA/QC and verification

Not Applicable as Included Elsewhere

3.2.8.6. Category-specific recalculations

Not Applicable as Included Elsewhere

3.2.8.7. Category-specific planned improvements

Not Applicable as Included Elsewhere

3.3. Fugitive emissions from solid fuels and oil and natural gas and other emissions from energy production (CRT 1.B)

Fugitive emissions include all intentional and unintentional emissions from the extraction, processing, storage and transport of fuel to the point of final use.

Fugitive emissions comprise 2 categories: Solid fuels (CRT 1.B.1) and Oil and natural gas (CRT 1.B.2) and emissions from that subsector increased by 52%, from 20,413 kt CO2 e in 2000 to 31,096 kt CO2 e in 2022 (Table 3.57).

The trend of emissions is provided in Table 3.57 for selected years. The Oil and Gas category is the main contributor throughout the time series. It increased by 33%, rising from 18,997 kt CO2 e in 2000 to 25,351 kt CO2 e in 2022. Emissions from Solid fuels rose from 1,416 kt CO2 e in 2000 to 5,745 kt CO2 e, representing an increase of 305.5%.

Table 3.57. Fugitive emissions (kt CO2 e) from year 2000 to year 2022

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.B - Fugitive emissions from fuels	20,413	22,639	20,887	24,203	26,784	27,461	28,304	30,858	29,828
1.B.1 Solid fuels	1,416	1,579	1,761	1,968	2,202	2,464	2,757	3,882	3,556
1.B.2 Oil and natural gas	18,997	21,061	19,127	22,235	24,582	24,997	25,547	26,976	26,272

Category	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.B - Fugitive emissions from fuels	25,530	31,932	32,670	34,388	31,169	33,695	36,672	33,759	34,979
1.B.1 Solid fuels	3,083	3,550	4,095	4,709	4,438	4,571	4,696	4,701	4,782
1.B.2 Oil and natural gas	22,447	28,382	28,574	29,679	26,731	29,123	31,975	29,058	30,197

Category	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1.B - Fugitive emissions from fuels	37,011	37,543	35,964	33,563	31,096	52.3%
1.B.1 Solid fuels	4,897	4,977	5,055	5,078	5,745	305.5%
1.B.2 Oil and natural gas	32,113	32,567	30,909	28,486	25,351	33.4%

3.3.1. Solid fuels (CRT 1.B.1)

3.3.1.1. Category description

Emissions from Solid fuels includes all intentional and unintentional emissions from the extraction, processing, storage and transport of solid fuel to the point of final use.

Solid fuels include two subcategories with emissions occurring, Coal mining and handling (CRT 1.B.1.a) and Fuel transformation (CRT 1.B.1.b). No emissions occurred in the Other (CRT 1.B.1.c) sub-category.

Emissions from Solid fuels increased by 305% during the review period, from 1,416 kt CO2 e in 2000 to 5,745 kt CO2 e in 2022 (Figure 3.14 and Table 3.58).

The trend of emissions for Solid Fuels is given in Figure 3.14. Fuel transformation emitted almost all, more than 98% of the GHGs throughout the time series.

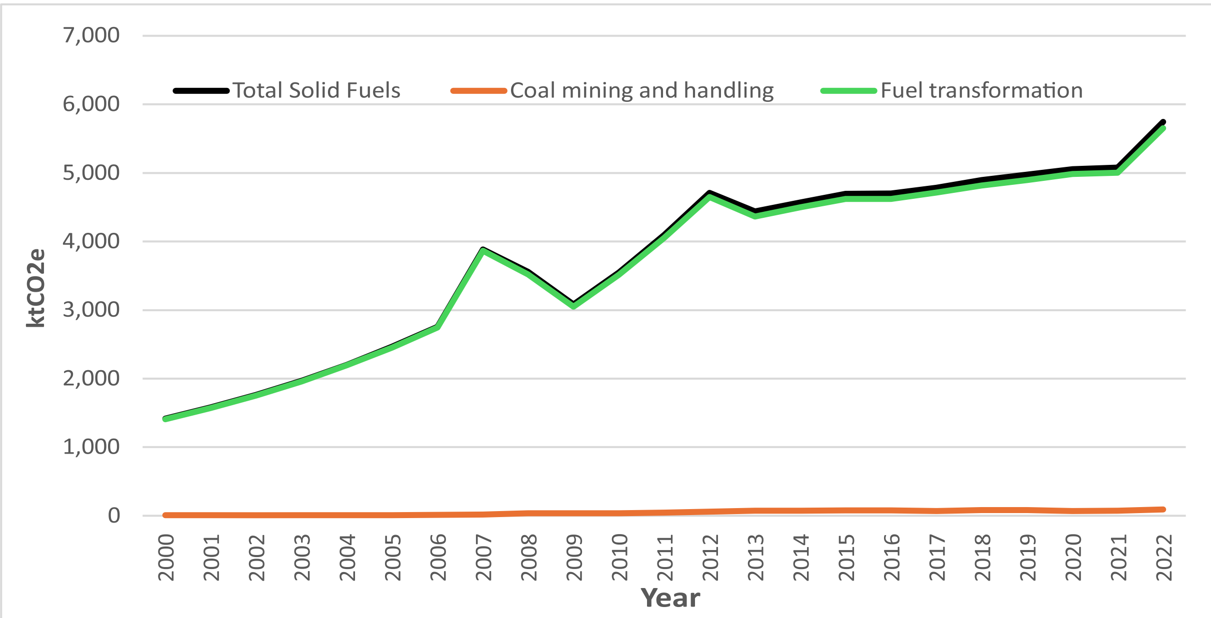

Figure 3.14. Trends of emissions (kt CO2 e) by sub-category for Solid Fuels (2000-2022)

Table 3.58. Emissions (kt CO2 e) for Solid Fuels category (2000-2022)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1,416	1,579	1,761	1,968	2,202	2,464	2,757	3,882	3,556	3,083	3,550	4,095
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
4,709	4,438	4,571	4,696	4,701	4,782	4,897	4,977	5,055	5,078	5,745	

The trend of emissions by gas is provided in Figure 3.15. Emissions from Solid fuels originated mostly from CH4 which represented a share of 98.1% of aggregated emissions which remained almost constant during the 2000 to 2022 period. CH4 emissions rose from 1,390 kt CO2 e in 2000 to reach 5,637 kt CO2 e in 2022 (+305.5%).

N2O emissions rose from 26 kt CO2 e in 2000 to 104.2% in 2022 (+301.6%), while that of CO2 rose from 0.3 kt CO2 e in 2000 to 3.0 kt CO2 e in 2022. These two gases contributed 1.9% to total aggregated emissions.

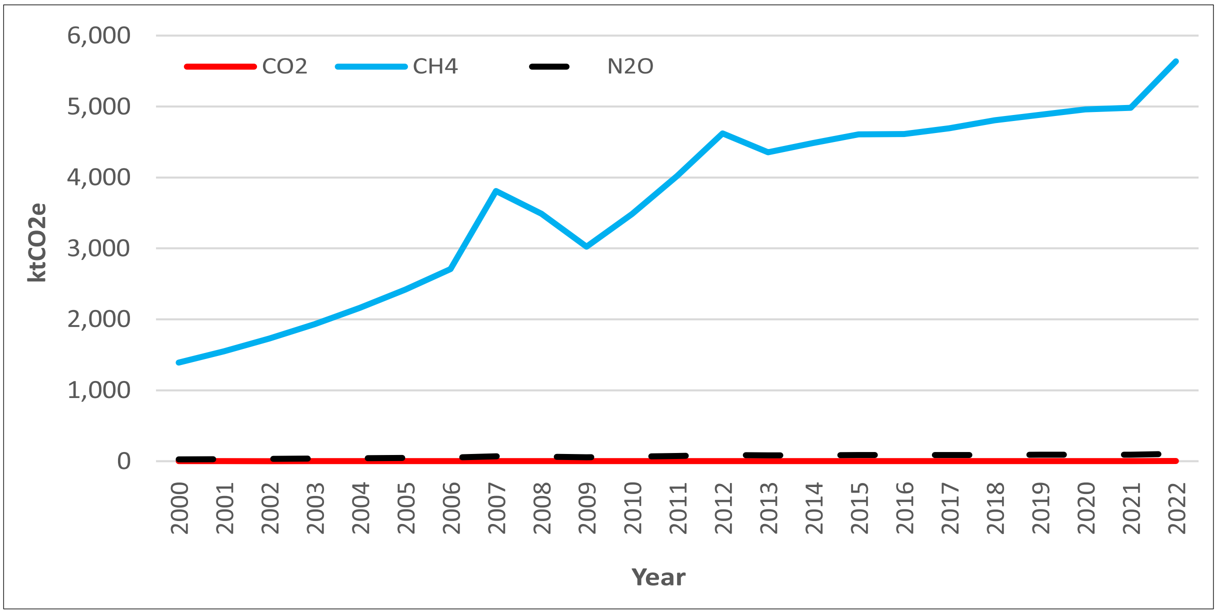

Figure 3.15. Trend of emissions (kt CO2 e) by gas for Solid Fuels (2000-2022)

Coal mining and handling (CRT 1.B.1.a)

Emissions from coal and mining increased from 9.1 kt CO2 e in 2000 to 192 kt CO2 e in 2022, which represent a 10fold increase over the period (Table 3.61). Coal mining and handling contribution to emissions from Solid fuels remained modest at 0.6% in 2000 to reach 1.6% in 2022 (Table 3.59).

Fuel transformation (CRT 1.B.1.b)

Fuel transformation activities were by far those which contributed the most to emissions from Solid fuels, with a share of 99.4% in 2000 which decreased slightly to 98.4% in 2022, representing 1,407 kt CO2 e and 5,653 kt CO2 e during these respective years (Table 3.59).

Table 3.59. Emissions (kt CO2 e) for Solid Fuels category by sub-category for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1.B.1 Solid fuels	1,416	2,464	3,550	4,696	4,897	4,977	5,055	5,078	5,745	305.5%
1.B.1.a - Coal										
	1,407	2,454	3,513	4,619	4,816	4,894	4,984	5,002	5,653	301.6%

mining and 9 10 37 77 81 82 71 76 92 907.6% handling
1.B.1.b - Fuel transformation

3.3.1.2. Methodological issues

The chosen method is Tier 1 level based on the applicable decision tree from the IPCC 2006 guidelines using national AD from international databases and default EFs from the IPCC 2006 guidelines for all Solid fuels sub-categories.

Coal mining and handling (CRT 1.B.1.a)

Table 3.60 provides updated Activity Data used for Coal Mining and Handling for the period 2000 to 2022 compared to those used in the previous inventory (NIR1).

Table 3.60. Activity Data used for Coal Mining and Handling (Amount of raw coal produced [t]) (2000-2022)

Surface mines (i) Mining activities, (ii) Post-mining activities)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	3,600	3,600	51,600	27,600	9,600	9,600	9,600	27,600
BTR1 - NID1	362,400	348,000	304,800	333,600	333,600	392,400	478,800	681,600
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	38,400	40,800	45,600	38,400	57,600	52,800	55,200	56,400
BTR1 - NID1	1,450,800	1,450,800	1,450,800	1,741,200	2,322,000	2,902,800	2,902,800	3,048,000
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	55,200	55,200	-	-	-	-	-	-
BTR1 - NID1	3,192,000	2,757,209	3,230,012	3,267,148	2,821,626	3,007,259	3,651,600	-

Table 3.61 provides updated Activity Data used for Fuel Transformation for the period 2000 to 2022 compared to those used in the previous inventory (NIR1).

Table 3.61. Activity Data used for Fuel Transformation (Amount of charcoal produced [t]) (2000-2022)

Charcoal production

Year					2004	2005	2006	2007
BUR2 - NIR1	1,218,000	1,361,000	1,521,000	1,698,000	1,897,000	2,120,000	2,367,000	3,333,000
BTR1 - NID1	1,224,223	1,365,666	1,524,730	1,704,710	1,908,195	2,134,598	2,387,924	3,361,634
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	3,054,000	2,619,000	3,029,000	3,483,000	4,005,000	3,743,000	3,867,000	3,971,000
BTR1 - NID1	3,061,715	2,650,342	3,056,088	3,524,278	4,044,970	3,796,919	3,912,746	4,018,171
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	3,966,000	4,032,602	-	-	-	-	-	-
BTR1 - NID1	4,019,530	4,099,397	4,189,039	4,257,392	4,335,218	4,350,924	4,916,952	-

Table 3.62 provides Emission Factors used for direct and indirect gases for Surface mines and Charcoal production.

Table 3.62. Emission Factors used for Surface mines and Charcoal production (2000-2022)

Sub-category	Activity data	Emission Factors of direct gases			
		Emission Factor[1]			Source: 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories/ Volume 2/Chapter 4 - Fugitive Emissions
		CO2	CH4	N2O	
Mining activities	Raw coal production	0.44 m3/ton	1.2 m3/ton	Not applicable	Paragraph 4.1.4.2, Page 4.25
Post-mining activities		Not available	0.1 m3/ton	Not available	Paragraph 4.1.4.2, Page 4.26
Charcoal production	Charcoal production	1570 g/kg of charcoal produced	40.3 g/kg of charcoal produced	0.08 g/kg of charcoal produced	Table 4.3.3 (New), page 4.101

Sub-category	Activity data	Emission Factors of indirect gases				
		Emission Factor (kg/Ton fuel)				Source
		NOx	CO	NMVOC	SO2	
Mining activities	Raw coal production	Not applicable	Not applicable	0.8	Not applicable	EMEP/EEA Guidebook 2023, 1.B.1.a Fugitive emissions from solid fuels: coal mining and handling, Table 3.2, page 8
Post-mining activities		Not applicable	Not applicable	0.8	Not applicable	
Charcoal production	Charcoal production	0.07	220	Not applicable	Not applicable	2019 Refinements to 2006 IPCC Guidelines, Table 4.3.3 (New), page 4.103

Note 1: Average emission factor used for (i) Mining activities and (ii) Post -mining activities

No CO2 was captured and stored

3.3.1.3. Description of any flexibility applied

Not resorted to for all sub-categories

3.3.1.4. Uncertainty assessment and time-series consistency

The uncertainty levels assigned to the AD (Table 3.63) are ±10% for mining activities and ±60% for charcoal and biochar production. For the EFs, default ranges of -67% to +200% and -38% and +60% for CO2 in Mining activities and Charcoal and Biochar production, were assigned respectively while for CH4 it is ±150% for Mining and postmining activities while in Charcoal and Biochar it is -68% to 121%. The levels assigned for N2O are -75 to +163% for N2O. All uncertainty values from the IPCC 2006 have been allocated.

Table 3.63. Uncertainty levels assigned for Solid fuels

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
1.B.1 - Solid fuels			
1.B.1.a.ii.1 - Mining activities	CO2	±10	-67 to +200
	CH4	±10	-150 to +150

1.B.1.a.ii.2 - Post-mining activities	CO2	±10	Not applicable
	CH4	±10	-150 to +150
1.B.1.b.i - Charcoal and biochar production	CO2	±60	-38 to +60
	CH4	±60	-68 to +121
	N2O	±60	-75 to +163

1: Source:(i) Mining activities - 2019 Refinement, Vol.2, Chapter 4, p. 4.1.3.6, page 4.23 and Chapter 2, Page 2.41, Table 2.15
(ii) Charcoal and biochar production - 2019 Refinement, Vol.2, Chapter 4, page 4.103
2: Source:(i) Mining activities - 2019 Refinement, Vol.2, Chapter 4, p. 4.1.4.6, Table 4.1.4 (Updated), page 4.26
(ii) Charcoal and biochar production - 2019 Refinement, Vol.2, Chapter 4, Table 4.3.3 (New), page 4.103

The estimated combined uncertainties are 131.8% for the level assessment for the base year 2000 and 130.5% for year-t 2022, and 332.5% for the trend between base year 2000 and year-t 2022 (Table 3.64).

Table 3.64. Uncertainty assessment for Solid Fuels

2006 IPCC Categories	Gas	Base Year (2000) (Gg CO2 equivalent)	Year T (2022) (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Contribution to Variance by Category in Year 2000	Contribution to Variance by Category in Year 2022	Uncertainty introduced into the trend in total national emissions (%)
1.B.1. Solid fuels								
1.B.1.a.ii.1 - Mining activities	CO2	0.3	2.9	10.0	200.0	0.0	0.0	0.1
1.B.1.a.ii.1 - Mining activities	CH4	8.2	82.2	10.0	150.0	0.7	4.6	27.7
1.B.1.a.ii.2 - Post-mining activities	CO2	0.0	0.0	10.0	200.0	0.0	0.0	0.0
1.B.1.a.ii.2 - Post-mining activities	CH4	0.7	6.9	10.0	150.0	0.0	0.0	0.2
1.B.1.b.i - Charcoal and biochar production	CO2	0.0	0.0	60.0	60.0	0.0	0.0	0.0
1.B.1.b.i - Charcoal and biochar production	CH4	1,381.4	5,548.3	60.0	121.0	17,348.6	17,016.1	110,484.2
1.B.1.b.i - Charcoal and biochar production	N2O	26.0	104.2	60.0	163.0	10.1	9.9	39.0
Sum		**1,416.5**	**5,744.5**			**17,359.5**	**17,030.7**	**110,551.2**
Uncertainty in level (L) and trend (T) assessment						**L - 131.8**	**L - 130.5**	**T - 332.5**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

3.3.1.5. Category-specific QA/QC and verification

The quality control checks were in line with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations, reference material and conversion factors. Quality Assurance during the estimation steps was done by independent international experts.

3.3.1.6. Category-specific recalculations

Recalculations were resorted to following availability of better-quality AD for the period 2000 to 2017 and changes in methodology when adopting the 2019 Refinements, namely Fuel Transformation that was not a separate subcategory but was treated under Manufacture of solid Fuels under Energy Industries. This led to a very high increment in emissions, from 1,415 kt CO2 e in 2000 increasing to 4,761 kt CO2 e in 2022 compared emissions of 1 kt CO2 e and 21 kt CO2 e for these 2 years respectively.

Table 3.65. emissions (kt CO2 e) from Solid fuels – recalculations

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	1	1	20	11	4	4	4	11	15	16	18	15
BTR1 - NID1	1,416	1,579	1,761	1,968	2,202	2,464	2,757	3,882	3,556	3,083	3,550	4,095
Difference	1,415	1,578	1,741	1,957	2,198	2,460	2,753	3,871	3,541	3,067	3,532	4,080
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	22	20	21	22	21	21	-	-	-	-	-	
BTR1 - NID1	4,709	4,438	4,571	4,696	4,701	4,782	4,897	4,977	5,055	5,078	5,745	
Difference	4,687	4,418	4,550	4,674	4,680	4,761						

3.3.1.7. Category-specific planned improvements

Sub-category charcoal production under Fuel transformation is a key category and emissions must be estimated at the Tier 2 level. The required additional AD and information for moving to Tier 2 will be collected and applied in the compilation of the next inventory in 2030.

3.3.2. Oil and natural gas and other emissions from energy production (CRT 1.B.2)

3.3.2.1. Category description

Oil and natural gas and other emissions from energy production include fugitive emissions from all oil and natural gas activities. The primary sources of these emissions may include fugitive equipment leaks, evaporation losses, venting, flaring and accidental releases.

Oil and natural gas and other emissions from energy production comprise Oil (CRT 1.B.2.a), Natural gas (CRT 1.B.2.b) and Venting and flaring (CRT 1.B.2.c).

The trend of emissions for the Oil and Gas category is given in Figure 3.16 and Table 3.66 for selected years. Emissions increased by 33% from 18,997 kt CO2 e in 2000 to 25,351 kt CO2 e in 2022. Venting and Flaring topped the emissions followed by Natural Gas and Oil contributing least. In 2022, Venting and Flaring contributed 68%, Natural Gas 28% and Oil 4%.

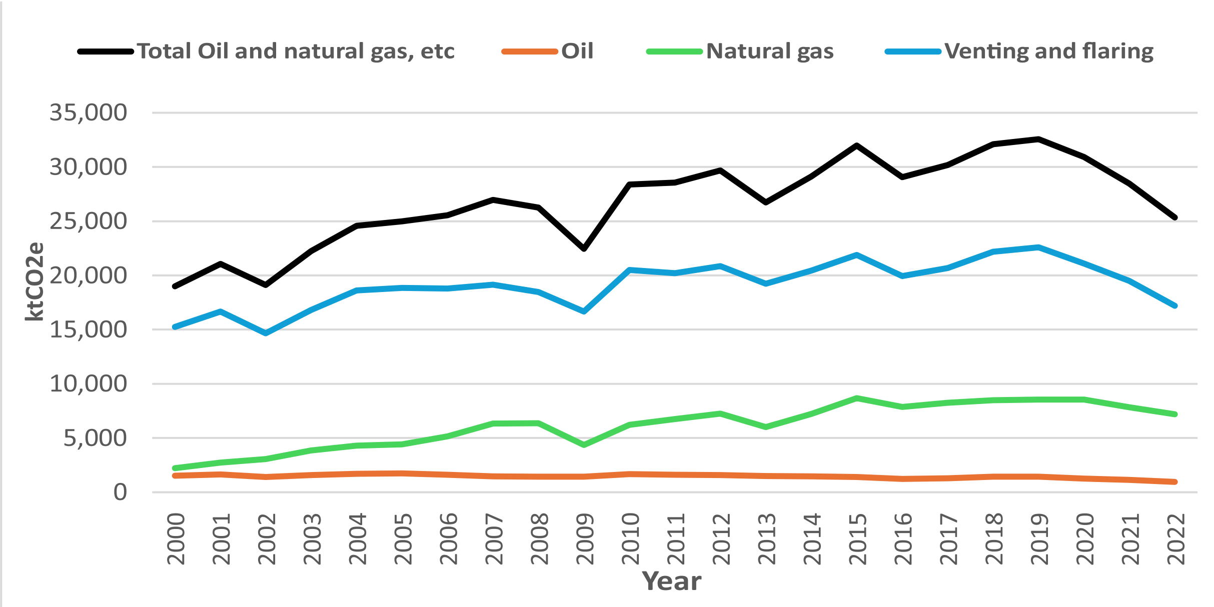

Figure 3.16. Trends of emissions (kt CO2 e) by sub-category for Oil and natural gas and other emissions from energy production (2000-2022)

The trend of emissions by gas is given in Figure 3.17. CH4 accounted for 17,886 kt CO2 e in 2000 and that contribution increased in a jiggered pattern to reach 24,499 kt CO2 e in 2022 (Figure 3.17), representing an increase of 37.0%.

The share of CH4 increased from 94.2% in 2000 to 96.6% in 2022. CO2 emissions showed a net decrease of 23.3%, from 1,107 kt CO2 e in 2000 to 849 kt CO2 e in 2022. Its share decreased from 5.8% in 2000 to 3.4% in 2022 (Figure 3.17). Yearly changes exhibited a jiggered pattern. A relatively low amount of N2O were emitted, with 3.5 kt CO2 e in 2000, decreasing to 2.8 kt CO2 e in 2022 (-20.4%).

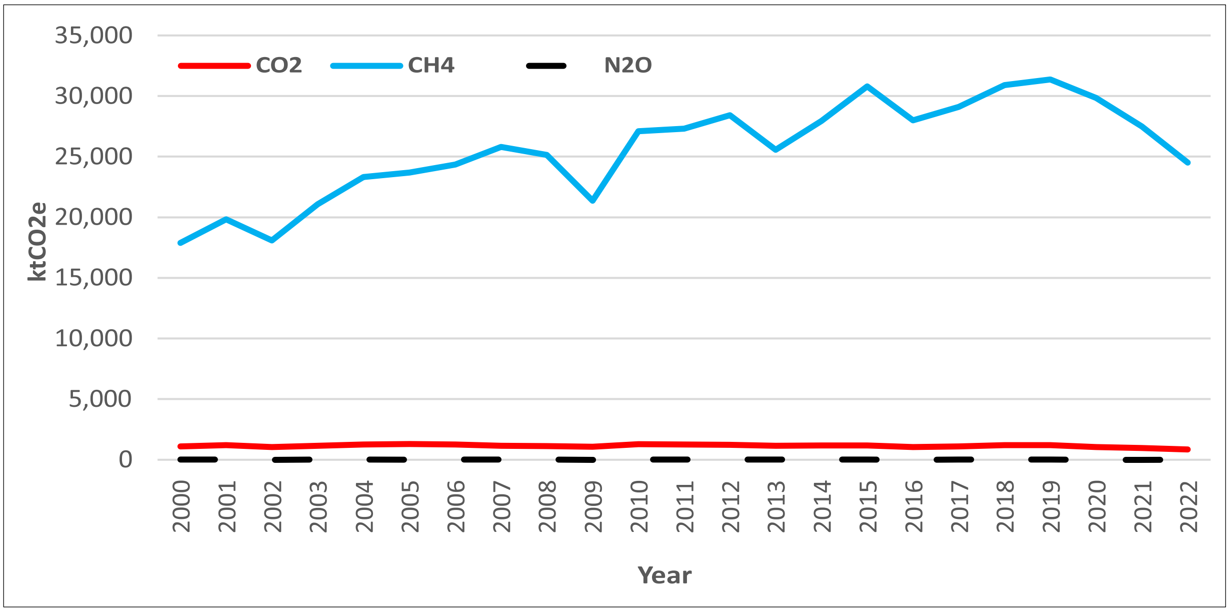

Figure 3.17. Trend of emissions (kt CO2 e) by gas for Oil and natural gas and other emissions from energy production (2000-2022)

Oil (CRT 1.B.2.a)

The subcategory Oil Comprises emissions from venting, flaring and all other fugitive sources associated with the exploration, production, transmission, upgrading, and refining of crude oil and distribution of crude oil products.

Emissions from oil decreased from 1,529 kt CO2 e in 2000 to 955 kt CO2 e in 2022, showing a reduction of 574.1 kt CO2 (-37.6%) (Table 3.66).

Natural gas (CRT 1.B.2.b)

Emissions from Natural gas rose from 2,223 kt CO_2 e in 2000 to 7,205 in 2022, representing an increase of 224% (Table 3.66).

Venting and flaring (CRT 1.B.2.c)

Emissions from Venting and flaring increased from 15,245 kt CO_2 e in 2000 to 17,191 kt CO_2 e in 2022, representing an increase of 13% (Table 3.66).

Table 3.66. Emissions (kt CO_2 e) for Oil and natural gas and other emissions from energy production by subcategory for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
1.B.2 Oil and natural gas and other emissions from energy production	18,997	24,997	28,382	31,975	32,113	32,567	30,909	28,486	25,351	33%
Oil	1,529	1,739	1,660	1,409	1,430	1,437	1,248	1,147	955	-38%
Natural gas	2,223	4,412	6,217	8,682	8,502	8,536	8,562	7,829	7,205	224%
Venting and flaring	15,245	18,847	20,506	21,885	22,182	22,594	21,099	19,509	17,191	13%

Other (CRT 1.B.2.d)

Not occurring

3.3.2.2. Methodological issues

The chosen method is Tier 1 level based on the applicable decision tree from the IPCC 2006 guidelines using national AD from international databases and default EFs from the IPCC 2006 guidelines for all Oil and natural gas subcategories.

Oil (CRT 1.B.2.a)

Table 3.67 provides Activity Data for subcategory Oil. Previously AD from Onshore and Offshore production were aggregated and are now available separately. AD for the different segments represent the different steps from production to distribution, including upgrading, refining and transport.

Table 3.67. Activity Data used for subcategory Oil (2000-2022)

(i) Production and Upgrading

Production (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	130,862	137,335	115,412	134,212	144,715	146,067	138,202	127,677
BTR1 - NID1								
Onshore	47,110	49,441	41,548	48,316	52,097	52,584	49,753	45,964
Offshore	83,752	87,895	73,864	85,896	92,618	93,483	88,449	81,713
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	122,231	124,075	142,471	137,733	135,591	127,278	126,968	122,980
BTR1 - NID1								
Onshore	44,003	44,667	51,290	49,584	48,813	45,820	45,709	44,273
Offshore	78,228	79,408	91,181	88,149	86,779	81,458	81,260	78,707
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	106,530	109,669	-	-	-	-	-	
BTR1 - NID1								

Onshore	38,351	39,481	44,289	45,266	39,465	36,238	30,121	
Offshore	68,179	70,188	78,736	80,473	70,159	64,423	53,549	

(ii) Transport

Liquefied natural gas (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	7,168	8,287	8,214	13,123	11,616	5,304	6,823	10,440
BTR1 - NID1	-	-	-	-	-	-	-	-
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	9,390	7,621	4,735	8,867	9,342	8,521	11,084	11,928
BTR1 - NID1	-	-	-	-	-	-	-	-
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	28,544	31,709	-	-	-	-	-	
BTR1 - NID1	-	-	-	-	-	-	-	

Liquefied petroleum gas (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	90	80	93	93	107	67	93	111
BTR1 - NID1	-	-	-	-	-	-	-	-
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	130	167	204	222	259	300	356	563
BTR1 - NID1	-	-	-	-	-	-	-	-
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	722	-	-	-	-	-	-	
BTR1 - NID1	-	-	-	-	-	-	-	

Pipelines (Oil production) (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	130,862	137,335	115,412	134,212	144,715	146,067	138,202	127,677
BTR1 - NID1	130,862	137,335	115,412	134,212	144,715	146,067	138,202	127,677
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	122,231	124,075	142,471	137,733	135,591	127,278	126,968	122,980
BTR1 - NID1	122,231	124,075	142,471	137,733	135,591	127,278	126,968	122,980
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	106,530	109,669	-	-	-	-	-	
BTR1 - NID1	106,530	109,669	123,025	125,738	109,624	100,662	83,670	

(iii) Oil refining

Crude processed (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	5,769	12,960	12,653	7,125	6,046	11,231	6,908	3,030
BTR1 - NID1	5,769	12,960	12,653	7,125	6,046	11,231	6,908	3,030
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	6,243	2,822	5,545	6,266	5,347	5,602	3,714	1,271

BTR1 - NID1	6,243	2,822	5,545	6,266	5,347	5,602	3,714	1,271
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	3,578	4,687	-	-	-	-	-	
BTR1 - NID1	3,578	4,687	4,244	707	0	166	290	

(iv) Distribution of products

Diesel, consumption data (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	2,580	2,671	2,803	2,668	1,921	2,374	1,654	1,388
BTR1 - NID1	2,580	2,671	2,803	2,668	1,921	2,374	1,654	1,388
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	1,521	1,133	882	980	678	2,838	3,227	2,838
BTR1 - NID1	1,521	1,133	882	980	678	2,838	3,227	2,838
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	3,912	3,907	-	-	-	-	-	
BTR1 - NID1	3,912	3,907	4,539	5,043	3,926	4,587	4,723	

Gasoline, consumption data (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	4,789	7,185	8,739	8,778	8,254	8,695	8,356	8,912
BTR1 - NID1	4,789	7,185	8,739	8,778	8,254	8,695	8,356	8,912
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	9,557	9,562	6,391	5,722	5,047	15,989	17,503	15,989
BTR1 - NID1	9,557	9,562	6,391	5,722	5,047	15,989	17,503	15,989
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	17,511	17,437	-	-	-	-	-	
BTR1 - NID1	17,511	17,437	18,347	19,618	17,349	19,478	20,562	

Kerosene, consumption data (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	186	319	347	402	90	285	288	348
BTR1 - NID1	186	319	347	402	90	285	288	348
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	1,065	808	208	232	55	433	386	433
BTR1 - NID1	1,065	808	208	232	55	433	386	433
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	542	511	-	-	-	-	-	
BTR1 - NID1	542	511	847	711	340	500	686	

Table 3.68 provides Emission Factors for direct and indirect gases for the oil subcategory.

Table 3.68. Emission Factors for subcategory Oil Emission

Factors of direct gases

Sub-category	Segment	Emission Factor (ton/000 m3)			Source: 2019 Refinement to the 2006 IPCC Guidelines/ Volume 2/Chapter 4 - Fugitive Emissions
		CO2	CH4	N2O	

Transport	Pipelines	0.00049	0.00540	NA	Page 4.57, Table 4.2.4B (New)
Refining / storage	All	5.85000	0.03000	0.0000877	Page 4.59, Table 4.2.4C (New)
Distribution of oil products	Gasoline / Diesel / Kerosene	NA	NA	NA	Page 4.61, Table 4.2.4D (New)

Emission Factors of indirect gases

Sub-category	Segment	Emission Factor				Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume 2/Chapter 4 - Fugitive Emissions
		NOx	CO	NMVOC	SO2	
Transport	Pipelines	NA	NA	0.054 (ton/10^3 m3 oil transported by pipeline)	NA	Page 4.57, Table 4.2.4B (New)
Refining/storage	All	NA	NA	0.26 (ton/10^3 m3 oil refined)	NA	Page 4.59, Table 4.2.4C (New)
Distribution of oil products	Gasoline	NA	NA	2.27 (ton/ 10^3 m3 consumed)	NA	Page 4.61, Table 4.2.4D (New)
	Diesel			0.15 (ton/ 10^3 m3 consumed)		Page 4.61, Table 4.2.4D (New)
	Kerosene					

Note 1: Considered EF for sub-segment "Onshore: Most activities occurring with higher- emitting technologies and practices"

The calculations of emission factors for the different sources of emissions for the Oil Production segment are provided in Table 3.69. The single EF provided in Table 4A.2.2 in the 2019 Refinements was disaggregated for the different sources of the Oil production segment as per the % provided to obtain source-specific EFs (Table 3.69).

Table 3.69. Calculated emission factors for emission sources of Oil – Production and upgrading

	EF	CO2	CH4	N2O	NMVOC
Onshore	EF[1] (tonnes/000 m3)	12.4	3.43	0.00019	1.48
Offshore	EF[1] (tonnes/000 m3)	4.08	2.46	0.000016	1.06
Disaggregation percent[2]					
Onshore	Leaks	0	7	0	7
	Vents	3	83	0	83
	Flares	97	10	100	10
	EF	**CO2**	**CH4**	**N2O**	**NMVOC**
Offshore	Leaks	0	20	0	20
	Vents	3	80	0	80
	Flares	97	0	100	0
Calculated disaggregated EF (tonnes/000 m3)					
Onshore	Leaks	NA	0.2401	NA	0.1036
	Vents	0.372	2.8469	NA	1.2284
	Flares	12.028	0.343	0.00019	0.148
Offshore	Leaks	NA	0.492	NA	0.212

Vents	0.1224	1.968	NA	0.848
Flares	3.9576	NA	0.000016	NA

Note 1 – Volume 2 Chapter 4, 2019 Refinements, Page 4.54, Table 4.2.4A (New). Considered EF for sub-segment "Onshore: Most activities occurring with higher- emitting technologies and practices" Note 2 - Source: 2019 Refinements, page 4.129, Table 4A.2.2 (New).

Natural gas (CRT 1.B.2.b)

Table 3.70 provides Activity Data for Natural gas.

Table 3.70. Activity Data used for Natural Gas (2000-2022)

(i) Production and Gathering

Production (10^6 m3 gas)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	45,282	51,644	46,773	51,784	58,970	59,292	61,806	68,411
BTR1 - NID1								
Onshore	23,547	26,855	24,322	26,928	30,665	30,832	32,139	35,574
Offshore	21,735	24,789	22,451	24,856	28,306	28,460	29,667	32,837
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	64,639	52,032	67,765	67,979	73,070	65,848	71,487	82,973
BTR1 - NID1								
Onshore	33,612	27,056	35,238	35,349	37,997	34,241	37,173	43,146
Offshore	31,027	24,975	32,527	32,630	35,074	31,607	34,314	39,827
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	78,667	82,174	-	-	-	-	-	
BTR1 - NID1								
Onshore	40,907	42,731	43,616	45,520	46,504	43,487	35,466	
Offshore	37,760	39,444	41,770	40,747	36,552	34,232	35,936	

(ii) Processing

Gas processed (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	20,283	25,564	25,700	27,825	33,863	36,286	39,151	46,051
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	46,763	37,607	51,295	50,448	56,399	54,256	63,286	73,306
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	NA	NA	-	-	-	-	-	
BTR1 - NID1	69,819	72,044	76,209	77,485	75,816	70,566	66,065	

(iii) Transmission and storage

Consumption data (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	10,521	13,418	15,732	20,676	22,413	22,668	27,422	34,687
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**

BTR1 - NID1	35,219	23,718	35,279	37,623	40,015	32,554	40,681	48,196
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	44,467	46,683	48,004	48,226	48,825	44,137	40,645	

Storage (10^6 m3)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BTR1 - NID1	1,886	2,917	5,421	5,726	8,844	14,905	17,830	21,544
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	23,296	13,083	24,877	25,159	26,837	20,856	25,226	32,589
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	12,222	11,949	12,334	12,048	12,731	13,813	10,979	

(iv) Distribution

Gas distributed (10^6 m3)

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
BTR1 - NID1	9,911	12,678	15,246	20,126	22,076	21,814	26,135	33,241
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BTR1 - NID1	33,560	22,133	30,491	35,387	37,950	31,226	37,720	46,013
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BTR1 - NID1	44,467	46,683	48,004	48,226	48,825	44,137	40,645	

Table 3.71 provides Emission Factors for direct and indirect gases for the segment Gas Production.

Table 3.71. Emission Factors for segment Gas Production

Emission Factors of direct gases

Sub-category: Natural gas	**Segment**	**Emission Factor (ton/10^6 m3)**			**Source: 2019 Refinement to the 2006 IPCC Guidelines/ Volume 2/Chapter 4 - Fugitive Emissions**
		CO2	**CH4**	**N2O**	
Processing	Gas processed[2]	NA	0.09150	NA	Page 4.73, Table 4.2.4H (New) See table on disaggregation of EF
Transmission and storage	Transmission[2]	0.06210	2.0832	NA	Page 4.76, Table 4.2.4I (New)
	Storage[2]	0.06000	0.67000	NA	See table on disaggregation of EF
Distribution	All[2]	0.09000	2.92000	NA	Page 4.79, Table 4.2.4J (New)

Emission Factors of indirect gases

Sub-category: Natural gas	**Segment**	**Emission Factor (ton/10^6 m3)**				**Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume 2/Chapter 4 - Fugitive Emissions**
		NOx	**CO**	**NMVOC**	**SO2**	
Processing	Gas processed[2]	NA	NA	0.00750	NA	Page 4.73, Table 4.2.4H (New) See table on disaggregation of EF
Transmission and storage	Transmission[2]	NA	NA	0.03350	NA	Page 4.76, Table 4.2.4I (New)
	Storage[2]	NA	NA	0.00940	NA	See table on disaggregation of EF
Distribution	All[2]	NA	NA	0.04100	NA	Page 4.79, Table 4.2.4J (New)

Note 1: Considered EF for sub-segment, "Onshore: Most activities occurring with higher- emitting technologies and practices". Note 2: Considered for sub-segment "With limited leak detection and repair" programs/practices

The calculations of emission factors for the different sources of emissions for the Natural gas production and gathering segment are provided in Table 3.72. The single EF provided in Table 4.2.4G in the 2019 Refinements was disaggregated for the different sources of the natural gas production and gathering segment as per the % provided to obtain source-specific EFs (Table 3.72).

Table 3.72. Calculation of emission factors for Natural gas – production and gathering

	EF	CO2	CH4	N2O	NMVOC
Onshore	EF[1,2] (tonnes/10^6 m3)	1.45	4.09	0.000025	0.98
Offshore	EF[1,2] (tonnes/10^6 m3)	4.8	2.94	0.000082	0.70
Disaggregation percent[3]					
Onshore	Leaks	4	11	0	11
	Vents	31	89	0	89
	Flares	65	0	100	0
Offshore	Leaks	0	23	0	23
	Vents	1	77	0	77
	Flares	99	0	100	0
Calculated disaggregated EF (tonnes/10^6 m3)					
Onshore	Leaks	0.0580	0.4499	NA	0.1078
	Vents	0.4495	3.6401	NA	0.8722
	Flares	0.9425	NA	0.000025	NA
Offshore	Leaks	NA	0.6762	NA	0.1610
	Vents	0.0480	2.2638	NA	0.5390
	Flares	4.7520	NA	0.00008	NA

Note 1 - Source: 2019 Refinement, Vol. 2, Chapter 4, Page 4.70, Table 4.2.4G (New)
Note 2 - Considered EF for sub-segment "Onshore: Most activities occurring with higher- emitting technologies and practices"
Note 3 - Source: 2019 Refinement, page 4.132, Table 4A.2.5 (New)

The calculations of emission factors for the different sources of emissions for the Gas processing segment are provided in Table 3.73. The single EF provided in Table 4A.4H in the 2019 Refinements was disaggregated for the different sources of the Gas processing segment as per the % provided to obtain source-specific EFs (Table 3.73).

Table 3.73. Calculated disaggregated emission factors for Gas processing

	EF	CO2	CH4	N2O	NMVOC
Gas processing	EF[1,2] (tonnes/10^6 m3)	0.12	1.83	0.000001	0.15
Disaggregation percent[3]					
Gas processing	Leaks	0	5	0	5
	Vents	1	95	0	95

	Flares	99	0	100	0
Calculated disaggregated EF (tonnes/10^6 m3)					
Gas processing	Leaks	NA	0.0915	NA	0.0075
	Vents	0.0012	1.7385	NA	0.1425
	Flares	0.1188	NA	0.0000013	NA

Note 1 - Source: 2019 Refinement, Vol. 2, Chapter 4, Page 4.73, Table 4.2.4H (New)
Note 2 - Considered for sub-segment "With limited leak detection and repair" programs/practices Note
3 - Source: 2019 Refinement, page 4.133, Table 4A.2.6 (New)

Table 3.74 provides the calculations of disaggregated emission factors for Natural gas – Transmission and storage.

Table 3.74. Calculated disaggregated emission factors for Natural gas – Transmission and storage

	EF	CO2	CH4	N2O	NMVOC
Gas transmission	$EF_{1,2}$ (tonnes/10^6 m3)	0.23	3.36	NA	0.05
Disaggregation percent[3]					
Gas transmission	Leaks	27	62	NA	67
	Vents	12	38	NA	33
	Flares	61	0	NA	0
Calculated disaggregated EF (tonnes/10^6 m3)					
Gas transmission	Leaks	0.0621	2.0832	NA	0.0335
	Vents	0.0276	1.2768	NA	0.0165
	Flares	0.1403	NA	NA	0.0000

Note 1 - Source: 2019 Refinement, Vol. 2, Chapter 4, Page 4.76, Table 4.2.4I (New)
Note 2 - Considered for sub-segment "With limited leak detection and repair" programs/practices Note
3 - Source: 2019 Refinement, page 4.134, Table 4A.2.7 (New)

Venting and flaring (CRT 1.B.2.c)

Table 3.75 provides Activity Data for subcategory Venting and flaring.

Table 3.75. Activity Data used for subcategory Venting and flaring (2000-2022)

Venting/Oil

(i) Production (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1 - On/Offshore	130,862	137,335	115,412	134,212	144,715	146,067	138,202	127,677
BTR1 - NID1 - Onshore	47,110	49,441	41,548	48,316	52,097	52,584	49,753	45,964
BTR1 - NID1 - Offshore	83,752	87,895	73,864	85,896	92,618	93,483	88,449	81,713
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	122,231	124,075	142,471	137,733	135,591	127,278	126,968	122,980
Onshore	44,003	44,667	51,290	49,584	48,813	45,820	45,709	44,273
Offshore	78,228	79,408	91,181	88,149	86,779	81,458	81,260	78,707
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	106,530	109,669	-	-	-	-	-	
BTR1 - NID1-Onshore	38,351	39,481	44,289	45,266	39,465	36,238	30,121	
BTR1 - NID1-Offshore	68,179	70,188	78,736	80,473	70,159	64,423	53,549	

(ii) Oil transport/Loading of Off-shore Production on Tanker Ships (Exports data) (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	113,583	124,035	105,469	125,772	139,614	134,220	130,061	125,900
Year	2008	2009	2010	2011	2012	2013	2014	2015
BTR1 - NID1	115,192	122,302	137,488	130,711	132,093	121,165	126,668	124,088
Year	2016	2017	2018	2019	2020	2021	2022	
BTR1 - NID1	102,624	104,937	111,402	118,610	90,827	76,119	80,553	

(iii) Oil transport / Tanker Trucks and Rail Cars (Net of Production less exports data) (10^3 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	17,279	13,300	9,943	8,440	5,101	11,847	8,141	1,777
Year	2008	2009	2010	2011	2012	2013	2014	2015
BTR1 - NID1	7,038	1,773	4,983	7,022	3,499	6,112	300	0
Year	2016	2017	2018	2019	2020	2021	2022	
BTR1 - NID1	3,906	4,732	11,623	7,128	18,797	24,543	3,117	

(2) Venting/Natural gas

(i) Production (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1-Onshore	23,547	26,855	24,322	26,928	30,665	30,832	32,139	35,574
BTR1 - NID1-Offshore	21,735	24,789	22,451	24,856	28,306	28,460	29,667	32,837
Year	2008	2009	2010	2011	2012	2013	2014	2015
BTR1 - NID1-Onshore	33,612	27,056	35,238	35,349	37,997	34,241	37,173	43,146
BTR1 - NID1-Offshore	31,027	24,975	32,527	32,630	35,074	31,607	34,314	39,827
Year	2016	2017	2018	2019	2020	2021	2022	
BTR1 - NID1-Onshore	40,907	42,731	43,616	45,520	46,504	43,487	35,466	
BTR1 - NID1-Offshore	37,760	39,444	41,770	40,747	36,552	34,232	35,936	

(ii) Gas processing (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	20,283	25,564	25,700	27,825	33,863	36,286	39,151	46,051
Year	2008	2009	2010	2011	2012	2013	2014	2015
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	46,763	37,607	51,295	50,448	56,399	54,256	63,286	73,306
Year	2016	2017	2018	2019	2020	2021	2022	
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	
BTR1 - NID1	69,819	72,044	76,209	77,485	75,816	70,566	66,065	

(iii) Gas transmission and storage (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BTR1 - NID1	10,521	13,418	15,732	20,676	22,413	22,668	27,422	34,687
Year	2008	2009	2010	2011	2012	2013	2014	2015
BTR1 - NID1	35,219	23,718	35,279	37,623	40,015	32,554	40,681	48,196

Year	2016	2017	2018	2019	2020	2021	2022	
BTR1 - NID1	44,467	46,683	48,004	48,226	48,825	44,137	40,645	

(3) Flaring/Oil

(i) Production: (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1[1]	130,862	137,335	115,412	134,212	144,715	146,067	138,202	127,677
BTR1 - NID1[2]								
Onshore	47,110	49,441	41,548	48,316	52,097	52,584	49,753	45,964
Offshore	83,752	87,895	73,864	85,896	92,618	93,483	88,449	81,713
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	122,231	124,075	142,471	137,733	135,591	127,278	126,968	122,980
BTR1 - NID1								
Onshore	44,003	44,667	51,290	49,584	48,813	45,820	45,709	44,273
Offshore	78,228	79,408	91,181	88,149	86,779	81,458	81,260	78,707
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	106,530	109,669	123,025	125,738	109,624	100,662	83,670	
BTR1 - NID1								
Onshore	38,351	39,481	44,289	45,266	39,465	36,238	30,121	
Offshore	68,179	70,188	78,736	80,473	70,159	64,423	53,549	

(4) Flaring/Natural gas

(i) Production: (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1[1]	25,000	26,080	21,073	23,959	25,107	23,005	22,656	22,360
BTR1 - NID1[2]-Onshore	23,547	26,855	24,322	26,928	30,665	30,832	32,139	35,574
Offshore	21,735	24,789	22,451	24,856	28,306	28,460	29,667	32,837
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	25,000	26,080	21,073	23,959	25,107	23,005	22,656	22,360
BTR1 - NID1-Onshore	23,547	26,855	24,322	26,928	30,665	30,832	32,139	35,574
BTR1 - NID1-Offshore	21,735	24,789	22,451	24,856	28,306	28,460	29,667	32,837
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	8,849	10,130	-	-	-	-	-	
BTR1 - NID1-Onshore	40,907	42,731	43,616	45,520	46,504	43,487	35,466	
BTR1 - NID1-Offshore	37,760	39,444	41,770	40,747	36,552	34,232	35,936	

Note 1 - Gas flared data

Note 2 - Production data

(ii) Gas processing: (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	20,283	25,564	25,700	27,825	33,863	36,286	39,151	46,051
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	46,763	37,607	51,295	50,448	56,399	54,256	63,286	73,306
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	

BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	69,819	72,044	76,209	77,485	75,816	70,566	66,065

(iii) Transmission and storage: (10^6 m3)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	10,521	13,418	15,732	20,676	22,413	22,668	27,422	34,687
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	NA
BTR1 - NID1	35,219	23,718	35,279	37,623	40,015	32,554	40,681	48,196
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	NA	NA	NA	NA	NA	NA	NA	
BTR1 - NID1	44,467	46,683	48,004	48,226	48,825	44,137	40,645	

Table 3.76 provides the Emission Factors for direct and indirect gases for segment Venting/Oil.

Table 3.76. Emission Factors for segment Venting / Natural gas

Emission Factors of direct gases

Sub-category: Venting/Oil	Segment	Emission factor (ton/10^3 m3)			Source: 2019 Refinement to the 2006 IPCC Guidelines/ Volume 2/Chapter 4 - Fugitive Emissions
		CO2	CH4	N2O	
Onshore production[1]	Oil production	0.372	2.846900	0.000000	Page 4.54, Table 4.2.4A (New)
Offshore production	Oil production	0.1224	1.968000	0.000000	See table on disaggregation of EF.
Oil Transport	Loading of Off-shore Production on Tanker Ships	ND	0.06500	ND	Page 4.57, Table 4.2.4B (New)
	Tanker Trucks and Rail Cars	0.00230	0.00250	NA	

Emission factors of indirect gases

Sub-category: Venting/Oil	Segment	Emission factor (ton/10^3 m3)			Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume 2/Chapter 4 - Fugitive Emissions
		NOx CO	NMVOC	SO2	
Onshore production[1]	Oil production	Not available	2.846900	Not available	Page 4.54, Table 4.2.4A (New)
Offshore production	Oil production	Not available	1.968000	Not available	See table on disaggregation of EF
Oil Transport	Loading of Off-shore Production on Tanker Ships	Not available	1.10000	Not available	Page 4.57, Table 4.2.4B (New)
	Tanker Trucks and Rail Cars	Not available	0.25000	Not available	

Note 1 - Considered EF for sub-segment "Onshore: Most activities occurring with higher- emitting technologies and practices"

Table 3.77 provides Emission Factors for direct and indirect gases for segment Venting / Natural gas.

Table 3.77. Emission Factors for segment Venting / Natural gas

Emission Factors of direct gases

Sub-category: Venting/Natural gas	Segment	Emission Factor (ton/10^6 m3)			Source: 2019 Refinement to the 2006 IPCC Guidelines/ Volume 2/Chapter 4 - Fugitive Emissions
		CO2	CH4	N2O	
Onshore production[1]	Gas production	0.4495	3.6401	NA	Page 4.70, Table 4.2.4G (New)
Offshore production	Gas production	0.0480	2.2638	NA	See Table 3.72 on disaggregation of EF.
Gas processing	Gas processing	0.00120	1.73850	NA	Page 4.73, Table 4.2.4H (New) See Table 3.73 on disaggregation of EF.
Gas transmission storage	Transmission and	0.02760	1.27680	NA	Page 4.76, Table 4.2.4I (New) See Table 3.74 on disaggregation of EF.

Emission Factors of indirect gases

Sub-category: Venting/Natural gas	Segment	Emission Factor (ton/10^6 m3)				Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume 2/Chapter 4 - Fugitive Emissions
		NOx	CO	NMVOC	SO2	
Onshore production[1]	Gas production	Not available		0.8722	Not available	Page 4.70, Table 4.2.4G (New)
Offshore production	Gas production	Not available		0.5390	Not available	See Table 3.72 on disaggregation of EF.
Gas processing	Gas processing	Not available		0.1425	Not available	Page 4.73, Table 4.2.4H (New) See Table 3.73 on disaggregation of EF.
Gas transmission and storage	Transmission	Not available		0.0165	Not available	Page 4.76, Table 4.2.4I (New) See Table 3.74 on disaggregation of EF.

Note 1 - Considered EF for sub-segment, "Onshore: Most activities occurring with higher- emitting technologies and practices".

Table 3.78 provides Emission Factors for direct and indirect gases for segment Flaring / Oil.

Table 3.78. Emission Factors for segment Flaring / Oil

Emission Factors of direct gases

Sub-category: Flaring/Oil	Segment	Emission Factor (ton/10^3 m3)			Source: 2019 Refinement to the 2006 IPCC Guidelines/ Volume 2/Chapter 4 - Fugitive Emissions
		CO2	CH4	N2O	
Onshore production[1]	Oil production	12.028	0.343000	0.000190	Page 4.54, Table 4.2.4A (New) See Table 3.69 on disaggregation of EF
Offshore production	Oil production	3.9576	0.000000	0.000016	

Emission Factors of indirect gases

Sub-category: Flaring/Oil	Segment	Emission Factor (ton/10^3 m3)				Source: 2019 Refinement to the 2006 IPCC Guidelines, Volume 2/Chapter 4 - Fugitive Emissions
		NOx	CO	NMVOC	SO2	
Onshore production[1]	Oil production	Not available		0.148000	Not available	Page 4.54, Table 4.2.4A (New)

Offshore production	Oil production	Not available	Not applicable	Not available		See Table 3.69 on disaggregation of EF

Note 1 - Considered EF for sub-segment "Onshore: Most activities occurring with higher- emitting technologies and practices"

Table 3.79 provides Emission factors for segment Flaring / Natural gas.

Table 3.79. Emission Factors for direct and indirect gases for segment Flaring / Natural gas

Emission Factors of direct gases

Sub-category: Flaring/Natural gas	Segment	Emission Factor (ton/10^6 m3)			Source: 2019 Refinement to the 2006 IPCC Guidelines/ Volume 2/Chapter 4 - Fugitive Emissions
		CO2	CH4	N2O	
Onshore production[1]	Gas production	0.9425	NA	0.000025	Page 4.70, Table 4.2.4G (New)
Offshore production	Gas production	4.7520	NA	0.00008	See Table 3.72 on disaggregation of EF
Gas processing	Gas processing	0.11880	NA	0.0000013	Page 4.73, Table 4.2.4H (New) See Table 3.73 on disaggregation of EF
Gas transmission and storage	Transmission	0.14030	NA	NA	Page 4.76, Table 4.2.4I (New) See Table 3.74 on disaggregation of EF

Emission Factors of indirect gases

Sub-category: Flaring/Natural gas	Segment	Emission Factor (ton/10^6 m3)				Source
		NOx	CO	NMVOC	SO2	
Onshore production[1]	Gas production	NA	NA	NA	Not available	(2019 Refinement, Vol.2, Chapter 4, Page 4.70, Table 4.2.4G (New)
Offshore production	Gas production	NA	NA	NA	Not available	
Gas processing	Gas processing	54	12	NA	77	Guidebook 2023, 1.B.2.c Venting and flaring, Page 8, Table 3-2
Gas transmission and storage	Transmission	NA	NA	NA	Not available	2019 Refinement, Vol.2, Chapter 4, Page 4.76, Table 4.2.4I (New)

No CO2 was captured and stored.

3.3.2.3. Description of any flexibility applied

Not resorted to.

3.3.2.4. Uncertainty assessment and time-series consistency

The uncertainty levels assigned to the AD (Table 3.80) are from 0 to ±5% depending on gas and operation while for the EFs, the default values from the IPCC 2006 guidelines are ±100% depending on the process for CO2 and CH4, and -100 to +1000 for N2O depending on the process as depicted in Table 3.80.

Table 3.80. Uncertainty levels assigned for Oil and natural gas and other emissions from energy production

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
1.B.2. Oil and natural gas and other emissions from energy production			
1.B.2.c.i.1- Venting	CO2	±3	-75 to +75
1.B.2.c.i.1 - Venting	CH4	±3	-75 to +75
1.B.2.c.i.1 - Venting	N2O	±3	NA
1.B.2.c.ii.1 - Flaring	CO2	±3	-75 to +75

1.B.2.c.ii.1 - Flaring	CH_4	±3	-75 to +75
1.B.2.c.ii.1 - Flaring	N_2O	±3	-10 to + 1000
1.B.2.a.ii - Production and Upgrading	CO_2	±5	-30 to + 30
1.B.2.a.ii - Production and Upgrading	CH_4	±5	-30 to + 30
1.B.2.a.ii - Production and Upgrading	N_2O	±5	-10 to + 1000
1.B.2.a.iii - Transport	CO_2	±3	-100 to + 100
1.B.2.a.iii - Transport	CH_4	±3	-100 to + 100
1.B.2.a.iii - Transport	N_2O	±3	NA
1.B.2.a.iv – Refining/storage	CO_2	±3	-50 to + 130
1.B.2.a.iv – Refining/storage	CH_4	±3	-50 to + 130
1.B.2.a.iv – Refining/storage	N_2O	±3	-100 to + 100
1.B.2.a.v - Distribution of oil products	CO_2	0	NA
1.B.2.a.v - Distribution of oil products	CH_4	0	NA
1.B.2.a.v - Distribution of oil products	N_2O	0	NA
1.B.2.c.i.2 - Venting	CO_2	±3	-40 to + 250
1.B.2.c.i.2 - Venting	CH_4	±3	-40 to + 250
1.B.2.c.i.2 - Venting	N_2O	±3	NA
1.B.2.c.ii.2 - Flaring	CO_2	±3	-75 to +75
1.B.2.c.ii.2 - Flaring	CH_4	±3	-75 to +75
1.B.2.c.ii.2 - Flaring	N_2O	±3	-10 to + 1000
1.B.2.b.ii – Production and gathering	CO_2	±5	-20 to + 20
1.B.2.b.ii – Production and gathering	CH_4	±5	-20 to + 21
1.B.2.b.ii – Production and gathering	N_2O	±5	-10 to + 1000
1.B.2.b.iii - Processing	CO_2	±5	-10 to + 10
1.B.2.b.iii - Processing	CH_4	±5	-10 to + 10
1.B.2.b.iii - Processing	N_2O	±5	-10 to + 1000
1.B.2.b.iv - Transmission and Storage	CO_2	±3	-20 to + 30
1.B.2.b.iv - Transmission and Storage	CH_4	±3	-20 to + 30
1.B.2.b.iv - Transmission and Storage	N_2O	±3	NA
1.B.2.b.v - Distribution	CO_2	±3	-20 to + 120
1.B.2.b.v - Distribution	CH_4	±3	-20 to + 120
1.B.2.b.v - Distribution	N_2O	±3	NA
Notes	**(1) 2019 Refinements, Vol.2, Chapter 4, page 4.93, paragraph 4.2.2.7.2 (2) (a) 2006 Guidelines, Vol. 2, Chapter 4, Table 4.25 for venting and flaring (b) 2019 Refinements, Vol. 2, Chapter 4, Tables 4.2.4 (A, B, C, D, G, H, I, J)**		

The estimated combined uncertainties are 76% and 106.7% respectively for the level assessment for the base year 2000 and year-t 2022, and 56%% for the trend between base year 2000 and year-t 2022 (Table 3.81).

Table 3.81. Uncertainty assessment for Oil and natural gas and other emissions from energy production

A	B	C	D	E	F	H	H	M
2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Gg CO2 e)	Year T (2022) emissions or removals (Gg CO2 e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Contribution to Variance by Category in Year 2000	Contribution to Variance by Category in Year 2022	Uncertainty introduced into the trend in total national emissions (%)
1.B.2. Oil and natural gas and other emissions from energy production								

1.B.2.a.i - Venting	CH4	8578.3		3.0	75.0	1148.9	265.1	548.2
1.B.2.a.i - Venting	N2O	0.0	0.0	3.0	0.0	0.0	0.0	0.0
1.B.2.a.ii - Flaring	CO2	898.1	574.2	3.0	75.0	12.6	2.9	6.1
1.B.2.a.ii - Flaring	CH4	452.4	289.3	3.0	75.0	3.2	0.7	1.5
1.B.2.a.ii - Flaring	N2O	2.7	1.7	3.0	1000.0	0.0	0.0	0.0
1.B.2.a.iii.2 - Production and Upgrading	CO2	0.0	0.0	5.0	30.0	0.0	0.0	0.0
1.B.2.a.iii.2 - Production and Upgrading	CH4	1470.5	940.2	5.0	30.0	5.5	1.3	2.7
1.B.2.a.iii.2 - Production and Upgrading	N2O	0.0	0.0	5.0	1000.0	0.0	0.0	0.0
1.B.2.a.iii.3 - Transport	CO2	0.1	0.0	3.0	100.0	0.0	0.0	0.0
1.B.2.a.iii.3 - Transport	CH4	19.8	12.7	3.0	100.0	0.0	0.0	0.0
1.B.2.a.iii.3 - Transport	N2O	0.0	0.0	3.0	0.0	0.0	0.0	0.0
1.B.2.a.iii.4 - Refining	CO2	33.7	1.7	3.0	130.0	0.1	0.0	0.1
1.B.2.a.iii.4 - Refining	CH4	4.8	0.2	3.0	130.0	0.0	0.0	0.0
1.B.2.a.iii.4 - Refining	N2O	0.1	0.0	3.0	100.0	0.0	0.0	0.0
1.B.2.a.iii.5 - Distribution of oil products	CO2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B.2.a.iii.5 - Distribution of oil products	CH4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.B.2.a.iii.5 - Distribution of oil products	N2O	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			17.8					
1.B.2.a.i - Venting	CO2	27.8	5498.6	3.0	75.0	0.0	0.0	0.0

1.B.2.b.i - Venting	CH4	5141.1		3.0	250.0	4578.3		2364.7
1.B.2.b.i - Venting	N2O	0.0	0.0	3.0	0.0	0.0	0.0	0.0
1.B.2.b.ii - Flaring	CO2	129.4	217.7	3.0	75.0	0.3	0.4	0.0

1.B.2.b.ii - Flaring	CH4	0.0	0.0	3.0	75.0	0.0	0.0	0.0
1.B.2.b.ii - Flaring	N2O	0.6	1.0	3.0	1000.0	0.0	0.0	0.0
1.B.2.b.iii.2 - Production	CO2	1.4	2.1	5.0	20.0	0.0	0.0	0.0
1.B.2.b.iii.2 - Production	CH4	708.2	1127.2	5.0	20.0	0.6	0.8	0.2
1.B.2.b.iii.2 - Production	N2O	0.0	0.0	5.0	1000.0	0.0	0.0	0.0
1.B.2.b.iii.3 - Processing	CO2	0.0	0.0	5.0	10.0	0.0	0.0	0.0
1.B.2.b.iii.3 - Processing	CH4	52.0	169.3	5.0	10.0	0.0	0.0	0.0
1.B.2.b.iii.3 - Processing	N2O	0.0	0.0	5.0	1000.0	0.0	0.0	0.0
1.B.2.b.iii.4 - Transmission and Storage	CO2	0.8	3.2	3.0	30.0	0.0	0.0	0.0
1.B.2.b.iii.4 - Transmission and Storage	CH4	649.1	2576.8	3.0	30.0	1.1	9.4	7.6
1.B.2.b.iii.4 - Transmission and Storage	N2O	0.0	0.0	3.0	0.0	0.0	0.0	0.0
1.B.2.b.iii.5 - Distribution	CO2	0.9	3.7	3.0	120.0	0.0	0.0	0.0
1.B.2.b.iii.5 - Distribution	CH4	810.3	3323.1	3.0	120.0	26.2	247.6	200.9
			29.0				0.1	
1.B.2.b.i - Venting	CO2	14.6	10561.6	3.0	250.0	0.0	10849.5	0.0
A	**B**	**C**	**D**	**E**	**F**	**H**	**H**	**M**
2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Gg CO2 e)	Year T (2022) emissions or removals (Gg CO2 e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Contribution to Variance by Category in Year 2000	Contribution to Variance by Category in Year 2022	Uncertainty introduced into the trend in total national emissions (%)
1.B.2.b.iii.5 - Distribution	N2O	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Sum		**18996.7**	**25351.0**	**Sum**		**5776.7**	**11377.8**	**3132.2**
Uncertainty in level (L) and trend (T) assessment						**L - 76.0**	**L - 106.7**	**T - 56.0**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

3.3.2.5. Category-specific QA/QC and verification

The quality control checks were in line with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations, reference material and conversion factors. Quality Assurance during the estimation steps was done by independent international experts

3.3.2.6. Category-specific recalculations

Recalculations were performed as new improved AD were available for some segments of the process and new methods as per the 2019 Refinements, including disaggregated EFS for some segments of the Oil and natural gas sub-categories. This resulted in a reduction of between 69% and 80% (Table 3.82) of emissions for the period 2000 and 2017.

Table 3.82. Oil and natural gas and other emissions from energy production – recalculations

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	93,777	99,988	85,517	98,691	107,550	108,559	105,078	101,601	97,132	93,016	110,076	107,622
BTR1 - NID1	18,997	21,061	19,127	22,235	24,582	24,997	25,547	26,976	26,272	22,447	28,382	28,574
% change	-80	-79	-78	-77	-77	-77	-76	-73	-73	-76	-74	-73
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
BUR2 - NIR1	108,276	100,335	102,576	104,774	93,063	96,259	-	-	-	-	-	
BTR1 - NID1	29,679	26,731	29,123	31,975	29,058	30,197	32,113	32,567	30,909	28,486	25,351	
% change	-73	-73	-72	-69	-69	-69	-	-	-	-	-	

3.3.2.7. Category-specific planned improvements

No planned improvement

3.4. CO_2 Transport and storage (CRT 1.C)

Not occurring.

3.5. Memo items (CRT 1.D)

Sub-categories occurring, namely International bunkers are reported under section xxx above.

3.5.1. International bunkers (CRT 1.D.1)

3.5.1.1. Aviation (CRT 1.D.1.a.)

See section 3.2.2 Full time series emission

3.5.1.2. Navigation (CRT 1.D.1.b.)

See section 3.2.2 Full time series emission

3.5.2. Multilateral operations (CRT 1.D.2)

Not Occurring

3.5.3. CO_2 emissions from biomass (CRT 1.D.3)

CO_2 emissions from biomass are provided in Table 3.8[1] for the full time series. Emissions from biomass varied from 305,241 kt to 533,147 kt.

[1] .5.4. CO_2 captured (CRT 1.D.4)

Table [12].83. CO2 emissions (kt) from biomass

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
305,241	314,515	324,018	334,574	344,780	356,260	368,391	384,492	397,415	410,458	428,564	446,780
											-

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
470,644	474,543	463,247	471,032	478,021	485,489	493,082	500,749	508,597	516,556	533,147	-

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[1] **.5.4.1. For domestic storage (CRT 1.D.4.a.)** Not occurring.

[2] **.5.4.2. For storage in other countries (CRT 1.D.4.b.)** Not occurring.

Chapter 4. Industrial processes and product use (CRT sector 2)

4.1. Overview of the sector

During industrial processes or product use, various GHGs, including CO_2, CH_4, N_2O, HFCs and PFCs, can be produced (2019 Refinement to IPCC 2006 Guidelines for National GHG Inventories V3_Ch 1) and emitted. Other gases also emitted in different sub-categories include SF6, NF3 and NMVOCs.

Industrial production is well developed in Nigeria with a number of sub-categories from which 3 categories mapped to-date are accounting for the emissions (Table 4.1). Sub-categories not estimated are Petrochemical and Carbon Black production of Chemical Industry category, Lubricant Use, Paraffin Wax Use and Solvent Use of Non-Energy Products from Fuels and Solvent Use category, Refrigeration and Air Conditioning, Fire protection, Aerosols and Solvents of the Products uses as Substitutes for Ozone Depleting Substances category, electrical equipment and N2O from Product Uses of the Other Product manufacture and Use category, Pulp and Paper Industry and Food and Beverage Industry for Other Category. All other subcategories are not occurring in Nigeria (Refer to the Completeness Table 1.4 of this document for extensive details).

Table 4.1. Categories and sub-categories with emissions occurring

Sectoral Categories	Sub-Categories from which emissions are reported
2.A Mineral Industry	2.A.1 - Cement production
2.B Chemical Industry	2.B.1 – Ammonia production 2.B.4 – Other Process uses of carbonates (Ceramic production)
2.C Metal Industry	2.C.1 – Iron and Steel Production

The trend of emissions for the time series 2000 to 2022 is provided in Figure 4.1 and in Table 4.2 for selected years. Emissions of the IPPU sector increased by 947% from 1,150 kt CO2 e in 2000 to 12,044 in 2022. The highest increase occurred in the Mineral industry category, by 1194% from 845 kt CO2 e in 2000 to 10,931 kt CO2 e in 2022. Emissions from the Chemical industry was very low up to 2010. It then shot up with the commissioning of new ammonia production plants. Thereafter, emissions increased normally up to 2022. The metal industry emitted around the same amount during the time series with an overall increase of 30% when comparing emissions of 2022 (396 kt CO2 e) with those of 2000 (304 kt CO2 e).

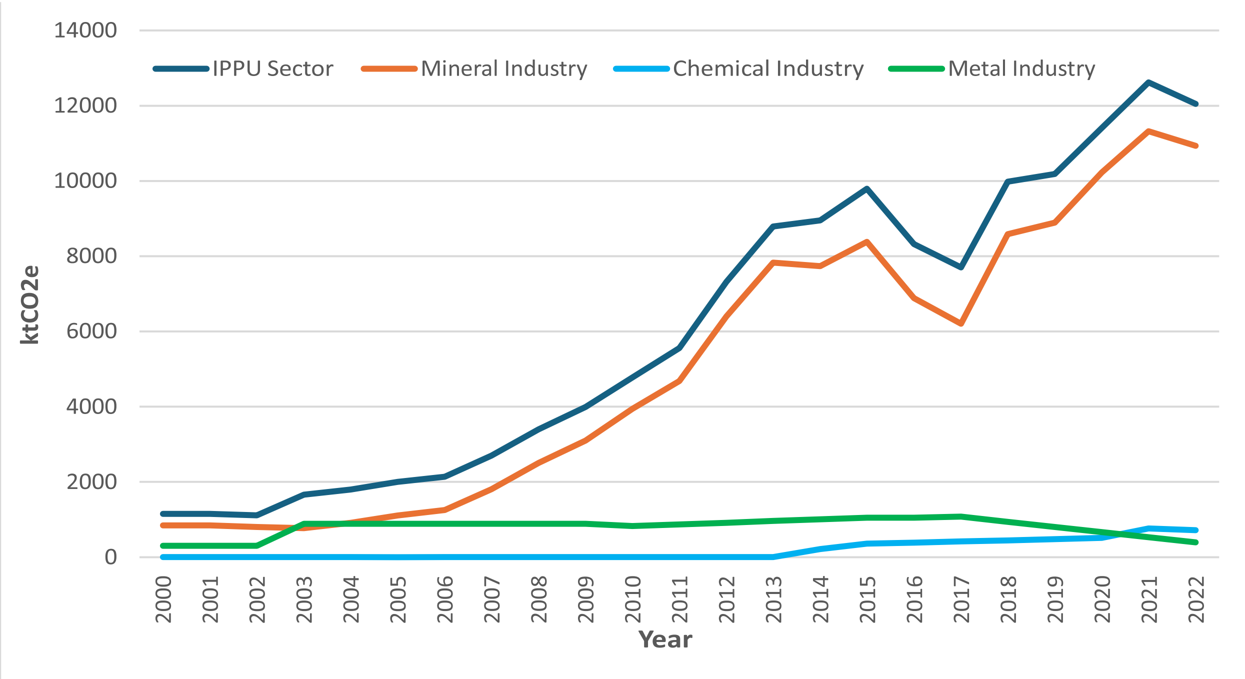

Figure 4.1. Trends of emissions (kt CO2 e) for the IPPU sector (2000-2022)

Table 4.2. Emissions (kt CO2 e) of the IPPU sector by sub sector for selected years

Year	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 to 2000 (% change)
IPPU Sector	**1,150**	**2,000**	**4,775**	**9,791**	**9,977**	**10,183**	**11,410**	**12,619**	**12,044**	**947%**
2.A - Mineral Industry	845	1,112	3,941	8,386	8,583	8,895	10,229	11,321	10,931	1194%
2.B - Chemical Industry	1	1	1	358	450	481	512	765	716	48761%
2.C - Metal Industry	304	888	833	1,048	943	806	670	533	396	30%

The % share of emissions from the emitting categories is provided in Figure 4.2. The Mineral Industry dominated emissions (particularly between 80-90%) throughout the time series followed by the Metal industry and the Chemical industry. The latter gained importance during the last decade to overcome the Metal industry which is seemingly declining after reaching its maximum in 2003. In 2022, 91% of IPPU emissions stemmed from Mineral industry, 6% from Chemical industry and 3% from Metal industry.

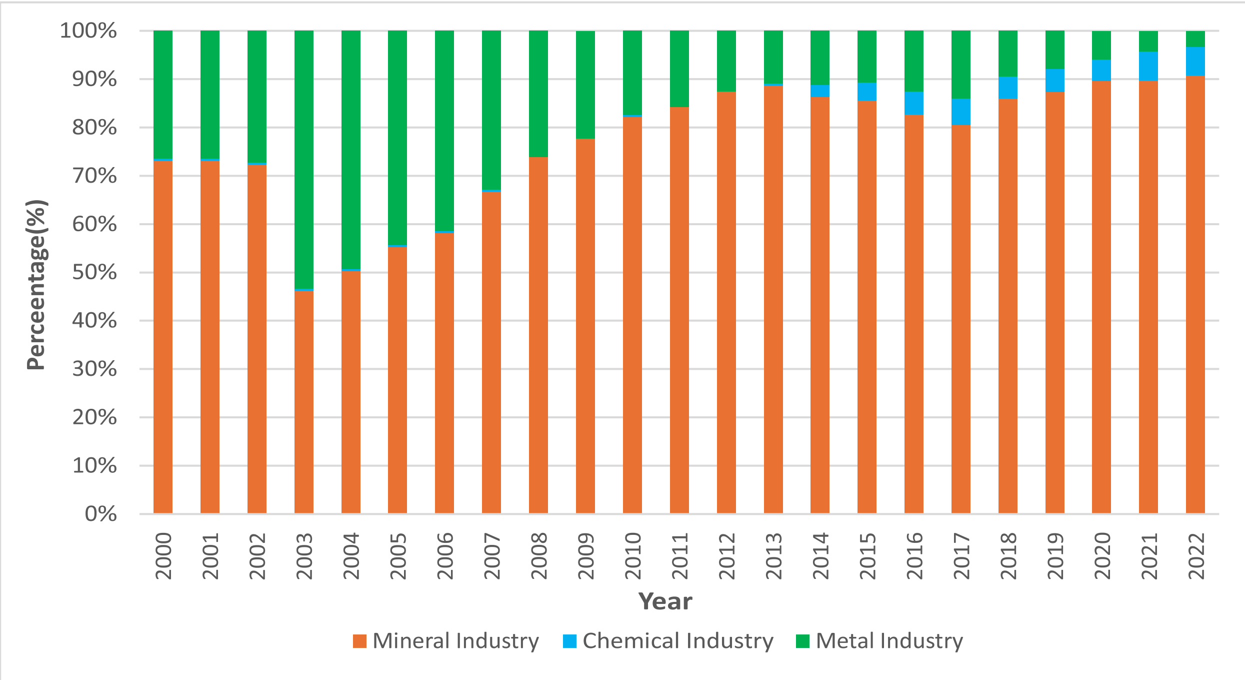

Figure 4.2. Share (%) of emissions by IPPU subsectors (2000-2022)

IPCC Tier 1 has been used to compute emissions for all categories in this sector. The methods and tier level by category/subcategory for each gas are provided in Table 4.3.

Table 4.3. Methodologies and TIER levels used for the categories estimated in sector IPPU

Categories	CO_2	CH4	N2O	HFCs	PFCs	SF6	NF3	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO_2
2 - Industrial Processes and Product Use													
2.A - Mineral Industry													
2.A.1 - Cement production	DT1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.A.4 - Other Process Uses of Carbonates													

2.A.4.a - Ceramics	DT1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Categories	CO_2	CH4	N2O	HFCs	PFCs	SF6	NF3	Other halogenated gases	Other halogenated gases	NOx	CO	NMVOCs	SO_2
2.B - Chemical Industry													
2.B.1 - Ammonia Production	DT1	NA	NA	NA	NA	NA	NA	NA	NA	EMEP/EEA T1	EMEP/EEA T1	NA	NA
2.C - Metal Industry													
2.C.1 - Iron and Steel Production	DT1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	EMEP/EEA T1	NA

4.2. Mineral industry (CRT 2.A)

4.2.1. Category description

Cement production and Other Process Uses of Carbonates are the two sub-categories of the Mineral industry category identified to-date as emitter of GHGs. Both industries emit carbon dioxide (CO2) emissions associated with the production processes. There are numerous facilities producing clinker and cement in Nigeria and all of them use dry kilns. Emissions resulting from the combustion of fossil fuels to generate heat to drive the reaction in the kiln have been estimated under the Energy sector as per the IPCC 2006 Guidelines to avoid double counting.

The trend of emissions for the Mineral Industry category is presented in Figure 4.3. and Table 4.4. Emissions increased from 845 kt CO2 e in 2000 to 10,931 kt CO2 e in 2022 following a regular increase in Cement production and a slight contribution from the Ceramics industry which commenced its activity in 2020. Cement production emitted the lion's share of emissions with 100% until 2019 and a marginally lower % from 2020 to 2022. Cement production increased by 1193% from 2000 to 2022 from 845 kt CO2 e to 10,924 kt CO2 e.

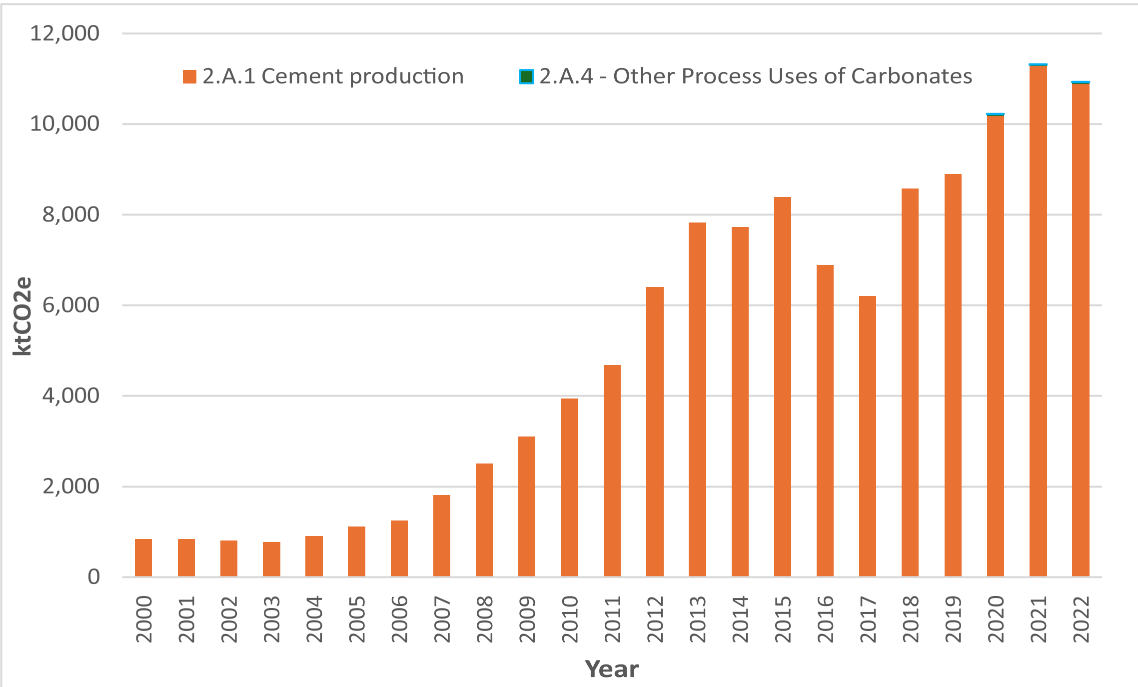

Figure 4.3. Emissions (kt CO2 e) from Mineral Industry (2000-2022)

Table 4.4. Emissions (kt CO2 e) for Mineral Industry for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
Mineral Industry	845	912	3,941	8,386	8,583	8,895	10,229	11,321	10,931	1194%
2.A.1 - Cement production	845	912	3,941	8,386	8,583	8,895	10,222	11,314	10,924	1193%
2.A.4 - Other Process Uses of Carbonates	NO	NO	NO	NO	NO	NO	7	7	7	-
2.A.4.a - Ceramics	NO	NO	NO	NO	NO	NO	7	7	7	-

4.2.2. Methodological issues

The decision tree for the activity areas were used to determine the method most applicable for estimating the emissions. The Tier 1 method (Equation 1 below) from the IPCC 2006 guidelines for cement production, was used for all plants since only aggregated data at the national level was available. For the Ceramics industry also the Tier 1 method was adopted, and Equation 1 below was used.

Equation 1

CO_2 emissions = [(Mass balance of cement[a] x Clinker fraction in cement) + (mass balance of clinker[a])] X Default emission factor for clinker X Kiln factor[b]

Where

a = Mass balance = Local Consumption – import + export b = 2% used as per good practice

AD used for cement production are provided in Table 4.5. All cement produced in Nigeria is assumed to have been used locally as no import / export data was available.

Table 4.5. Activity Data used for cement production (t) (2000-2022)

Year	2000	2001	2002	2003	2004	2005	2006	2007
	2,165,368	2,168,000	2,071,000	1,981,000	2,337,000	2,849,000	3,209,000	4,642,000
Year	**2008**	**2009**	**2012**	**2013**	**2014**			
	6,425,000	7,955,000	16,412,000	20,068,000	19,828,000			
Year	**2019**	**2020**	**2021**					-
	22,800,000	26,200,000	29,000,000					-

AD used for ceramics production are provided in Table 4.6. This activity started in year 2020.

Table 4.6. Activity Data used for ceramics production (mass of carbonate by used (t) by type) (2000 – 2022)

Year	2020	2021	2022
Siderite	-	1,000	1,000
Dolomite	-	14,000	14,000

Mix limestone 85% and dolomite 15%	14	18	16

		EF	Units	Source
Cement production	Clinker fraction in cement	0.75	Fraction	
	Emission Factor for clinker	0.51	t CO2/ t clinker	
	CKD fraction	1.02	Fraction	
Ceramic - Siderite	Emission Factor for carbonate	0.37987	t CO2 / t carbonate	
	Fraction calcination	1	Fraction	
Ceramic - Dolomite	Emission Factor for carbonate	0.47732	t CO2 / t carbonate used	
	Fraction calcination	1	Fraction	
Ceramic - Mix	Emission Factor for carbonate	0.44535	t CO2 / t carbonate used	
				Tables 2.1 and 2.2, Chapter 2, Volume 3, IPCC 2006 Guidelines
limestone 85% and dolomite 15%	Fraction calcination	1	Fraction	

EFs used for the Mineral industry are provided in Table 4.7.

Table 4.7. Emission Factors used for direct gases in the Mineral Industry category

No CO2 was captured and stored.

4.2.3. Description of any flexibility applied

Flexibility is resorted to for Glass production that has not been estimated due to unavailability of data.

4.2.4. Uncertainty assessment and time-series consistency

The uncertainty levels assigned to the AD (Table 4.8) are ±5% for Ceramics and ±35% for Cement production. Those for EFs are ±[12]% for Ceramics and ±30% for Cement production, which are the default ranges from the IPCC 2006 guidelines.

Table 4.8. Uncertainty levels assigned for Mineral Industry

2006 IPCC Categories	Gas	Uncertainty assigned (%)		
		AD[3]	EF[4]	
2.A. Mineral industry				
2.A.1. Cement production	CO2	±35	±30	
2.A.4.a Ceramics	CO2	±5	±2	
Uncertainty in level (L) and trend (T) assessment		**L - 46.1**	**L - 46.1**	**T - 640.0**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

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[1] **.5.2, Page 2.39 Volume 3 for Ceramics**

The estimated combined uncertainties are 46.1% for the level assessment for both the base year 2000 and the yeart 2022 while for the trend between base year 2000 and year-t 2022 (Table 4.9), it is 640%. This latter level of uncertainty is explained by the fact that the time series is not complete for Ceramics production.

Table 4.9. Uncertainty assessment for Mineral Industry

2006 IPCC Categories	Gas	Base Year (1990) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-1990	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
2.A - Mineral Industry									
[2] .A.1 - Cement production	CO2	844.8	10924.2	35.0	30.0	46.1	2125.0	2122.3	409,655.5
2.A.4.a - Ceramics	CO2	-	7.1	5.0	2.0	5.4	0.0	0.0	0.004
Sum	**844.8**		**10,931.3**			**Sum**	**2,125.0**	**2122.3**	**409,655.5**

[3] **: Source - 2006 Guidelines, Table 2.3, Page 2.17, Chapter 2, Volume 3 for cement production and Section 2.5.2, Page 2.39 Volume 3 for Ceramics**

[4] **: Source - 2006 Guidelines, Table 2.3, Page 2.17, Chapter 2, Volume 3 for cement production and Section**

4.2.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method and AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by independent international experts.

4.2.6. Category-specific recalculations

Not Applicable

4.2.7. Category-specific planned improvements

Extend coverage to include Glass production by 2028 and move from Tier 1 to Tier 2 for Cement production as it is a key category. The latter is expected to be finalized by 2026.

4.3. Chemical industry (CRT 2.B)

4.3.1. Category description

The Chemical industry category comprises 10 sub-categories and two are known to occur at the moment, namely ammonia production and ethylene production that falls under Petrochemical and Carbon Black production. The ammonia production industry was a small one during the period 2000 to 2013 and in 2014 a new plant with substantial production capacity was commissioned. Production increased smoothly until 2020 and shot up in 2021 when additional facilities were commissioned to slightly regress in 2022.

The trend of emissions from Ammonia production for the time series 2000 to 2022 is provided in Figure 4.4. and Table 4.10. The emissions which stalled at 1 Kt CO2 e between 2000 and 2013 jumped to 215 Kt CO2 e in 2014 to increase to 716 Kt CO2 e in 2022. The increase between 2000 and 2022 is 48,761%.

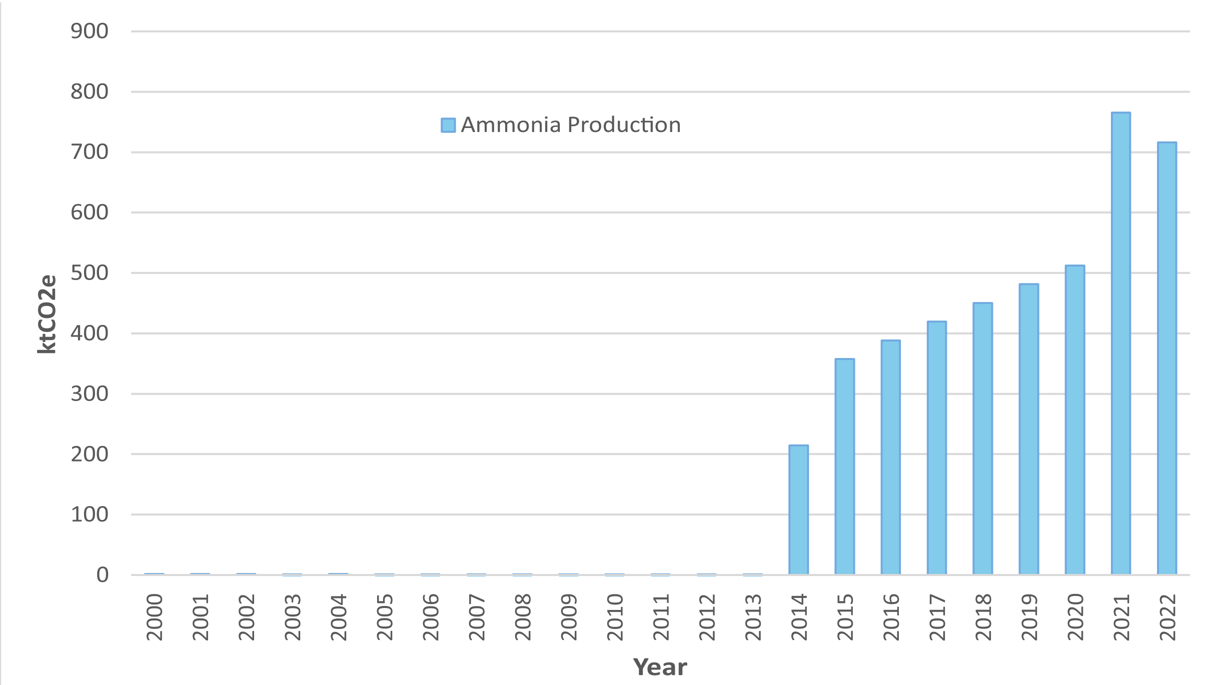

Figure 4.4. Emissions (kt CO2 e) from Chemical Industry (2000-2022)

Table 4.10. Emissions (kt CO2 e) for Chemical Industry for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)

2.B.1 - Ammonia Production	1	1	1	358	450	481	512	765	716	48,761%

4.3.2. Methodological issues

The IPCC Tier 1 method has been used for estimating CO2 emissions after applying the appropriate decision tree. For the indirect gases, it is the EMEP/EEA Guidebook of 2023 at Tier 1 level.

Activity data used are provided in Table 4.11. Data for the period 2014 to 2017 replaced with new ones.

Only 1 facility has communicated the activity data for ammonia production, and it started in year 2021. It has also communicated the amount of urea produced which is necessary to compute emissions. The amount of urea produced was 370,463 t and 969,612 t for years 2021 and 2022 respectively.

Table 4.11. Activity Data used for Ammonia production (t) (2000-2022)

Year	2000	2001	2002	2003	2004	2005	2006	2007
BUR2 - NIR1	615	615	695	506	550	494	497	500
BTR1 - NID1	615	615	695	506	550	494	497	500
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
BUR2 - NIR1	502	505	508	511	514	517	519	522
BTR1 - NID1	502	505	508	511	514	517	90,000	150,000
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**-**
BUR2 - NIR1	525	528	-	-	-	-	-	-
BTR1 - NID1	62,967	175,934	188,901	201,868	214,835	227,802	567,603	-

Default EFs used and their sources for direct and indirect gases are given in Tables 4.12 and 4.13 respectively. The feedstock fuel used in 2021 and 2022 were obtained from the producer.

Table 4.12. Emission Factors used for direct gases in the Chemical Industry category

Category	For CO2 emissions	Years 2000 to 2020	2021	2022	Units	Source
Ammonia production	Feedstock fuel requirement of ammonia	42.5	81.40	44.83	GJ/tonne ammonia produced	2006 IPCC Guidelines, Table 2.3, Page 3.1, Chapter 3, Volume 3.
	Carbon fraction of fuel	15.3	15.3	15.3	kg C/GJ	
	Carbon oxidation factor of fuel	1	1	1	Fraction	

Table 4.13. Emission Factors used for indirect gases in the Chemical Industry category

Category	Gas	EF	Units	Source
Ammonia production	NOx	1	kg/t NH3	EMEP EEA, Guidebook: 2B- Chemical-industry-2023, Page 15 Table 3.2-Tier 1 emission factors for source category 2.B.1 Ammonia production.
	CO	0.1	kg/t NH3	

No CO2 was captured and stored.

4.3.3. Description of any flexibility applied

Not resorted to.

4.3.4. Uncertainty assessment and time-series consistency

Default Uncertainty values provided for AD and EFs in the IPCC 2006 Guidelines have been used in the tool developed in an Excel sheet for making the assessment.

The uncertainty levels assigned to the AD (Table 4.14) and EFs are the mid values of the default ranges from the IPCC 2006 guidelines. It is ±2% for AD and ±7% for EFs.

Table 4.14. Uncertainty levels assigned for Chemical Industry

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
2.B. Chemical industry			
2.B.1 - Ammonia Production	CO2	±2	±7

1: Source - 2006 IPCC Guidelines, Section 3.2.3, Page 3.17, Chapter 3, Volume 3.

2: Source - 2006 IPCC Guidelines, Section 3.2.3, Page 3.17, Chapter 3, Volume 3.

The estimated combined uncertainty is 7.3% for the level assessment for both the base year 2000 and year-t 2022 while for the trend between the base year 2000 and year-t 2022 (Table 4.15) it is 1382%.

Table 4.15. Uncertainty assessment for Chemical Industry

2006 IPCC Categories	Gas	Base Year (1990) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-1990	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
2.B - Chemical industry									
2.B.1 - Ammonia Production	CO2	1.5	716.5	2.0	7.0	7.3	53.0	53.0	1909897.5
Sum		**1.5**	**716.5**			**Sum**	**53.0**	**53.0**	**1909897.5**
				Uncertainty in level (L) and trend (T) assessment			**L - 7.3**	**L - 7.3**	**L - 1382.0**

The time series is consistent as the AD have always been sourced from national institution, the default EFs of IPCC used as well as a common methodology applied for all the years of the time series.

4.3.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method and AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

4.3.6. Category-specific recalculations

Recalculations were made for the full time series for the subcategory Ammonia production following the availability of new data for the years 2014 to 2017 and also because of the new method in the 2019 Refinements to the 2006 IPCC Guidelines. The net impact is a reduction of emissions by 27% for the period 2000 to 2013 resulting from the change in method and an increase varying from 12,523% to 24,147% from 2014 to 2017 stemming from the new AD (Table 4.16).

Table 4.16. Chemical Industry - recalculations

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	2	2	2	2	2	2	2	2	2	2	2	2
BTR1 - NID1	1	1	2	1	1	1	1	1	1	1	1	1
% change	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	-
BUR2 - NIR1	2	2	2	2	2	2	-	-	-	-	-	-
BTR1 - NID1	1	1	215	358	389	419	450	481	512	765	716	-
% change	-27	-27	12,523	20,814	22,490	24,147	-	-	-	-	-	-

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

4.3.7. Category-specific planned improvements

Extend estimates for the Chemical industry category to include ethylene production under the Petrochemical and Carbon Black production sub-category by 2028.

4.4. Metal industry (CRT 2.C)

4.4.1. Category description

The Metal industry category is subdivided into 7 sub-categories. Only one is recognized to be occurring presently and estimates of emissions for this sub-category, Iron and Steel production, have been made.

The emissions trend is provided in Figure 4.5 for the full time series and in Table 4.17 for selected years. Emissions increased by an overall 30% over the time series 2000 to 2022, from 304 kt CO2 e to a peak of 1,080 kt CO2 e in 2017 to regress to 396 kt CO2 e.

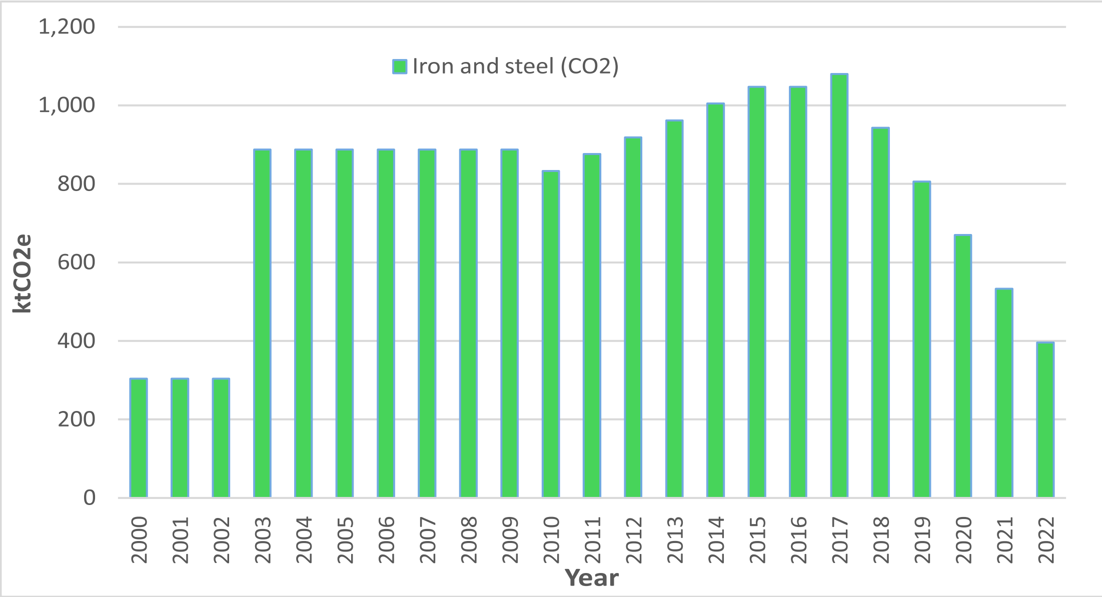

Figure 4.5. Emissions (kt CO2 e) from Metal Industry (2000-2022)

Table 4.17. Emissions (kt CO2 e) for Metal Industry for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
2.C.1 - Iron and Steel Production	304	888	833	1,048	943	806	670	533	396	30%

4.4.2. Methodological issues

The IPCC Tier 1 method has been adopted, based on the decision tree, for estimating CO2 emissions while for the indirect gases, it is the EMEP/EEA Guidebook at Tier 1 level.

Activity data used are provided in Table 4.18.

Table 4.18. Activity Data used for Iron and Steel production (t) (2000-2022)

Year								
2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	
1,689,647	1,689,647	1,689,647	4,931,257	4,931,257	4,931,257	4,931,257	4,931,257	
Year								
2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	
4,931,257	4,931,257	4,626,679	4,865,468	5,104,257	5,343,046	5,581,835	5,820,624	
Year								-
2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**		
5,820,624	6,000,000	5,240,000	4,480,000	3,720,000	2,960,000	2,200,000		-

Default EFs used and their source are provided in Table 4.19.

Table 4.19. Emission Factors used for direct and indirect gases in the Metal Industry category

	Gas	EF	Units	Source
2.C.1 - Iron and Steel Production	CO2	0.18	t CO2 / t produced	Table 4.1B(new), Page 4.29, Chapter 4, Volume 3, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
	NMVOC	150	g/Mg Steel produced	EMEP EEA, Guidebook: 2-C-1-iron-and steel, Page 24 Table 3.1 Tier 1 emission factors for source category 2.C.1 Iron and steel production.

No CO2 was captured and stored.

4.4.3. Description of any flexibility applied

Not Applicable

4.4.4. Uncertainty assessment and time-series consistency

Default Uncertainty values provided for AD and EFs in the IPCC 2006 Guidelines have been used in the tool developed in an Excel sheet for making the assessment.

The uncertainty levels assigned to the AD (Table 4.20) and EFs are the mid values of the default ranges from the IPCC 2006 guidelines. It is ±10% for both AD and EFs.

Table 4.20. Uncertainty levels assigned for Metal Industry

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
2.C. Metal industry			
2.C.1 - Iron and Steel Production	CO2	±10	±10

1: Source - IPCC 2006 Guidelines, Table 4.4 (Updated), Page 4.36, Chapter 4, Volume 3.

The estimated combined uncertainty is 14.1% for the level assessment for both the base year 2000 and year-t 2022 while for the trend between the base year 2000 and year-t 2022 (Table 4.21), it is 18.4%.

Table 4.21. Uncertainty assessment for Metal Industry

2006 IPCC Categories	Gas	Base Year (1990) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year- 1990	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
2.C. Metal industry									
2.C.1 - Iron and Steel Production	CO2	304.1	396.0	10.0	10.0	14.1	200.0	200.0	339.1
Sum		**304.1**	**396.0**			**Sum**	**200.0**	**200.0**	**339.1**
				Uncertainty in level (L) and trend (T) assessment			**L - 14.1**	**L - 14.1**	**T - 18.4**

The time series is consistent as the AD have always been sourced from national institutions, the default EFs of IPCC used as well as a common methodology applied for all the years of the time series.

4.4.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method and AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

4.4.6. Category-specific recalculations

Emissions for all years of the time series have been recalculated because of fresh information available on the process, namely that only recycling is practiced using the electric arc furnace technology. This resulted in more accuracy and a reduction of 83% in emissions over the recalculated period 2000 to 2017 (Table 4.22).

Table 4.22. Comparison of previous and recalculated emissions (kt CO2 e) for Metal industry

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	1,796	1,796	1,796	5,241	5,241	5,241	5,241	5,241	5,241	5,241	4,917	5,171
BTR1 - NID1	304	304	304	888	888	888	888	888	888	888	833	876
% change												-83
						-83 -83 -83 -83 -83 [illegible] 2017 2018 2019 2020 2021 2022						-
BUR2 - NIR1	5,425	5,679	5,933	6,186	6,186	6,377	-	-	-	-	-	-
BTR1 - NID1	919	962	1,005	1,048	1,048	1,080	943	806	670	533	396	-
% change	-83	-83	-83	-83	-83	-83	-	-	-	-	-	-

4.4.7. Category-specific planned improvements

No improvement is planned for the Metal industry category.

4.5. Non-energy products from fuels and solvent use (2.D)

4.5.1. Category description

Non-Energy Products from Fuels and Solvent Use comprises 4 sub-categories and estimates have not been made due to unavailability of data for Lubricants and Paraffin wax use, the two occurring in Nigeria. The category description will be provided when estimates will be made.

4.5.2. Methodological issues

Not Applicable as Not estimated.

4.5.3. Description of any flexibility applied

Not resorted to.

4.5.4. Uncertainty assessment and time-series consistency

Not Applicable as Not estimated.

4.5.5. Category-specific QA/QC and verification

Not Applicable as Not estimated.

4.5.6. Category-specific recalculations,

Not Applicable as Not estimated.

4.5.7. Category-specific planned improvements

Data collection to cover the 2 sub-categories Lubricants and Paraffin wax use is planned for during the inventory compilation of 2028.

4.6. Electronics industry (2.E)

4.6.1. Category description

Not Applicable as Not occurring.

4.6.2. Methodological issues Not

Applicable as Not occurring.

4.6.3. Description of any flexibility applied (i.e. by developing country Parties that need flexibility in the light of their capacities as per paras. 4–6 of the MPGs)7 Not Applicable as Not occurring.

4.6.4. Uncertainty assessment and time-series consistency Not

Applicable as Not occurring.

4.6.5. Category-specific QA/QC and verification Not

Applicable as Not occurring.

4.6.6. Category-specific recalculations Not

Applicable as Not occurring.

4.6.7. Category-specific planned improvements Not

Applicable as Not occurring.

4.7. Product uses as substitutes for ODS (2.F)

4.7.1. Category description

The category Product uses as substitutes for ODS includes 6 sub-categories and 4 of them, namely Refrigeration and air conditioning, Fire protection, Aerosols and Solvents occur but have not been estimated because AD were not available. The category description will be provided when estimates will be made.

4.7.2. Methodological issues

Not Applicable as Not estimated.

4.7.3. Description of any flexibility applied

Flexibility resorted to under provision made in paragraph 48 of the MPGs on coverage of mandatory gases. More details are provided under improvement.

4.7.4. Uncertainty assessment and time-series consistency Not

Applicable as Not estimated.

4.7.5. Category-specific QA/QC and verification Not

Applicable as Not estimated.

4.7.6. Category-specific recalculations Not

Applicable as Not estimated.

4.7.7. Category-specific planned improvements

Unavailability of activity data and an appropriate system to collect same. Thus, efforts will be deployed to address this situation by 2032.

4.8. Other product manufacture and use (2.G)

4.8.1. Category description

Three sub-categories of the category Other Product Manufacture and Use occur and has not been estimated due to unavailability of AD. They are Electrical equipment, SF6 and PFCs from other product use and N2O from product uses. The category description will be provided when estimates will be made.

4.8.2. Methodological issues

Not Applicable as Not estimated.

4.8.3. Description of any flexibility applied

Flexibility resorted to under provision made in paragraph 48 of the MPGs on coverage of mandatory gases. More details are provided under improvement.

4.8.4. Uncertainty assessment and time-series consistency Not

Applicable as Not estimated.

4.8.5. Category-specific QA/QC and verification Not

Applicable as Not estimated.

4.8.6. Category-specific recalculations Not

Applicable as Not estimated.

4.8.7. Category-specific planned improvements

Unavailability of activity data and an appropriate system to collect same. Thus, efforts will be deployed to address this situation by 2032.

4.9. Other (2.H)

4.9.1. Category description (e.g. characteristics of sources)

The subcategories Pulp and Paper Production and Food and Beverage Industry have not been estimated as it is not known if CO2 used in these industries are of biogenic or non-biogenic origin. The category description will be provided when estimates will be made.

4.9.2. Methodological issues

Not Applicable as Not estimated.

4.9.3. Description of any flexibility applied

Not Applicable as Not Estimated

4.9.4. Uncertainty assessment and time-series consistency

Not Applicable as Not estimated.

4.9.5. Category-specific QA/QC and verification

Not Applicable as Not estimated.

4.9.6. Category-specific recalculations

Not Applicable as Not estimated.

4.9.7. Category-specific planned improvements

Investigations will be undertaken to determine the origin of the CO2 used and eventual estimation. This is planned by 2030.

Chapter 5. Agriculture (CRT sector 3)

5.1. Overview of the sector

Agriculture comprises 10 categories, themselves sometimes subdivided in sub-categories. Of these, only 7 categories are responsible for emissions in Nigeria and 6 have been estimated. Three categories, Prescribed burning of savannahs, Other carbon-containing fertilizers and Other, do not occur and one, Liming, has not been estimated. Based on the last inventories it is certain that the highest emitting sources have been covered. Nigeria has an important livestock production activity inherent of extensive grazing areas available and population size. The major ruminant livestock in terms of number of animals is goat, followed by the sheep and cattle. Most livestock are in a communal system of rearing. Production of poultry both on a communal basis and in intensive commercial farms is common. Livestock rearing contribute emissions mainly through Enteric Fermentation and Manure management. Crop production also contributes emissions through the application of urea and other organic and chemical fertilizers and Rice production among others.

The activities addressed are Enteric Fermentation, Manure Management, Rice cultivation, Agricultural Soils, Field burning of agricultural residues and Urea application. Emissions have been fully estimated for all 6 categories for the direct GHGs. Tier 1 has been adopted for making the emissions estimates based on the decision tree.

The trend of emissions for the Agriculture sector, decomposed by category, are provided in Figure 5.1 for all years of the time series. Total emissions for the Agriculture sector increased from 44,480 kt CO2 e in 2000 to 77,981 kt CO2 e in 2022. Enteric Fermentation dominated the emissions from the Agriculture sector followed by Agricultural soils and Rice cultivation. In 2022, Enteric Fermentation emitted 49% of the sector emissions, Agricultural soils 29% and Rice cultivation 15%. The other emitting categories contributed the remaining 7%.

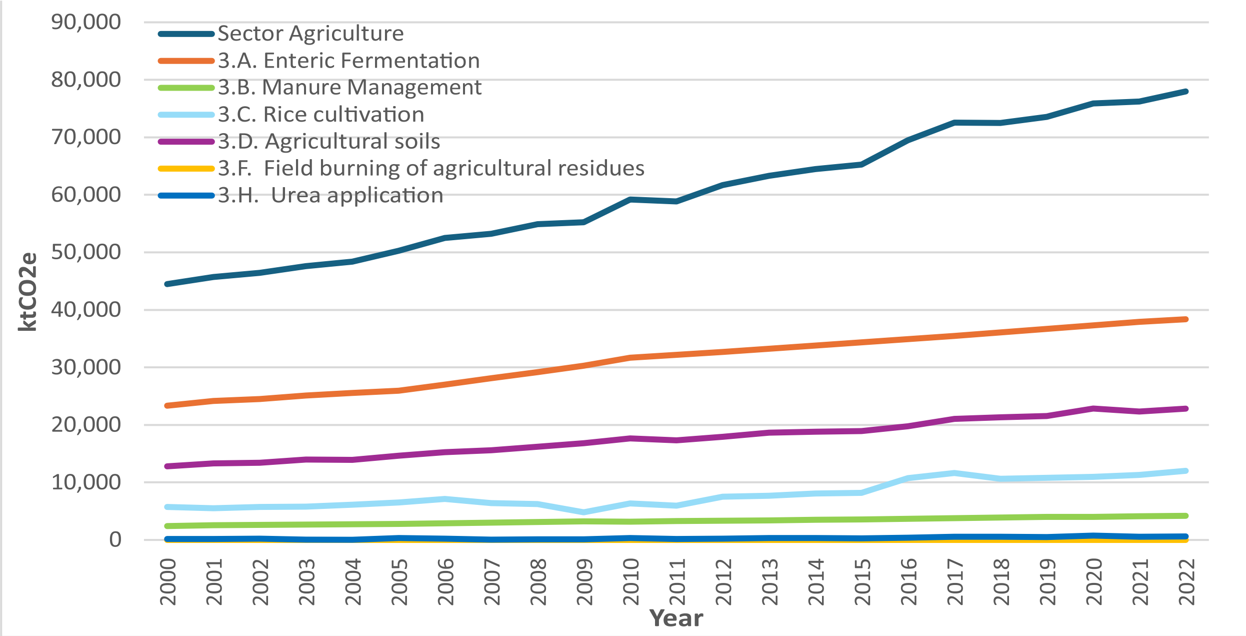

Figure 5.1. Trends of emissions (kt CO2 e) for the Agriculture sector (2000-2022)

Emissions of the Agriculture sector and its categories are provided in Table 5.1 for selected years. Emissions increased by 75% when comparing 2022 with 2000. Among the sub-categories, the increases varied between 64% and 219%.

Table 5.1. Emissions (kt CO2 e) of the Agriculture sector by sub sector for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
Sector Agriculture	44,480	50,257	59,185	65,253	72,492	73,540	75,887	76,205	77,981	75%
3.A. Enteric Fermentation	23,340	25,961	31,668	34,330	36,064	36,666	37,295	37,911	38,369	64%
3.B. Manure Management	2,409	2,799	3,166	3,589	3,905	4,020	4,012	4,120	4,195	74%
3.C. Rice cultivation	5,752	6,524	6,363	8,165	10,634	10,794	10,973	11,300	12,017	109%
3.D. Agricultural soils	12,793	14,665	17,677	18,915	21,329	21,539	22,848	22,326	22,804	78%
3.F. Field burning of agricultural residues	1	2	2	4	4	4	4	4	4	255%
3.H. Urea application	185	306	308	250	557	516	755	544	591	219%

Aggregated emissions by gas are provided in Figure 5.2. CH4 is the major gas emitted in the Agriculture sector followed by N2O and CO2.

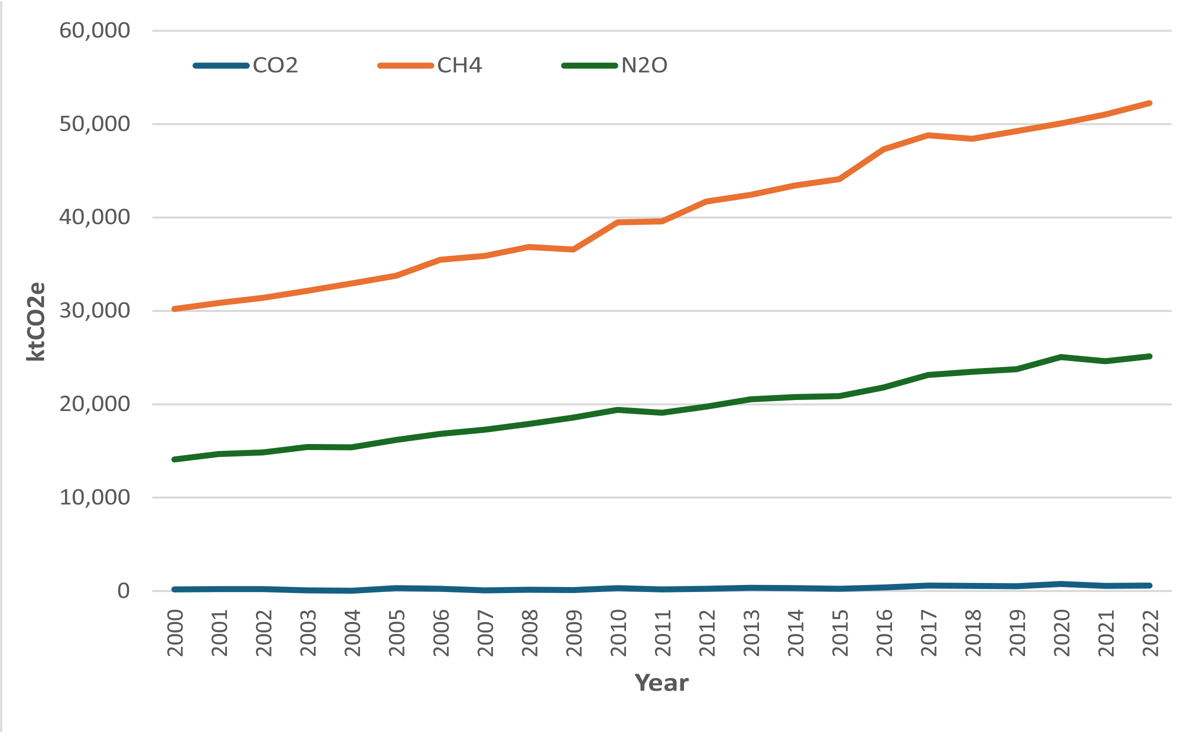

Figure 5.2. Emission (kt) trend by gas for the Agriculture sector (2000-2022)

The IPCC 2006 guidelines and its 2019 refinements as applicable have been used for estimating emissions using the 2006 IPCC software v 2.93. Details on the method and Tier level are given in Table 5.2. **Table 5.2. Method and Tier level adopted for the Agriculture sector**

GHG source and sink Categories	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SOx
3. Agriculture							
3.A. Enteric Fermentation	NA		NA	NA	NA	NA	NA
Option A							
3.A.1.b. Non-dairy cattle	NA	IPCC T1	NA	NA	NA	NA	NA
3.A.2 Sheep	NA	IPCC T1	NA	NA	NA	NA	NA
3.A.3. Swine	NA	IPCC T1	NA	NA	NA	NA	NA
3.A.4. Other livestock	NA	IPCC T1	NA	NA	NA	NA	NA
3.B. Manure Management							
Option A							
3.B.1.b. Non-dairy cattle	NA	DT1	DT1	NA	NA	NE	NA
3.B.2. Sheep	NA	DT1	DT1	NA	NA	NE	NA
GHG source and sink Categories	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SOx
3.B.3. Swine	NA	DT1	DT1	NA	NA	NE	NA
3.B.4. other livestock	NA	DT1	DT1	NA	NA	NE	NA
3.B.5. Indirect N2O emissions	NA	DT1	DT1	NA	NA	NA	NA
3.C – Rice Cultivation	NA	DT1	NA	NA	NA	NA	NA
3.D – Agricultural soils							
3.D.1. Direct N_2O emissions from managed soils							
3.D.1.a. Inorganic N fertilizers	NA	NA	DT1	NA	NA	NA	NA
3.D.1.b. Organic N fertilizers	NA	NA	DT1	NA	NA	NA	NA
3.D.1.c. Urine and dung deposited by grazing animals	NA	NA	DT1	NA	NA	NA	NA
3.D.2. Indirect N_2O Emissions from managed soils	NA	NA	DT1	NA	NA	NA	NA
3.F. Field burning of agricultural residues							
3.F.4. Sugar cane	NA	DT1	DT1	DT1	DT1	NE	NA

3.H. Urea application	DT1	NA	NA	NA	NA	NA	NA

5.2. Enteric fermentation (CRT 3.A)

5.2.1. Category description

The livestock sector of Nigeria is characterized by the rearing of cattle, sheep and goats primarily at the communal level. The animals are responsible for Enteric Fermentation when they digest the grasses they ingest. Other animals contributing to this process are camels, horses, mules and asses, and swine to a much lesser degree. The trend of emissions for Enteric fermentation is provided in Figure 5.3.

Emissions from Enteric Fermentation, which are provided in Table 5.3 for selected years, increased by 64% from 23,340 kt CO2 e in 2000 to 38,369 kt CO2 e in 2022. The livestock group cattle contributed most of the emissions over the full time series, between 80% and 88%.

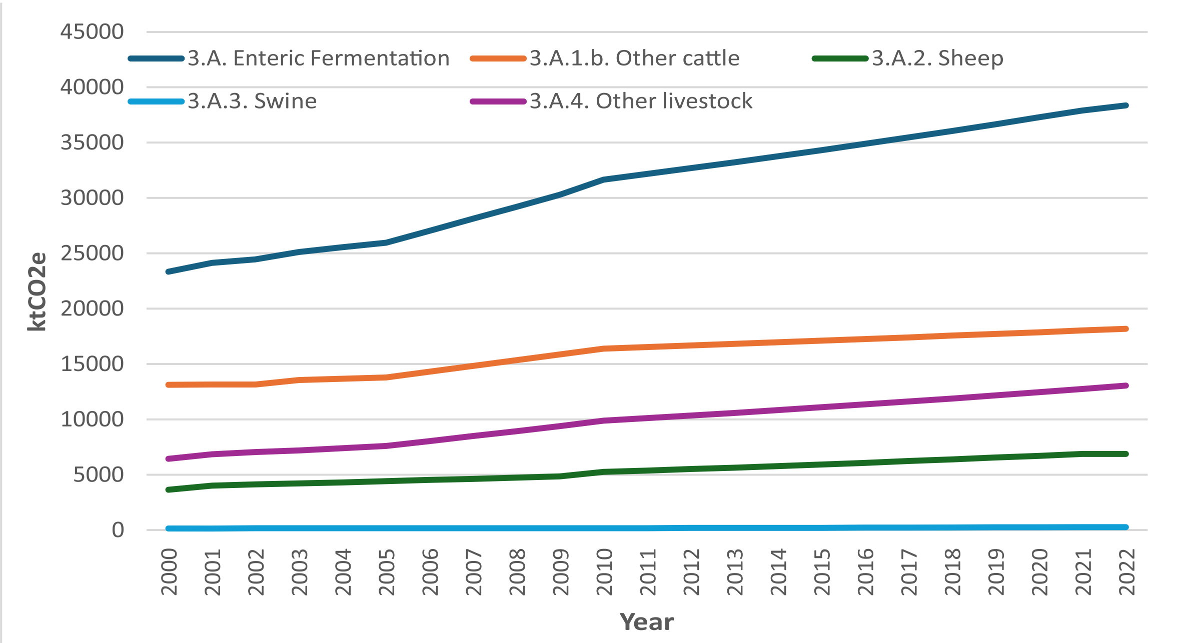

Figure 5.3. Trends of emissions (kt CO2 e) for Enteric Fermentation (2000-2022)

Table 5.3. Emissions (kt CO2 e) from Enteric Fermentation by sub-category for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
3.A. Enteric Fermentation	23,340	25,961	31,668	34,330	36,064	36,666	37,295	37,911	38,369	64%
3.A.1.b. Other cattle	13,123	13,780	16,385	17,111	17,561	17,714	17,868	18,023	18,180	39%
3.A.2. Sheep	3,640	4,417	5,242	5,930	6,386	6,546	6,710	6,877	6,877	89%
3.A.3. Swine	141	170	169	206	231	241	250	260	260	84%
3.A.4. Other livestock	6,436	7,594	9,872	11,083	11,885	12,165	12,467	12,749	13,051	103%

5.2.2. Methodological issues

The Tier 1 approach of the IPCC 2006 guidelines was adopted after applying the decision tree for the category for all animal groups due to lack of disaggregated data for moving to Tier2.

AD used for estimating emissions of Enteric Fermentation is given in Table 5.4.

Table 5.4. Activity Data used for Enteric Fermentation (number of heads per year) (2000-2022)

Year								
	2000	2001	2002	2003	2004	2005	2006	2007
Other Cattle	15,118,300	15,133,400	15,148,600	15,602,601	15,738,343	15,875,267	16,475,622	17,075,976
	26,000,000	28,692,600	29,400,000	30,086,406	30,808,479	31,547,883	32,305,000	33,080,353
	42,500,000	45,260,400	46,400,000	47,517,330	48,740,532	49,959,046	53,097,487	56,235,928

Sheep

Goats

Camels	80,000	100,000	120,000	139,716	159,432	179,148	198,864	218,579
Horses	204,000	205,000	205,000	205,000	204,426	203,215	160,592	147,157
Mules and asses	1,000,000	1,000,000	1,000,000	949,084	950,033	950,983	951,934	952,886
Swine (breeding)	504,762	524,954	611,182	610,295	609,407	608,520	607,632	606,745
	4,542,862	4,724,586	5,500,642	5,492,654	5,484,666	5,476,678	5,468,690	5,460,702
	37,728,000	41,212,800	47,700,000	52,415,744	56,864,048	58,581,844	62,403,038	64,961,601

Swine (market)

Poultry (broilers)

Year								
	125,280,000	138,240,000	141,120,000	144,329,067	149,718,003	158,329,309	165,353,673	174,182,946
Poultry (layers)	2008	2009	2010	2011	2012	2013	2014	2015
Other Cattle	17,676,331	18,276,685	18,877,040	19,041,270	19,206,929	19,374,029	19,542,583	19,712,604
	33,874,281	34,687,264	37,440,022	38,376,023	39,335,423	40,318,809	41,326,780	42,359,948
	59,374,370	62,512,811	65,651,252	67,292,533	68,974,847	70,699,218	72,466,698	74,278,367
Camels	238,295	258,011	277,727	278,005	278,283	278,561	278,840	279,118

Sheep

Goats

Swine (market)	5,452,714	5,444,726	5,436,738	5,654,208	5,880,376	6,115,591	6,360,215	6,614,622
	68,282,339	69,321,561	40,765,933	9,892,989	19,254,033	28,959,933	30,980,956	46,961,626
	182,819,435	194,335,302	98,452,703	138,999,854	140,000,240	141,392,616	151,259,967	148,014,910
Year	2016	2017	2018	2019	2020	2021	2022	-
	19,884,104	20,057,095	20,231,592	20,407,607	20,585,153	20,764,244	20,944,893	-
	43,418,947	44,504,420	45,617,031	46,757,457	47,926,393	49,124,553	49,124,553	-
	76,135,326	78,038,709	79,989,677	81,989,419	84,039,154	86,140,132	88,293,635	-
Camels	279,397	279,677	279,956	280,326	291,595	282,612	282,752	-
Horses	104,053	102,492	101,509	101,611	101,713	101,715	101,817	102,018
Mules and asses	953,839	954,793	970,610	971,581	972,552	973,525	974,499	975,472
Swine (breeding)	605,857	604,970	604,082	628,245	653,375	679,510	706,691	734,958

Poultry (broilers)

Poultry (layers)

Other Cattle

Sheep

Goats

Horses	102,120	102,222	102,324	102,427	102,529	102,477	102,527	-
Mules and asses	976,447	977,424	978,401	979,380	978,879	979,364	979,848	-

Swine (breeding)	764,356	794,931	826,728	859,797	894,189	929,957	929,957	-
Swine (market)	6,879,207	7,154,375	7,440,550	7,738,172	8,047,699	8,369,609	8,369,609	-
Poultry (broilers)	53,162,911	58,154,909	63,615,655	69,589,165	55,758,716	59,940,656	64,436,205	-
Poultry (layers)	160,126,720	175,162,618	191,610,388	209,602,604	167,945,284	180,541,289	194,081,886	-

Default EFs from the IPCC guidelines (Table 10.10 (updated) Volume 4 Chapter 10 for all other animals and for Other Cattle from the NIR1) were used for making estimates are provided in Table 5.5.

Table 5.5. Emission factors and other information used for Enteric Fermentation

Animal type	Typical mass (Kg)	Emission factor [kg CH4/(head yr)]
Other Cattle	173	31
Sheep	28	5
Goats	30	5
Camels	217	46
Horses	238	18
Mules and asses	130	10
Swine (breeding and market)	28	1
Poultry (broilers)	0.9	-
Poultry (layers)	1.8	-

5.2.3. Flexibility

Not resorted to.

5.2.4. Uncertainty assessment and time-series consistency

Default Uncertainty values provided for AD and EFs in the IPCC 2006 Guidelines have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 5.6) are ±20% for all animal groups. For the EFs ±40% has been adopted.

Table 5.6. Uncertainty levels assigned for Enteric Fermentation

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
3.A. Enteric fermentation			
3.A.1.b – Other cattle	CH4	±20	±40
3.A.1.c - Sheep	CH4	±20	±40
3.A.1.d - Goats	CH4	±20	±40
3.A.1.e - Camels	CH4	±20	±40
3.A.1.f - Horses	CH4	±20	±40
3.A.1.g – Mules and asses	CH4	±20	±40
3.A.1.h - Swine	CH4	±20	±40

1: Refer to 2006 Guidelines, Page 10.23, Chapter 10, Volume 4.

2: Refer to 2006 Guidelines, Page 10.33, Chapter 10, Volume 4.

The estimated combined uncertainties are 28.5% for the level assessment for base year 2000 and 26.9% for year-t, and 28.9% for the trend between the base year 2000 and year-t 2022 (Table 5.7).

Table 5.7. Uncertainty assessment for Enteric Fermentation

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
3.A. Enteric Fermentation									
3.A.1.b. - Other Cattle	CH4	13122.7	18180.2	20.0	40.0	44.7	632.2	449.0	518.8
3.A.2. - Sheep	CH4	3640.0	6877.4	20.0	40.0	44.7	48.6	64.3	71.8
3.A.3. - Swine	CH4	141.3	260.4	20.0	40.0	44.7	0.1	0.1	0.1
3.A.4.b - Camels	CH4	103.0	364.2	20.0	40.0	44.7	0.0	0.2	0.3
3.A.4.d - Goats	CH4	5950.0	12361.1	20.0	40.0	44.7	130.0	207.6	243.8
3.A.4e - Horses	CH4	102.8	51.7	20.0	40.0	44.7	0.0	0.0	0.0
3.A.4.f - Mules and Asses	CH4	280.0	274.4	20.0	40.0	44.7	0.3	0.1	0.2
Sum		**23339.9**	**38369.3**			**Sum**	**811.3**	**721.2**	**835.1**
			Uncertainty in level (L) and trend (T) assessment				**L - 28.5**	**L - 26.9**	**T - 28.9**

The time series is consistent as the AD have always been obtained in the same way, the same default EFs of IPCC as well as a common methodology used for all the years of the time series.

5.2.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the procedures for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations and reference material. Quality Assurance during the estimation steps was done by an independent international expert.

5.2.6. Category-specific recalculations

Not Applicable

5.2.7. Category-specific planned improvements

The improvement that has been retained is to move from Tier 1 to Tier 2 as Enteric Fermentation is a key category for Cattle and goats. This will imply the collection of data and other animal characteristics throughout the country to develop country-specific methane conversion factors. Given the size of the territory and other factors such as availability of resources and capacity, it is expected that this exercise will be quite lengthy. The country specific methane conversion factors are expected to be generated by 2032 subject to availability of resources.

5.3. Manure management (CRT 3.B)

5.3.1. Category description

CH4 and N2O are the two direct GHGs emitted during handling and storage of livestock manure. The magnitude of emissions depends on the quantity of manure handled, its characteristics, and the manure management system. Generally, poorly aerated manure management systems generate more CH4 than well-aerated systems. The manure management systems assigned in this inventory are paddock, range and pasture (PRP) and solid storage. All the animals listed for enteric fermentation plus poultry were considered for estimating emissions for manure management.

The trend of emissions is given in Figure 5.4. Manure management emissions increased from 2,409 kt CO2 e to 4,195 kt CO2 e from 2000 to 2022, an increase of 74%. Other livestock comprising goats, horses, Mules and Asses, Camels and poultry remained the highest emitter throughout the full time series. In 2022, Other livestock contributed 39% followed by both Other cattle and Indirect N2O emissions at 18%, Sheep at 15% and swine at 9%.

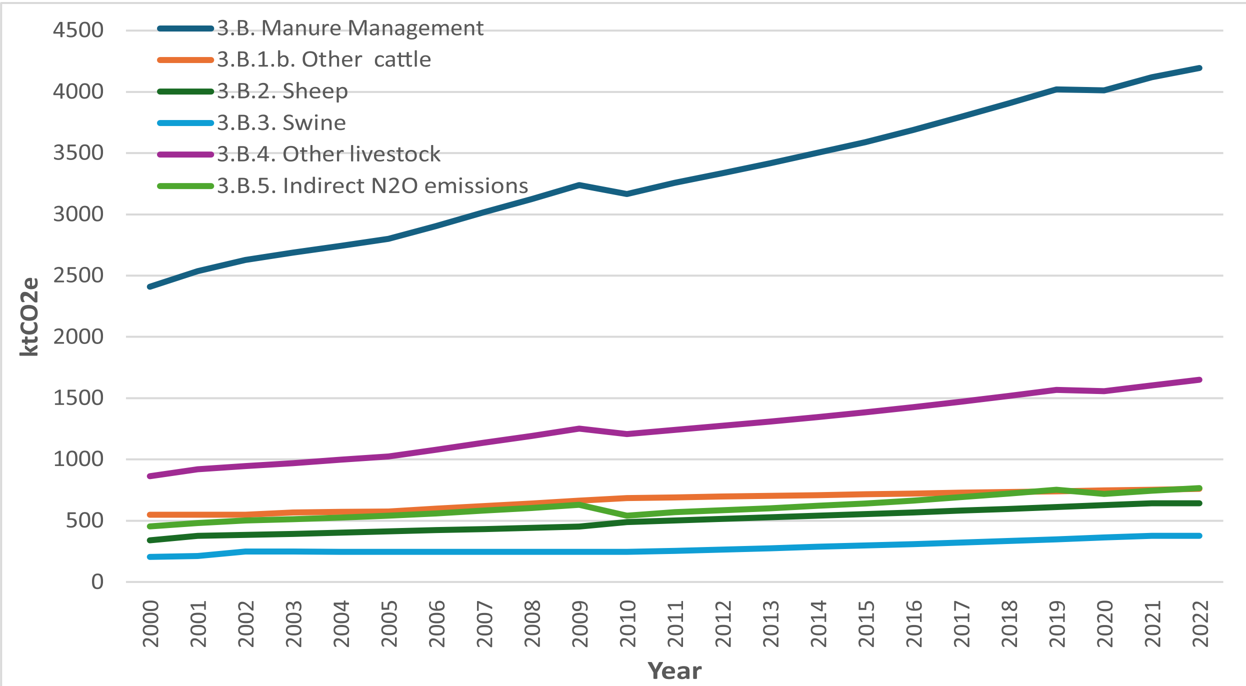

Figure 5.4. Trends of emissions (kt CO2 e) for Manure Management (2000-2022)

The trend of emissions for selected years are depicted in Table 5.8. Emissions from Other cattle increased by 39%, Sheep 89%, Swine 84%, Other livestock by 91% and Indirect emissions by 69%.

Table 5.8. Emissions (kt CO2 e) from Manure Management by sub-category for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
3.B. Manure Management	2,409	2,799	3,166	3,589	3,905	4,020	4,012	4,120	4,195	74%
3.B.1.b. Other	549	576	685	715	734	740	747	753	760	39% cattle
3.B.2. Sheep	340	412	489	554	596	611	626	642	642	89%
3.B.3. Swine	204	246	245	298	335	348	362	377	377	84%
3.B.4. Other livestock	863	1,025	1,206	1,383	1,518	1,568	1,558	1,603	1,650	91%

3.B.5. Indirect N2O emissions	453	540	542	639	721	753	719	745	766	69%

5.3.2. Methodological issues

Emissions from manure management were calculated using IPCC 2006 guidelines, Tier 1 methodology based on the appropriate decision tree and default EFs. This was done by multiplying the individual animal population with the default EF of the respective animal type according to manure management system. The fraction of manure treated under the different manure management systems (MMS) for each livestock species is given in Table 5.9.

Table 5.9. Manure management systems by livestock category (2000-2022)

Type of animal	Manure management system
Other Cattle	90% Pasture-Range-Paddock (PRP) and 10% Solid storage
Sheep	70% Pasture-Range-Paddock (PRP) and 30% Solid storage
Goats	70% Pasture-Range-Paddock (PRP) and 30% Solid storage
Camels	90% Pasture-Range-Paddock (PRP) and 10% Solid storage
Horses	70% Pasture-Range-Paddock (PRP) and 30% Solid storage
Mules and asses	70% Pasture-Range-Paddock (PRP) and 30% Solid storage
Swine (breeding and market)	60% Pasture-Range-Paddock (PRP)and 40% solid storage
Poultry (broilers and layers)	Poultry manure with litter 100%

The default EFs from the IPCC 2006 guidelines (Volume 4 Chapter 10 Table 10.14) adopted for estimating emissions from Manure management are given in Table 5.10.

Table 5.10. Emission factors used for Manure Management (2000-2022)

Type of animal	CH4 EF	Direct N2O-N EF	Indirect N2O-N EF	
	(kgCh4/head/year)	(kg N2O-N/(Kg N and runoff)	(kg N2O-N/ kg NH3-N + NOx-N in MMS)) Volatilized)	(kg N2O-N/ kg N Leached
Other Cattle	1.00	0.005	0.01	0.0075
Sheep	0.20	0.005	0.01	0.0075
Goats	0.22	0.005	0.01	0.0075
Camels	2.56	0.005	0.01	0.0075
Horses	2.19	0.005	0.01	0.0075
Mules and asses	1.20	0.005	0.01	0.0075
Swine (breeding and market)	1.00	0.005	0.01	0.0075
Poultry (broilers and layers)	0.02	0.001	0.01	0.0075

5.3.3. Flexibility

Not resorted to.

5.3.4. Uncertainty assessment and time-series consistency

Uncertainty values provided for AD and EFs within the IPCC 2006 Guidelines' ranges have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 5.11) and EFs are ±20% for all animal groups. Uncertainty levels assigned to EFs were ±30% for CH4 and -50% to +100% for N2O for all types of animals and -80% to 400% for Indirect N2O emissions.

Table 5.11. Uncertainty levels assigned for Manure Management

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
3.B. Manure management			
3.B.1 - Dairy cows	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.1.a. - Other cattle	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.2 - Sheep	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.3 - Swine	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.4.b - Camels	CH4	±20	±30
2006 IPCC Categories	**Gas**	**AD[1]**	**EF[2]**
	N2O	±20	-50 to +100
3.B.4.d - Goats	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.4.e - Horses	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.4.f – Mules and asses	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.4.g - Poultry	CH4	±20	±30
	N2O	±20	-50 to +100
3.B.5. Indirect N2O emissions	N2O	±20	-80 to +400

1: Refer to 2006 Guidelines, Page 10.23, Chapter 10, Volume 4.

2: Refer to 2006 Guidelines, Page 10.48, Chapter 10, Volume 4.

The estimated combined uncertainties are 21% for the level assessment for base year 2000, 23.6% for year-t and 16% for the trend between base year 2000 and year-t 2022 (Table 5.12).

Table 5.12. Uncertainty assessment for Manure Management

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
3.B. Manure Management									
3.B.1.b - Other cattle	CH4	423.3	586.5	20.0	30.0	36.1	40.1	25.4	50.9
3.B.1.b - Other cattle	N2O	125.2	173.5	20.0	100.0	102.0	28.1	17.8	7.6
3.B.2. - Sheep	CH4	145.6	275.1	20.0	30.0	36.1	4.7	5.6	10.5
3.B.2. - Sheep	N2O	194.2	366.9	20.0	100.0	102.0	67.6	79.6	20.0
3.B.3. - Swine	CH4	141.3	260.4	20.0	30.0	36.1	4.5	5.0	9.4
3.B.3. - Swine	N2O	63.1	116.2	20.0	100.0	102.0	7.1	8.0	1.9
3.B.4.b - Camels	CH4	5.7	20.3	20.0	30.0	36.1	0.0	0.0	0.1
3.B.4.b - Camels	N2O	0.6	2.1	20.0	100.0	102.0	0.0	0.0	0.0

3.B.4.d - Goats	CH4	261.8	543.9	20.0	30.0	36.1	15.4	21.9	42.0
3.B.4.d - Goats	N2O	398.2	827.4	20.0	100.0	102.0	284.2	404.6	125.2
3.B.4.e - Horses	CH4	12.5	6.3	20.0	30.0	36.1	0.0	0.0	0.0
3.B.4.e - Horses	N2O	11.9	6.0	20.0	100.0	102.0	0.3	0.0	0.4
3.B.4.f - Mules and Asses	CH4	33.6	32.9	20.0	30.0	36.1	0.3	0.1	0.3
3.B.4.f - Mules and Asses	N2O	13.6	13.4	20.0	100.0	102.0	0.3	0.1	0.2
3.B.4.g - Poultry	CH4	91.3	144.8	20.0	30.0	36.1	1.9	1.5	2.9
3.B.4.g - Poultry	N2O	33.8	53.2	20.0	100.0	102.0	2.0	1.7	0.4
3.D.2 - Indirect N2O Emissions manure management	N2O from	453.3	765.9	34.6	692.8	693.7	17036.4	16042.8	287.5
Sum		**2409.1**	**4194.7**			**Sum**	**440.1**	**554.8**	**256.1**
			Uncertainty in level (L) and trend (T) assessment				**L - 21.0**	**L - 23.6**	**T - 6.0**

The time series is consistent as the AD have always been obtained from the same, the default EFs of IPCC used as well as the same methodology adopted for all the years of the time series.

5.3.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included the use of the decision tree for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

5.3.6. Category-specific recalculations

Not Applicable

5.3.7. Category-specific planned improvements

No improvement planned.

5.4. Rice cultivation (CRT 3.C)

5.4.1. Category description

Rice cultivation is responsible for methane emissions depending on the system. When it is flooded with water, organic matter in the soil decomposes anaerobically to produce methane which is then lost to the atmosphere. The deeper the flooding, the higher the emissions. Nigeria practices 4 types of rice cultivation, upland rice, rainfed, deep water and irrigated.

The trend of emissions for rice cultivation for the full time series is provided in Figure 5.5. Emissions varied with years but shows a definite increasing trend from 2000 to 2022. The increase is from 5,752 kt CO2 e in 2000 to 12,017 kt CO2 e in 2022.

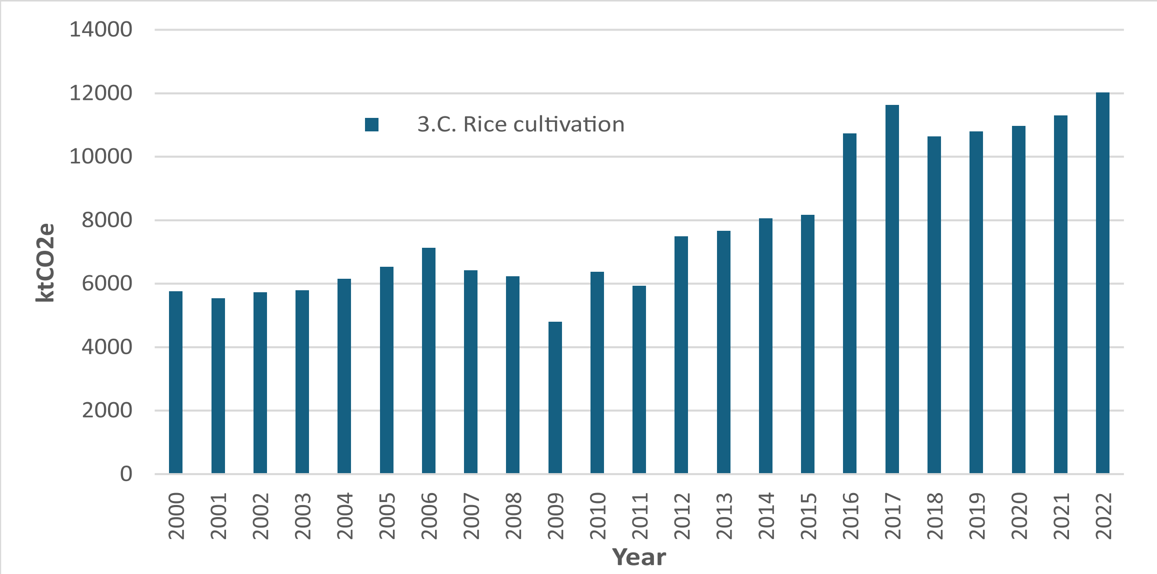

Figure 5.5. Trends of emissions (kt CO2 e) for Rice Cultivation (2000-2022)

Emissions from rice cultivation for selected years are depicted in Table 5.13. the increase from 2000 to 2022 is 109%.

Table 5.13. Emissions (kt CO2 e) from Rice Cultivation for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
3.C. Rice Cultivation	5,752	6,524	6,363	8,165	10,634	10,794	10,973	11,300	12,017	109%

5.4.2. Methodological issues

Emissions from Rice cultivation were calculated using IPCC 2006 guidelines and category decision tree Tier 1 methodology and the default EF of the respective production type according to water management and based on the decision tree. The activity data used are provided in Table 5.14.

Table 5.14. Activity Data (ha) by production system used for Rice Cultivation (2000-2022)

Year								
			2003	2004	2005	2006	2007	
Total rice area			2,210,000	2,348,000	2,494,000	2,725,000	2,451,000	
Upland	659,700	635,100	655,500	663,000	704,400	748,200	817,500	735,300
	87,960	84,680	87,400	88,400	93,920	99,760	109,000	98,040
Irrigated	1,407,360	1,354,880	1,398,400	1,414,400	1,502,720	1,596,160	1,744,000	1,568,640
Rainfed								
Deep water	43,980	42,340	43,700	44,200	46,960	49,880	54,500	49,020

Year								
			2011	2012	2013	2014	2015	
Total rice area			2,269,410	2,863,815	2,931,400	3,081,923	3,121,562	
Upland	714,600	551,064	729,789	680,823	859,145	879,420	924,577	936,469
	95,280	73,475	97,305	90,776	114,553	117,256	123,277	124,862
Irrigated	1,524,480	1,175,603	1,556,883	1,452,422	1,832,842	1,876,096	1,972,431	1,997,800

Rainfed								
Deep water	47,640	36,738	48,653	45,388	57,276	58,628	61,638	62,431

Year								-
		2019	2020	2021	2022			
Total rice area		4,126,670	4,195,100	4,320,100	4,594,200			-
Upland	1,230,353	1,334,094	1,219,653	1,238,001	1,258,530	1,296,030	1,378,260	-
Irrigated	164,047	177,879	162,620	165,067	167,804	172,804	183,768	-
Rainfed	2,624,753	2,846,067	2,601,926	2,641,069	2,684,864	2,764,864	2,940,288	-
Deep water	82,024	88,940	81,310	82,533	83,902	86,402	91,884	-

The default EFs (Volume 4 Chapter 4 Tables 5.11 to 5.13) used for the different rice cultivation types are given in Table 5.15. The scaling factor was determined by using an application rate of 5 t/ha of compost and 2.5 t/ha straw as obtained from AD submitted by States.

Table 5.15. Emission factors and other information used for Rice Cultivation (2000-2022)

Production system	Cultivation period (days)	Baseline emission factor continuously flooded fields without organic amendments - (kg CH4 ha^{-1} d^{-1})	Scaling factor to account for the for differences in water regimes in the pre-season before the cultivation period - Aggregated case	Scaling factor for both type and amount of organic amendments - (Compost 5 t/ha and straw 2.5 t/ha - Dry weight)
Upland	125	1.19	-	2.1811
Irrigated	120	1.19	0.78	2.1811
Rainfed	145	1.19	0.27	2.1811
Deep water	130	1.19	0.27	2.1811

5.4.3. Flexibility

Not resorted to.

5.4.4. Uncertainty assessment and time-series consistency

Uncertainty values provided for AD and EFs within the IPCC 2006 Guidelines' ranges have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 5.16) are ±20%. Uncertainty levels assigned to EFs are -33% and +48%.

Table 5.16. Uncertainty levels assigned for Rice Cultivation

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
3.C. Rice Cultivation			
3.C. - Rice cultivation	CO2	±20	-33 to +48

1: Source - IPCC 2006 Guidelines, Table 5.11 (Updated), Page 5.53, Chapter 5, Volume 4.

The estimated combined uncertainties are 52% for both the level assessment for base year 2000 and year-t 2022, and 59% for the trend between base year 2000 and year-t 2022 (Table 5.17).

Table 5.17. Uncertainty assessment for Rice Cultivation

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
3.C. Rice Cultivation									
3.C. - Rice cultivation	CH4	5752.0	12017.2	20.0	48.0	52.0	2704.0	2704.0	3491.9
Sum		**5752.0**	**12017.2**			**Sum**	**2704.0**	**2704.0**	**3491.9**
			Uncertainty in level (L) and trend (T) assessment				**L - 52.0**	**L - 52.0**	**T - 59.1**

The time series is consistent as the AD have always been sourced from the same institutions, the default EFs of IPCC used as well as the same methodology adopted for all the years of the time series.

5.4.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included the use of the decision tree for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

5.4.6. Category-specific recalculations

Recalculations were undertaken following allocation of the total area of rice production in the different production systems for the period 2000 to 2017 and a change in the information from FAOSTATS. The recalculations resulted in a reduction of 15% of emissions for the period 2000 to 2015 and an increase of 12% for 2016 and 2017 (Table 5.18).

Table 5.18. Comparison of previous and recalculated emissions (kt CO2 e) for Rice Cultivation

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	6,743	6,492	6,700	6,777	7,200	7,648	8,356	7,516	7,304	5,633	7,460	6,959
BTR1 - NID1	5,752	5,538	5,715	5,781	6,142	6,524	7,128	6,411	6,231	4,805	6,363	5,936
% change	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	-
BUR2 - NIR1	8,782	8,989	9,451	9,572	9,572	9,572	-	-	-	-	-	-
BTR1 - NID1	7,491	7,668	8,062	8,165	10,728	11,632	10,634	10,794	10,973	11,300	12,017	-
% change	-15	-15	-15	-15	12	22	-	-	-	-	-	-

5.4.7. Category-specific planned improvements

Rice cultivation is a key category and efforts will be deployed to collect appropriate data and information required to move to Tier 2 estimates by 2028.

5.5. Agricultural soils (CRT 3.D)

5.5.1. Category description

The category Agricultural Soils comprises two sub-categories Direct and Indirect N2O emissions from managed soils and several activity areas under the former. Both sub-categories occur in Nigeria and have been addressed in this inventory.

Direct N2O emissions from managed soils

Within the sub-category Direct N2O emissions from managed soils, activities covered are use of Inorganic and organic nitrogen (N) fertilizers, Urine and dung deposited by grazing animals and Mineralization/immobilization associated with loss/gain of soil organic matter. The remaining activities do not occur in Nigeria. Part of crop residues are usually grazed by animals and thus do not result in emissions, and part to be used as fuel for cooking and this has been estimated under Energy sector.

Indirect N2O emissions from managed soils

Part of the N in manure and fertilizers seeps away from the point of application or discharge. They can then generate N2O that is emitted. These are accounted for under this activity area.

The trends of emissions for Agricultural soils and its 2 categories for the full time series are given in Figure 5.6. Emissions from Agricultural soils increased by 78% between 2000 and 2022 from 12,793 kt CO2 e to 22,804 kt CO2 e. Direct N2O emissions are higher than the Indirect component for all years.

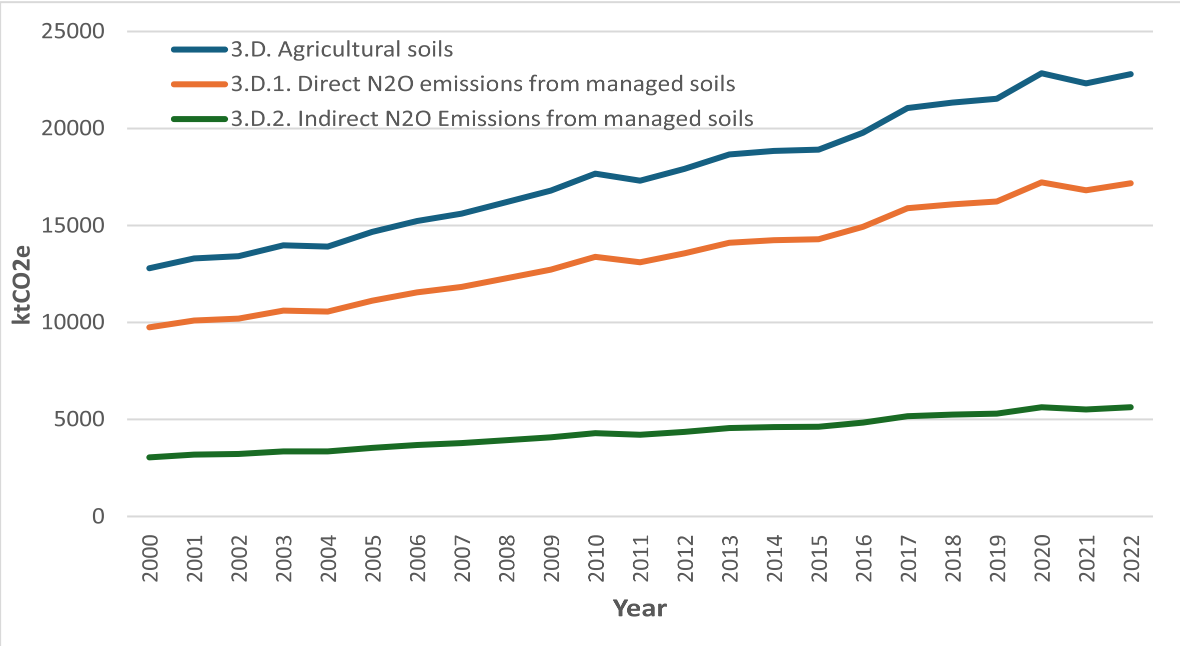

Figure 5.6. Trends of emissions (kt CO2 e) for Agricultural Soils (2000-2022)

Emissions for selected years are presented in Table 5.19. Direct emissions from managed soils increased by 76% from 9,749 kt CO2 e in 2000 to 17,174 kt CO2 e in 2022. Indirect emissions from managed soils similarly increased by 85% from 3,044 kt CO2 e to 5,631 kt CO2 e.

Table 5.19. Emissions (kt CO2 e) from Agricultural Soils by subcategory for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
3.D. Agricultural soils	12,793	14,665	17,677	18,915	21,329	21,539	22,848	22,326	22,804	78%
3.D.1. Direct N2O emissions from managed soils	9,749	11,128	13,389	14,290	16,087	16,237	17,222	16,819	17,174	76%

3.D.2. Indirect N2O Emissions from managed soils	3,044	3,538	4,288	4,625	5,242	5,302	5,626	5,507	5,631	85%

5.5.2. Methodological issues

The method adopted is Tier 1 based on the decision tree and according to the IPCC 2006 Guidelines and the 2006 IPCC Software – v 2.93 has been used to compute emissions for these categories.

AD in terms of amount of N applied through inorganic and organic fertilizers, and urine and dung deposited by grazing animals are provided in table 5.20.

Table 5.20. Activity Data used for Agricultural soils (kg N applied) (2000-2022)

Year								
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
	145,017,450	150,476,550	125,131,000	167,778,000	116,343,000	213,221,000	216,854,000	183,231,150
Year								
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
	188,690,250	194,149,350	263,151,000	138,428,000	192,598,730	269,528,610	242,150,990	196,103,730
Year								-
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	
	288,746,460	453,000,000	436,400,000	404,865,900	591,627,680	426,742,240	463,224,388	-

The default EFs from the 2006 IPCC guidelines adopted for estimating emissions for the different components are given in Table 5.21.

Table 5.21. Emission factors used for Agricultural Soils (2000-2022)

Categories	Emission factors
3.D.1. Direct N2O emissions from managed soils	
3.D.1.a. Inorganic N fertilizers	0.01 kg N2O-N/kg N applied
3.D.1.b. Organic N fertilizers	0.01 kg N2O-N/kg N deposited
3.D.1.c. Urine and dung deposited by grazing animals (Sheep, goat, horses, mules and asses, camels)	0.01 kg N2O-N/kg N deposited
3.D.1.c. Urine and dung deposited by grazing animals (Cattle and swine)	0.02 kg N2O-N/kg N deposited
3.D.2. Indirect N2O Emissions from managed soils	0.02 - Fraction of urine and dung that volatilizes 0.01 kg N2O-N/ kg NH3-N + NOx-N Volatilized

Source – IPCC 2006 Guidelines – Table Tables 11.1 and 11.3, Chapter 11, Volume 4.

5.5.3. Flexibility Not

resorted to.

5.5.4. Uncertainty assessment and time-series consistency

Uncertainty values provided for AD and EFs within the IPCC 2006 Guidelines' ranges have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 5.22) are ±20% for Organic N fertilizers, Urine and dung deposited by grazing animals (Cattle, Sheep, goat, horses, mules and asses, camels) for Direct emissions from managed soils as well as for indirect emissions for managed soils. The uncertainty level assigned to AD for Inorganic fertilizers for Direct emissions from managed soils is ±50%. Uncertainty levels applied for EFs varied between -65% to +400% depending on the component considered (Table 5.22).

Table 5.22. Uncertainty levels assigned for Agricultural Soils

2006 IPCC Categories	Uncertainty assigned (%)	
3.D. Agricultural soils	AD[1]	EF[2]
3.D.1. Direct N2O emissions from managed soils		
3.D.1.a. Inorganic N fertilizers	±50	-65 to +200
3.D.1.b. Organic N fertilizers	±20	-70 to +200
3.D.1.c. Urine and dung deposited by grazing animals (Sheep, goat, horses, mules and asses, camels)	±20	-65 to +200
3.D.1.c. Urine and dung deposited by grazing animals (Cattle)	±20	-65 to +200
3.D.2. Indirect N2O Emissions from managed soils	±20	-80 to +400

1: Refer to 2006 Guidelines, Chapter 10 and Chapter 11, Volume 4.

2: Refer to 2006 Guidelines, Tables 11.1-11.3, Chapter 11, Volume 4.

The estimated combined uncertainties are 350.4% for the level assessment for base year 2000 and 350.2% for yeart 2022, and 124.1% for the trend between base year 2000 and year-t 2022 (Table 5.23).

Table 5.23. Uncertainty assessment for Agricultural Soils

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year- 2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
3.D. Agricultural soils									
3.D.1. Direct N2O emissions from managed soils	N2O	9748.7	17173.8	64.0	400.5	405.6	95522.7	93295.4	14817.3
3.D.2. Indirect N2O Emissions from managed soils	N2O	3044.4	5630.6	34.6	692.8	693.7	27250.9	29336.0	586.134
Sum		**12793.1**	**22804.4**			**Sum**	**122773.6**	**122631.4**	**15403.4**
			Uncertainty in level (L) and trend (T) assessment				**L - 350.4**	**L - 350.2**	**T - 124.1**

The time series is consistent as the AD have always been sourced from the same institutions, the default EFs of IPCC used as well as the same methodology adopted for all the years of the time series.

5.5.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included the use of the decision tree for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

5.5.6. Category-specific recalculations

Not Applicable

5.5.7. Category-specific planned improvements

The planned improvement consists in the collection of disaggregated data and information for moving from Tier 1 to Tier 2 as both Direct and Indirect emissions of N2O from managed soils are key categories. However, both these subcategories are directly related with the livestock sector primarily. It is planned to make this improvement in the inventory of 2032 through improvement in the quality of data collected and any other information that could be responsible for this outcome.

5.6. Field burning of agricultural residues (CRT 3.F)

5.6.1. Category description

Usually, agricultural residues are not burned in Nigeria as they are used for other purposes such production of heat, for cooking and grazed by animals. However, sugarcane cultivation is somewhat special, and the dried leaves are burned prior to harvest to facilitate the latter operation and sending a better-quality crop for milling. This activity is considered here for estimating emissions from burning of crop residues. It is of note that only CH4 and N2O are considered here as the CO2 component is regarded as biogenic.

Emissions from burning of crop residues fluctuated between years as it is related to production which is climate based. The overall trend is an increase over the time series. Emissions increased from in 1.2 kt CO2 e 2000 to 4.2 kt CO2 e in 2022 (Figure 5.7).

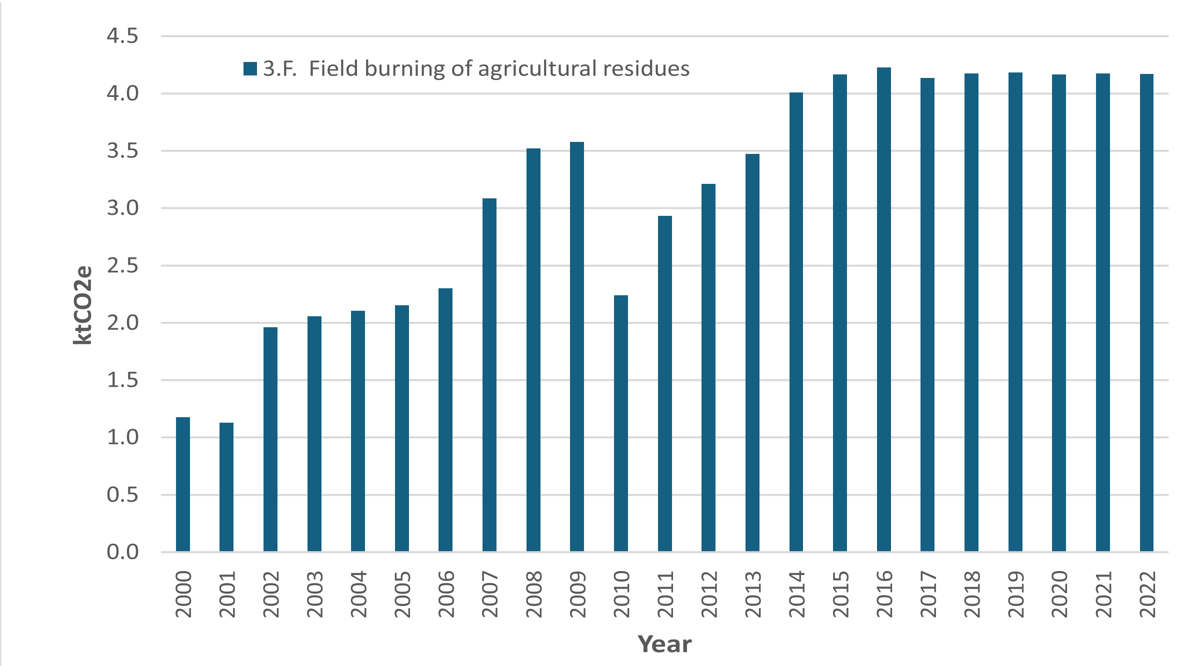

Figure 5.7. Trends of emissions (kt CO2 e) for Field burning of agricultural residues (2000-2022)

Emissions from burning of crop residues for selected years are given in Table 5.24. The increase over the period 2000 to 2022 is 255%.

Table 5.24. Emissions (kt CO2 e) from Field burning of agricultural residues by sub-category for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
3.F. Field burning of agricultural residues - Sugar cane	1.2	2.2	2.2	4.2	4.2	4.2	4.2	4.2	4.2	255%

5.6.2. Methodological issues

The method adopted is Tier 1 based on the decision tree and according to the IPCC 2006 Guidelines and the 2006 IPCC Software – v 2.93 has been used to compute emissions for these categories.

AD in terms of amount of crop residues burned are provided in table 5.25.

Table 5.25. Activity Data used for Field burning of agricultural residues (2000-2022)

Year	2000	2001	2002	2003	2004	2005	2006	2007
Area burnt (ha)	24,000	23,000	40,000	42,000	43,000	44,000	47,000	63,000
Dry matter (kg)	15,600,000	14,950,000	26,000,000	27,300,000	27,950,000	28,600,000	30,550,000	40,950,000

Year	2008	2009	2010	2011	2012	2013	2014	2015
Area burnt (ha)	71,890	73,060	45,680	49,008	61,821	70,926	81,872	85,018
Dry matter (kg)	46,729,000	47,489,000	29,692,000	38,953,000	42,645,000	46,102,000	53,216,800	55,261,800

Year	2016	2017	2018	2019	2020	2021	2022	-
Area burnt (ha)	86,373	84,421	88,415	86,403	86,413	87,077	86,631	
Dry matter (kg)	56,142,600	54,873,700	55,426,100	55,480,800	55,260,200	55,389,000	55,368,167	-

Default EFs as available in the IPCC Software were used and are provided in Table 5.26.

Table 5.26. Emission factors used for Field burning of agricultural residues (2000-2022)

	EF
Combustion factor	0.8
CH4 EF (g/kg dm burnt)	2.7
N2O EF (g/kg dm burnt)	0.07
NOx EF (g/kg dm burnt)	2.5
CO EF (g/kg dm burnt)	92

5.6.3. Flexibility

Not resorted to.

5.6.4. Uncertainty assessment and time-series consistency

Uncertainty values provided for AD and EFs within the IPCC 2006 Guidelines' ranges have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 5.26) are ±20% for both CH_4 and N_2O. The uncertainty level assigned for EFs are ±50% for CH_4 and -40% to +140% for N_2O (Table 5.27).

Table 5.27. Uncertainty levels assigned for Field burning of agricultural residues

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
3.F. Field burning of agricultural residues			
3.F.4. Field burning of agricultural residues - Sugar cane	CH4	±20	-±50
	N2O		-40 to +140

The estimated combined uncertainties are 51.4% for both the level assessment for base year 2000 and year-t 2022, and 83% for the trend between base year 2000 and year-t 2022 (Table 5.28).

Table 5.28. Uncertainty assessment for Field burning of agricultural residues

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty	Contribution to Variance by Category in 2000	Contribution to Variance by Category in 2022	Uncertainty introduced into the trend Data in total national emissions (%)
3.F.Field burning of agricultural residues									
3.F.4. Field burning of agricultural residues - Sugar cane	CH4	0.94	3.35	20.0	50.0	53.9	1869.8	1869.8	6497.8
3.F.4. Field burning of agricultural residues - Sugar cane	N2O	0.23	0.82	20.0	140.0	141.4	776.4	776.4	391.2
Sum		**1.17**	**4.17**			**Sum**	**2646.2**	**2646.2**	**6889.0**
			Uncertainty in level (L) and trend (T) assessment				**L - 51.4**	**L - 51.4**	**T - 83.0**

The time series is consistent as the AD have always been sourced from the same institutions, the default EFs of IPCC used as well as the same methodology adopted for all the years of the time series.

5.6.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included the use of the decision tree for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

5.6.6. Category-specific recalculations

Not Applicable.

5.6.7. Category-specific planned improvements

No improvement is planned.

5.7. Liming

5.7.1. Category description.

Not Estimated.

5.7.2. Methodological issues

Not Applicable as Not Estimated

5.7.3. Flexibility

Not Applicable as Not Estimated

5.7.4. Uncertainty assessment and time series consistency Not

Applicable as Not Estimated.

5.7.5. Category-specific QA/QC and verification Not

Applicable as Not Estimated.

5.7.6. Category-specific recalculations Not

Applicable as Not Estimated.

5.7.7. Category specific planned improvement

The planned improvement is to collect data and widen the scope of the inventory by making estimates of this category by 2028.

5.8. Urea application (CRT 3.H)

5.8.1. Category description

Nigeria applies urea in crop production and this release CO2 to the atmosphere.

The trend of emissions for Urea application is given in Figure 5.8. Emissions from urea application fluctuated between years of the time series but show a clear increasing trend. Emissions increased from 185 kt CO2 e to a peak of 755 kt CO2 e in 2020 to regress slightly to 591 kt CO2 e in 2022.

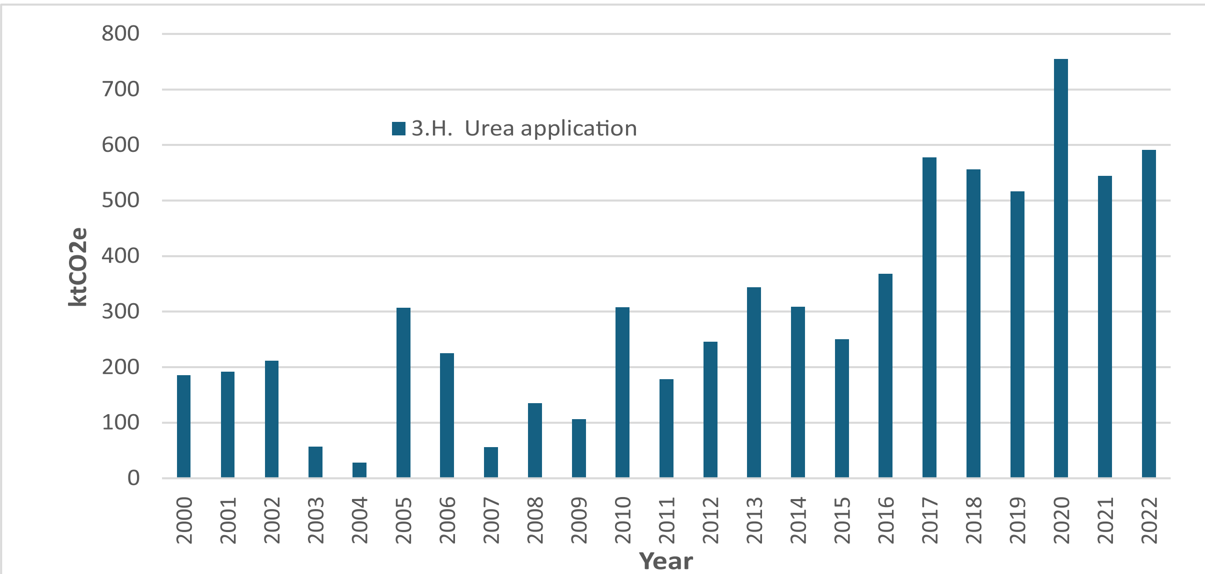

Figure 5.8. Trends of emissions (kt CO2 e) for Urea Application (2000-2022)

Emissions for selected years are given in Table 5.29. It shows an increase of 219% over the period 2000 to 2022.

Table 5.29. Emissions (kt CO2 e) from Urea Application for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
3.H. Urea application	185	306	308	250	557	516	755	544	591	219%

5.8.2. Methodological issues

The method adopted is Tier 1 based on the decision tree and according to the IPCC 2006 Guidelines and the 2006 IPCC Software – v 2.93 has been used to compute emissions from Urea application.

The AD used for making the estimates of emissions are provided in Table 5.30.

Table 5.30. Activity Data (t) used for Urea Application (2000-2022)

Year	2001	2002	2003	2004	2005	2(	2007
Urea applied	261,698	288,252	77,207	39,000	417,900	30(	75,864

Year	2012	2013	2014	2(
Urea applied	334,954	468,745	421,132	34:

Year				2019	2020	2021	2(	
Urea applied	502,168	787,826	758,957	704,115	1,028,918		742,160	805,608 -

The default EF, 0.2 t C/t Urea from the 2019 refinements was used for estimating emissions for all years.

5.8.3. Flexibility

Not resorted to.

5.8.4. Uncertainty assessment and time-series consistency

Uncertainty values provided for AD and EFs within the IPCC 2006 Guidelines' ranges have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 5.31) are ±50% and ±20% for the EF.

Table 5.31. Uncertainty levels assigned for Urea Application

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
3.H. Urea application	CO2	±50	±20

1: Refer to 2006 Guidelines, Page 11.34, Chapter 11, Volume 4.

2: Refer to 2006 Guidelines, Page 11.34, Chapter 11, Volume 4.

The estimated combined uncertainties are 52% for both the level assessment for base year 2000 and year-t 2022, and 59.1% for the trend between base year 2000 and year-t 2022 (Table 5.32).

Table 5.32. Uncertainty assessment for Urea Application

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
3.H. Urea application									
3.H. Urea application	CO2	184.9	590.8	50.0	20.0	53.9	2900.0	2900.0	51016.7
Sum		**5752.0**	**12017.2**			**Sum**	**2704.0**	**2704.0**	**3491.9**
			Uncertainty in level (L) and trend (T) assessment				**L - 52.0**	**L - 52.0**	**T - 59.1**

The time series is consistent as the AD have always been sourced from the same institutions, the default EFs of IPCC used as well as the same methodology adopted for all the years of the time series.

5.8.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included the use of the decision tree for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

5.8.6. Category-specific recalculations

Not Applicable

5.8.7. Category-specific planned improvements

No improvement planned.

5.9. Other carbon containing fertilizers (CRT 3.I)

Not Occurring

5.9.1. Category description

Not Applicable as Not Occurring.

5.9.2. Methodological issues

Not Applicable as Not Occurring.

5.9.3. Flexibility

Not Applicable as Not Occurring.

5.9.4. Uncertainty assessment and time-series consistency Not

Applicable as Not Occurring.

5.9.5. Category-specific QA/QC and verification Not

Applicable as Not Occurring.

5.9.6. Category-specific recalculations Not

Applicable as Not Occurring.

5.9.7. Category-specific planned improvements Not

Applicable as Not Occurring.

5.10. Other

Not Occurring

Chapter 6. Land use, land-use change and forestry (CRT sector 4)

6.1. Overview of the sector

All lands in Nigeria have been classified under the six IPCC land categories and have been treated in this inventory as managed land.

The six land categories are:

- 3.B.1 Forestland
- 3.B.2 Cropland
- 3.B.3 Grassland
- 3.B.4 Wetlands
- 3.B.5 Settlements
- 3.B.6 Other land

They have all been accounted for in the compilation of emissions and removals. Activities within the six IPCC land classes and between the classes have not been possible due to data constraints. Only three subcategories have been estimated, namely Forestland remaining Forestland, Cropland remaining Cropland and Settlements remaining Settlements.

Land use changes have not been derived due to the non-existence of a consistent set of land cover maps for land representation of the 6 IPCC classes to generate changes between these classes.

The LULUCF sector also include emissions from gain and loss of biomass when a particular land class changes use such as Forestland being converted to Grassland or Settlements, burning of biomass caused by wildfires and emissions or removals estimated for Harvested Wood Products (HWP). In this inventory, only activities within Forestland, Cropland and Settlements, and Harvested Wood Products have been addressed. The sector remained a net emitter throughout the time series 2000 to 2022.

The trend in emissions for the sector is depicted in Figure 6.1. Overall, net emissions increased gradually and corresponded with those of Forestland remaining Forestland until 2020 when it dipped on account of removals through Soil Organic Carbon in Cropland and Settlements which started to be accounted for within the software. These stemmed from these two land classes as they reached 20 years and are thus reclassified with the software automatically calculating the removals and assigning them in the results as from 2020 instead of spanning this process annually. Over the full time series net emissions increased from 208,675 kt CO_2 e to peak at 306,996 kt CO_2 e in 2019 and dipping to 225,599 kt CO_2 e in 2022.

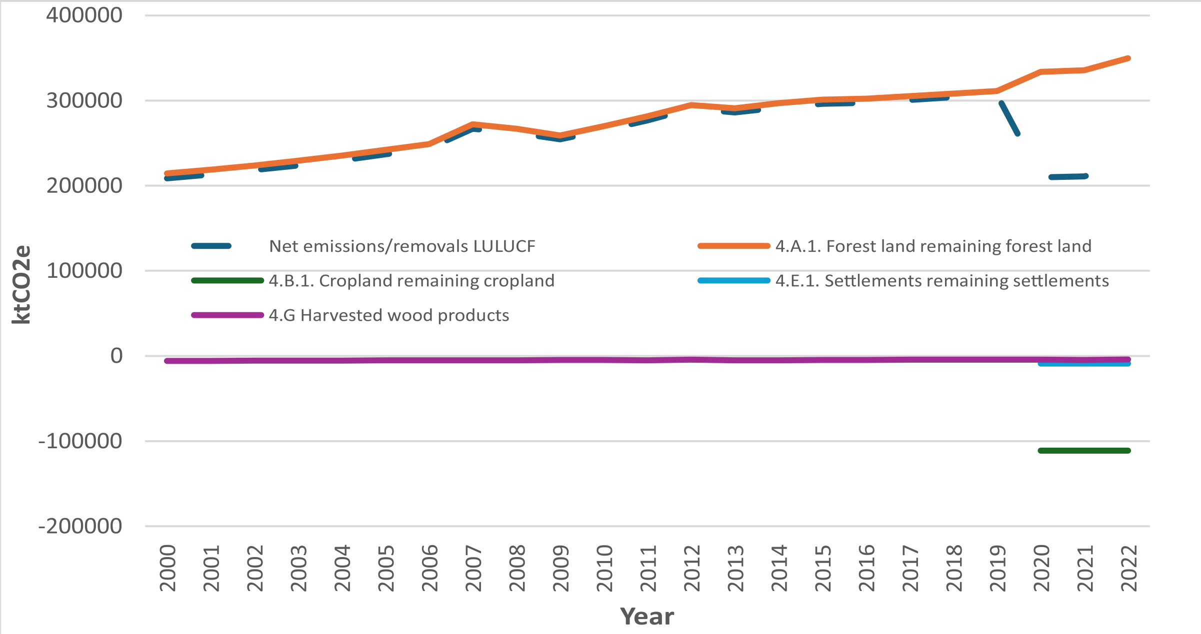

Figure 6.1. Trends of emissions (kt CO2 e) for the LULUCF sector (2000-2022)

Emissions and Removals by category for selected years are presented in Table 6.1. Emissions increased from 214,488 kt CO2 e in 2000 to 349,744 kt CO2 e for Forestland. Net emissions for the sector increased by 8% over the period 2000 to 2022. When considering categories, Forestland remaining Forestland increased by 63% while Harvested Wood Products regressed by 29% in its sink potential. Cropland remaining Cropland and Settlements remaining Settlements started acting as sinks as from the year 2020 when definitely reclassified after 20 years within the same class.

Table 6.1. Emissions (kt CO2 e) of the LULUCF sector by sub-sector for selected years

Category	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022 on 2000 (% change)
4. Total LULUCF	208,675	236,815	265,155	296,277	304,141	306,996	209,650	210,989	225,599	8%
4.A.1. Forest land remaining forest land	214,488	242,045	269,853	300,965	308,357	311,167	333,955	335,669	349,774	63%
4.B.1. Cropland remaining cropland	-	-	-	-	-	-	-111,179	-111,179	-111,179	-
4.E.1. Settlements remaining settlements	-	-	-	-	-	-	-8,876	-8,876	-8,876	-
4.G Harvested wood products	-5,813	-5,230	-4,699	-4,688	-4,216	-4,171	-4,250	-4,625	-4,120	-29%

Table 6.2. Methodologies and TIER levels used for the categories in sector LULUCF

Categories						
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs
4. LULUCF						
4.A. Forest land						
4.A.1. Forest land remaining forest land	DT1	NA	NA	NA	NA	NA
4.B. Cropland						

4.B.1. Cropland remaining cropland	DT1	NA	NA	NA	NA	NA
4.C. Grassland	DT1					
4.C.1. Grassland remaining grassland	DT1	NA	NA	NA	NA	NA
4.D. Wetlands	DT1					
4.D.1. Wetlands remaining wetlands	DT1	NA	NA	NA	NA	NA
4.E. Settlements	DT1					
4.E.1. Settlements remaining settlements	DT1	NA	NA	NA	NA	NA
4.F. Other land	DT1					
4.F.1. Other land remaining other land	DT1	NA	NA	NA	NA	NA
4.G. Harvested wood products	DT1	NA	NA	NA	NA	NA

6.2. Land-use definitions and the land representation approach(es) used and their correspondence to the land use, land-use change and forestry categories

On the basis of available data from different sources, a land use table with areas of the different IPCC land classes has been constructed with no movement between them i.e. using Approach 1 as per the IPCC 2006 Guidelines as from the NC3 report. The total area of the country was balanced with corrections made to the Other land category. Information obtained from USGS (2016) together with other sources including FRA (2015), FAO Aquastat and NBS were used to validate the different areas adopted for the period 2000 to 2017. The default soil type Low Activity Clay and climate Tropical moist short dry season were adopted since these were considered as being most appropriate to represent the country.

Two categories of forestland were considered, forestland and woodland which have been merged. The areas of land classified in the USGS 2016 report and Foresty Resource Assessment (FRA) 2015 were reassigned to fall within the six different IPCC land classes. The area of forestland declined during the timeseries on account of deforestation and wood removals for both merchantable wood and wood fuel.

Cropland was assumed to fall under two subclasses: Cropland Annual for annual crops, Cropland perennial for perennial crops such as coffee, rubber, palm, tea, etc. and rice paddy. Annual cropland relates to rainfed crops produced during part of the year and thereafter used for production of fodder and grazing during the remaining part of the same year. Rice cultivation is considered as a separate entity as per the 2006 IPCC Guidelines.

There is a mix of permanent grazing land and grassland and these have been summed as area of the Grassland land class.

With the rapidly increasing population of Nigeria, an important change in the area of settlement has been identified, but it has not been possible to track from which land category they originated over the time period under consideration. Areas of the different land classes from 2000 to 2022 are given in Table 6.3.

Table 6.3. Area hectare (ha) of each land class (2000-2022) used for Approach 1

Year	2000	2001	2002	2003	2004	2005	2006	2007
Forestland remaining forestland	15,796,400	15,681,908	15,567,415	15,452,923	15,338,431	15,223,938	15,109,446	14,994,954
Cropland Annual	31,228,000	31,873,138	32,518,277	33,163,415	33,808,554	34,453,692	35,098,831	35,743,969
Cropland Perennial	188,800	188,277	187,754	187,231	186,708	186,185	185,662	185,138
Grassland	39,310,800	38,734,185	38,157,569	37,580,954	37,004,338	36,427,723	35,851,108	35,274,492
Wetland	3,387,600	3,382,585	3,377,569	3,372,554	3,367,538	3,362,523	3,357,508	3,352,492
Settlement	1,205,200	1,256,708	1,308,215	1,359,723	1,411,231	1,462,738	1,514,246	1,565,754
Other land	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100

Year	2008	2009	2010	2011	2012	2013	2014	2015
Forestland remaining forestland	14,880,462	14,765,969	14,651,477	14,536,985	14,422,492	14,308,000	14,193,508	14,079,015
Cropland Annual	36,389,108	37,034,246	37,679,385	38,324,523	38,969,662	39,614,800	40,259,938	40,905,077
Cropland perennial	184,615	184,092	183,569	183,046	182,523	182,000	181,477	180,954
Grassland	34,697,877	34,121,262	33,544,646	32,968,031	32,391,415	31,814,800	31,238,185	30,661,569
Wetland	3,347,477	3,342,462	3,337,446	3,332,431	3,327,415	3,322,400	3,317,385	3,312,369
Settlement	1,617,262	1,668,769	1,720,277	1,771,785	1,823,292	1,874,800	1,926,308	1,977,815
Other land	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100

Year	2016	2017	2018	2019	2020	2021	2022	-
Forestland remaining forestland	13,964,523	13,850,031	13,735,538	13,621,046	13,506,554	13,392,062	13,277,569	-

6.3. Country-specific approaches

Wetland								-
Settlement	2,029,323	2,080,831	2,132,338	2,183,846	2,235,354	2,286,862	2,338,369	-
Otherland	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	1,260,100	-
Cropland Annual	41,550,215	42,195,354	42,840,492	43,485,631	44,130,769	44,775,908	45,421,046	-
Cropland Perennial	180,431	179,908	179,385	178,862	178,338	177,815	177,292	-
Grassland	30,084,954	29,508,338	28,931,723	28,355,108	27,778,492	27,201,877	26,625,262	-
	3,307,354	3,302,338	3,297,323	3,292,308	3,287,292	3,282,277	3,277,262	

6.3.1. Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Approach 1 from the IPCC 2006 guidelines has been used for the representation of Land Use and Land Use Change. The country has developed a Land Use and Land Use change matrix as from the BUR2 (https://unfccc.int/documents/180677) which has been extrapolated to Year 2022. Information from FAOSTATS, USGS, FRA and NBS have been compiled to derive this Land use matrix. In line with the national circumstances of the country, there is deforestation occurring due to wood removal while the population growth of over 75 M individuals from 2000 to 2022 is reflected in the increase in Settlement area and the increase in Cropland area to ensure food production.

An attempt to improve this Land use matrix was made during the reporting round of the BUR2 but the Coronavirus disease (COVID-19) pandemic disturbed the program of work. The National Space Research and Development Agency (NASRDA) holds a database which must be reworked to align with IPCC land class definitions. This is planned for the next reporting round due to the delay in the BTR1 reporting cycle. Furthermore, national biomass stock and emission factors must be derived to represent the situation of the country as the rainfall pattern changes drastically from North to South.

6.3.2. Information on approaches used for natural disturbances, if applicable

No natural disturbance has been identified yet.

6.3.3. Information on approaches used for reporting harvested wood products

The stock change approach used for the previous inventory has been maintained. Data from FAOSATS are still the source of data for this category.

6.4. Forest land (CRT 4.A)

6.4.1. Category description (e.g. characteristics of sources)

Forestland remaining Forestland includes processes leading to emissions and removals of CO2. The dynamics are emissions occurring from deforestation, degradation from removal of biomass, namely wood for use as fuelwood, for making charcoal and for commercial purposes while removals stem from accumulation of biomass from growth.

The Forest Level Emission Level (FREL) 2019 report of Nigeria identifies forested areas from the coastline with a diminishing tree density and cover while moving North. Mangroves, freshwater swamp forests and lowland rain forests are ecological zones where significant forests cover still exits. The northern areas would qualify more for woodland as the density of the vegetation is impacted by wood removal and lower rainfall regimes.

Land converted to Forestland from afforestation, reforestation have not been considered given the dearth of satisfactory AD.

Trend of emissions, removals and the net effect are provided under section 6.1 above, inclusive of the appropriate table and graph.

6.4.2. Methodological issues

Biomass gain through growth of trees and biomass loss through wood removal are the only carbon pools where emissions or removals estimates have been done for this category. The two forest types, namely Forestland and Woodlands, have been merged into a single entity and an average biomass stock estimated.

AD are provided in Table 6.3 above.

The Stock factors adopted since the NC3 (https://unfccc.int/documents/226453) report have been kept and are given below.

- Above ground biomass (tdm / ha) = 144.1
- Above ground biomass growth (tdm / ha / yr) = 1.0
- Ratio above to below ground = 0.26
- BCEF (Wood Removal) = 1.44

Other characteristics are Tropical moist for climate and Low activity clay for soil type.

AD regarding wood removal in Forestland are provided in Table 6.4.

Table 6.4. Activity Data (m3) used for roundwood and fuelwood removal (2000-2022)

Year					2004	2005	2006			
Round Wood					36,175,297	36,907,380	37,616,038			
Fuelwood	59,348,652	59,697,552	60,064,328	60,449,216		60,852,440		61,274,260	61,629,309	62,000,000

Year					2012	2013	2014			
Round Wood					41,716,039	42,512,672	43,629,823			
Fuel wood	62,388,600	62,793,234	63,214,728	63,599,551		63,999,115		64,413,551	64,843,002	65,287,615

Year	2019	2020	2021						-
Round Wood	66,540,702	66,883,195	67,239,649						-
Fuel wood	65,583,432	65,891,233	41,945,707	42,433,943	42,989,843		43,102,029	47,165,450	-

6.4.3. Description of any flexibility applied

Not resorted to.

6.4.4. Uncertainty assessment and time-series consistency

Uncertainty values provided for AD and EFs within the IPCC 2006 Guidelines' ranges have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 6.5) are ±10% and ±30% for the EF.

Table 6.5. Uncertainty levels assigned for Forestland

Categories and parameters	Uncertainty assigned (%)	
4.A.1 Forestland remaining forestland	AD[1]	EF[2]
Biomass gain	±10	±30
Biomass loss (Wood removals and fuelwood removals)	±10	±30

The estimated combined uncertainties are 54.8% for both the level assessment for base year 2000 and year-t 2022, and 39.9% for the trend between base year 2000 and year-t 2022 (Table 6.6).

Table 6.6. Uncertainty assessment for Forestland

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
4.A. Forestland									
4.A.1. Forest land remaining forest land	CO_2	214487.9	349773.8	17.3	52.0	54.8	3000.0	3000.0	1595.6
Sum		**214487.9**	**349773.8**			**Sum**	**3000.0**	**3000.0**	**1595.6**

Uncertainty in level (L) and trend (T) assessment	**L - 54.8**	**L - 54.8**	**T - 39.9**

The time series is consistent as the AD have always been sourced from the same institutions, the default EFs of IPCC used as well as the same methodology adopted for all the years of the time series

6.4.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included the use of the decision tree for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy and the calculations. Quality Assurance during the estimation steps was done by an independent international expert.

6.4.6. Category-specific recalculations

Recalculations have been undertaken following a change in the AD for charcoal production and this impacted the emissions. The available AD from FAOSTATS have been replaced with those from the UN Database used for Energy sector. The trend in the AD from this source reflects more the change in use of charcoal happening with the demographic growth. The emissions regressed by 1% to 16% depending on year for the period 2000 to 2017.

Table 6.7. Comparison of previous and recalculated emissions (kt CO2 e) for Forestland

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	256,674	259,641	262,771	266,267	270,082	273,939	277,513	281,226	283,105	287,973	291,571	295,704
BTR1 - NID1	214,488	218,939	223,890	229,306	235,359	242,045	249,021	272,166	266,914	259,214	269,853	281,751
% change	-16	-16	-15	-14	-13	-12	-10	-3	-6	-10	-7	-5

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	-
BUR2 - NIR1	299,235	303,270	308,355	312,676	315,977	319,971	-	-	-	-	-	-
BTR1 - NID1	294,889	290,905	296,977	300,965	302,144	305,109	308,357	311,167	333,955	335,669	349,774	-
% change	-1	-4	-4	-4	-4	-5	-	-	-	-	-	-

6.4.7. Category-specific planned improvements

This is a key category since the last inventory. It is mandatory to develop Tier 2 country specific stock and EFs for forest types (dryland to tropical).

The key activities of the improvement plan are listed below.

- Generate new unsupervised land cover land use maps from satellite data for the period 2000 to 2025 at 5 year-time steps.
- Work back the timeseries since 1990 to avail the country of a complete timeseries
- Ground reference the unsupervised version to finetune and align representativeness of actual conditions in 2025.
- Determine the area converted from and to the Forestland and Grassland classes with respect to the other land classes for the different 5 years steps to 2025.
- Estimate live standing biomass stocks as appropriate for all classes of importance for making emissions/removals estimates.
- Confirm or develop new EFs and stock factors for all Forestland sub-classes.
- Evaluate deadwood amounts in all Forestland sub-classes.

- Assign the appropriate soil organic carbon amounts by ecological zones.
- Refine data on fuelwood, charcoal production and other purposes.

Timeframe: 6 years subject to availability of funds to remunerate international and national consultants, international and local travel and DSA, technical assistance through international consultants and purchase of satellite images. Expected to be done by year 2030.

6.5. Cropland (CRT 4.B)

6.5.1. Category description

Cropland is described as land cultivated for crops. There exist 2 main types of Cropland in Nigeria, the annual and perennial croplands.

No emissions and removals occurred between 2000 and 2019 as it was an inactive category. However, there is a sudden increase in removals as from 2020 because of the increase in area under cropland and the commencement of accounting of soil organic carbon by the software. Details are provided in Figure 6.1 and Table 6.1 in section 6.1 above.

Land converted to cropland has not been considered in this inventory, the AD being unavailable.

6.5.2. Methodological issues

Tier 1 of the 2006 IPCC guidelines after applying the decision tree was adopted to estimate ermissions. AD on area of cropland retained are already given in Table 6.3 in section 6.2 above.

EFs adopted are defaults from the IPCC 2006 guidelines and software which are provided below.

6.5.3. Description of any flexibility applied

Not resorted to.

6.5.4. Uncertainty assessment and time-series consistency

Uncertainty values provided for AD and EFs within the IPCC 2006 Guidelines' ranges have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 6.8) are ±50% and ±30% for the EF.

Table 6.8. Uncertainty values adopted for Cropland

Categories and parameters	Uncertainty assigned (%)	
4.B.1 Cropland remaining Cropland	AD[1]	EF[2]
SOM mineral	±50	±30

1: Refer to 2006 Guidelines, Page 5.23 Chapter 5, Volume 4.

1: Refer to 2006 Guidelines, Page 5.23 Chapter 5, Volume 4.

The estimated combined uncertainty is 58.3% for the level assessment for year-t 2022, as there are no estimates for the period 2000 to 2019 (Table 6.9)

Table 6.9. Uncertainty assessment for Cropland

2006 IPCC Categories	Gas	Base Year (2000) (Kt CO2e)	Year T (2022) (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-emissions or removals 2000	Contribution to Variance by Category in Year T - emissions or removals 2022	Uncertainty introduced into the trend in total national emissions (%)
4.B. Cropland									
4.B.1. Cropland remaining cropland	CO2	-	-111178.9	50.0	30.0	58.3	-	3400.0	-
Sum		**-**	**-111178.9**			**Sum**	**-**	**3400.0**	**-**
			Uncertainty in level (L) and trend (T) assessment				**-**	**L - 58.3**	**-**

The time series is consistent as the AD have always been sourced from the same institutions, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

6.5.5. Category-specific QA/QC and verification

Not applicable

6.5.6. Category-specific recalculations

Not Applicable

6.5.7. Category-specific planned improvements

This category is now a key category and will need to be estimated at Tier 2 by developing country specific stock and EFs (Mandatory) for perennial crops.

This will require the production of land cover maps from satellite images to represent the 6 IPCC types over the period 1990 to 2025 at intervals of 5 or 10 years to generate changes in use between the land classes. Country specific carbon stocks in the different carbon pools, particularly soil organic carbon and woody biomass, in this land class must also be estimated.

Timeframe: Same as for Forestland

Needs: Funds to remunerate international and national consultants, international and local travel and DSA, technical assistance through international consultants and purchase of satellite images.

6.6. Grassland (CRT 4.C)

6.6.1. Category description

Not Applicable as Not Estimated.

6.6.2. Methodological issues

Not Applicable as Not Estimated.

6.6.3. Description of any flexibility applied

Not resorted to.

6.6.4. Uncertainty assessment and time-series consistency Not

Applicable as Not Estimated.

6.6.5. Category-specific QA/QC and verification Not

Applicable as Not Estimated.

6.6.6. Category-specific recalculations Not

Applicable as Not Estimated.

6.6.7. Category-specific planned improvements

There is information showing the existence of savannah and shrubland with the presence of woody biomass in the country. This category must be improved to reflect the current status of the different sub-classes together with the dynamics of the different carbon pools.

This will require the production land cover maps from satellite images to represent the 6 IPCC types over the period 1990 to 2025 at intervals of 5 or 10 years to generate the changes in use between land classes.

Timeframe: Same as for Forestland.

Needs: Funds to remunerate international and national consultants, international and local travel and DSA, technical assistance through international consultants and purchase of satellite images.

6.7. Wetlands (CRT 4.D)

4.D.1. Wetlands remaining wetlands

Not Estimated due top unavailability of AD.

4.D.2. Land converted to wetlands

Not Estimated due top unavailability of AD.

6.7.1. Category description

Not Applicable as Not Estimated.

6.7.2. Methodological issues

Not Applicable as Not Estimated.

6.7.3. Description of any flexibility applied Not

resorted to.

6.7.4. Uncertainty assessment and time-series consistency Not

Applicable as Not Estimated.

6.7.5. Category-specific QA/QC and verification Not

Applicable as Not Estimated.

6.7.6. Category-specific recalculations Not

Applicable as Not Estimated.

6.7.7. Category-specific planned improvements

Already incorporated under other Forestland, Cropland and Grassland

6.8. Settlements (CRT 4.E)

6.8.1. Category description

Land with infrastructures such as roads, buildings, houses and other man-made structures have been included under Settlements. Urbanization and development of the road network are the major contributors to change in this land class.

This category has not been estimated technically due to unavailability of AD. However, due to increase in area under Settlements, the soil carbon module of the IPCC Software has computed this parameter and provided removals as from the year 2020.

These removals have been provided under section 6.1 of this NID with the corresponding table and graph.

6.8.2. Methodological issues

Tier 1 of the IPCC 2006 Guidelines with default EFs.

6.8.3. Description of any flexibility applied

Not resorted to.

6.8.4. Uncertainty assessment and time-series consistency

Default Uncertainty values provided for AD and EFs in the IPCC 2006 Guidelines have been adopted in the tool generated for this purpose for making the assessment.

The uncertainty levels assigned to the AD and EFs are based on the default ranges from the IPCC 2006 guidelines are ±50% and ±30%. These are shown in Table 6.10 for Settlements.

Table 6.10. Uncertainty values assigned for Settlements.

Categories and parameters	Uncertainty assigned (%)	
4.E.1. Settlements remaining settlements	AD[1]	EF[2]
SOM mineral	±50	±30

1: Refer to 2006 Guidelines, Page 8.17, Chapter 8, Volume 4.

1: Refer to 2006 Guidelines, Page 8.17, Chapter 8, Volume 4.

The combined uncertainty is available for the level assessment for year-t only and is 58.3% (Table 6.11) as there exists no time series.

Table 6.11. Uncertainty assessment for Settlements

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions

								(%)
4.E. Settlements								
4.E.1. remaining settlements	SettlementsCO2	--8876.5	50.0	30.0	58.3	-	3400.0	-
Sum		**- -8876.5**			**Sum**	**-**	**3400.0**	**-**
		Uncertainty in level (L) and trend (T) assessment				**-**	**L - 58.3**	**-**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

6.8.5. Category-specific QA/QC and verification Not

Applicable as Not Estimated.

6.8.6. Category-specific recalculations Not

Applicable as Not Estimated.

6.8.7. Category-specific planned improvements

Incorporated in the planned improvement of the other above land classes.

6.9. Other land (CRT 4.F)

4.F.1. Other land remaining other land

No activity in Other land and hence no emissions

4.F.2. Land converted to other land

Not Occurring

6.9.1. Category description Not

Applicable.

6.9.2. Methodological issues Not

Applicable.

6.9.3. Description of any flexibility applied Not

Applicable.

6.9.4. Uncertainty assessment and time-series consistency Not

Applicable.

6.9.5. Category-specific QA/QC and verification Not

Applicable.

6.9.6. Category-specific recalculations Not

Applicable.

6.9.7. Category-specific planned improvements Not

Applicable.

6.10. Harvested wood products (CRT 4.G)

6.10.1. Category description

Emissions from wood removal not used as fuel do not necessarily occur in the same year of harvest as there is a lifetime associated with wood used for construction purposes or furniture for example. This sink or emission activity is accounted for under the HWP category and Nigeria has been reporting this category since the Third national communication (NC3).

Regarding the trend of emissions and the evolution of the time series, readers are kindly requested to refer to Figure 6.1 and table 6.1 of section 6.1 above. As a recall, removals decreased by 29% from 5,813 kt CO2 e in 2000 to 4,120 kt CO2 e in 2022.

6.10.2. Methodological issues

The stock change approach adopted in the NIR1 has been kept for this inventory. Data from the FAO statistics for the years 2018 to 2022 were aggregated to fit the different inputs required by the IPCC 2006 software version 2.93 for estimating removals/emissions in this category. For data for the period 2000 to 2017, refer to the NIR1 https://unfccc.int/sites/default/files/resource/NIGERIA%20NIR1%20%20First%20National%20GHG%20Inventory%20Report%20.pdf.

The activity data for the different components for years 2018 to 2022 are given in Table 6.12.

Table 6.12. AD for Harvested Wood Products for the period 2018 to 2022

Component	Year	2018	2019	2020	2021	2022
Fuelwood (m3)	Production	66,231,938	66,562,702	66,905,195	67,261,649	67,629,483
	Import	-	-	-	-	-
	Export	4,304	121	57	386	-
Industrial roundwood (m3)	Production	2,400,000	2,400,000	2,400,000	2,400,000	2,400,000
	Import	2,016	756	12,191	12,634	234
	Export	603,471	139,259	120,022	160,312	58,657
Sawnwood (m3)	Production	9,602,000	9,602,000	9,602,000	9,602,000	9,602,000
	Import	1,229	3,347	2,013	1,358	3,050
	Export	90,579	34,054	39,932	12,780	4,993
Wood-based panels (m3)	Production	97,500	97,500	97,500	97,500	97,500
	Import	298,785	369,661	584,342	697,676	548,238
	Export	19,524	14,330	550	853	644
Paper + Paperboard (t)	Production	19,000	19,000	19,000	19,000	19,000
	Import	638,477	550,149	455,361	640,846	459,979
	Export	8,973	13,776	5,840	12,566	613
Wood Pulp (1875) + recycled paper (t)	Import	109,675	75,604	74,341	83,048	102,492
	Export	984	310	310	310	288

Chips and particles (m3)	Import	174	-	6	1	1
	Export	1,664	1,664	1,664	44	1
Wood charcoal (t)	Import	285	79	353	107	424
	Export	280,080	257,971	267,855	118,626	99,330
Wood residues (m3)	Import	20	20	20	20	20
	Export	17	17	21,423	21,423	27,803

6.10.3. Description of any flexibility applied

Not resorted to.

6.10.4. Uncertainty assessment and time-series consistency

Default Uncertainty values provided for AD and EFs in the IPCC 2006 Guidelines have been used in the tool developed in Excel worksheet for making the assessment.

The uncertainty levels assigned to the AD (Table 6.13) are ±50% for both the AD and EF.

Table 6.13. Uncertainty values assigned for Harvested Wood Products

Category	Uncertainty assigned (%)	
4.G Harvested Wood Products	**AD[1]**	**EF[2]**
Harvested Wood Products	±50	±50

1: Refer to 2006 Guidelines, Chapter 12, Volume 4.

2: Refer to 2006 Guidelines, Chapter 12, Volume 4.

The estimated combined uncertainties are 70.7% for the level assessment for both the base year 2000, and year-t 2022 and 50.1% for the trend between the base year 2000 and year-t 2022 (Table 6.14).

Table 6.14. Uncertainty assessment for Harvested Wood Products

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions (%)
4.G Harvested wood products									
4.G Harvested wood products	CO2	-5813.4	-4119.5	50.0	50.0	70.7	5000.0	5000.0	2510.7
Sum		**5752.0**	**12017.2**			**Sum**	**5000.0**	**5000.0**	**2510.7**
			Uncertainty in level (L) and trend (T) assessment				**L - 70.7**	**L - 70.7**	**T - 50.1**

The time series is consistent as the AD have always been sourced from the same source, the country specific stock factors and EFs used as well as the same methodology for all the years of the time series.

6.10.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, AD, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations, reference material and conversion factors. Quality Assurance during the estimation steps was done by independent international experts.

6.10.6. Category-specific recalculations Not

Applicable.

6.10.7. Category-specific planned improvements

No planned improvement

6.11. Other (CRT 4.H) Not

Occurring.

6.12. Memo items

Nigeria is not reporting emissions and subsequent removals from natural disturbances on managed lands as there are no record of these.

Chapter 7. Waste (CRT sector 5)

7.1. Overview of the sector

Solid waste is generated in Nigeria through domestic, industrial, commercial and agricultural activities whereas wastewater is generated mostly through domestic, industrial and commercial actions. As in other countries, waste generation is directly related to population growth, industrialization rate and urbanization trend, the latter being an important impacting factor. GHG emissions in the waste sector are also affected by the type of disposal mechanism, treatment method as well as the level of management exercised.

During the period under review, the categories falling under the 3 waste subsectors for which emissions were estimated are:

- 5.A. Solid waste disposal
- 5.C. Incineration and open burning of waste.
- 5.D. Wastewater treatment and discharge.

The trend of total emissions for the Waste sector is given in Figure 7.1. Emissions increased by 99% from 19,921 kt CO2 e in 2000 and 38,050 kt CO2 e in 2022. Wastewater Treatment and discharge dominated this sectors' emissions followed by Solid Waste Disposal and Incineration and Open Burning of waste.

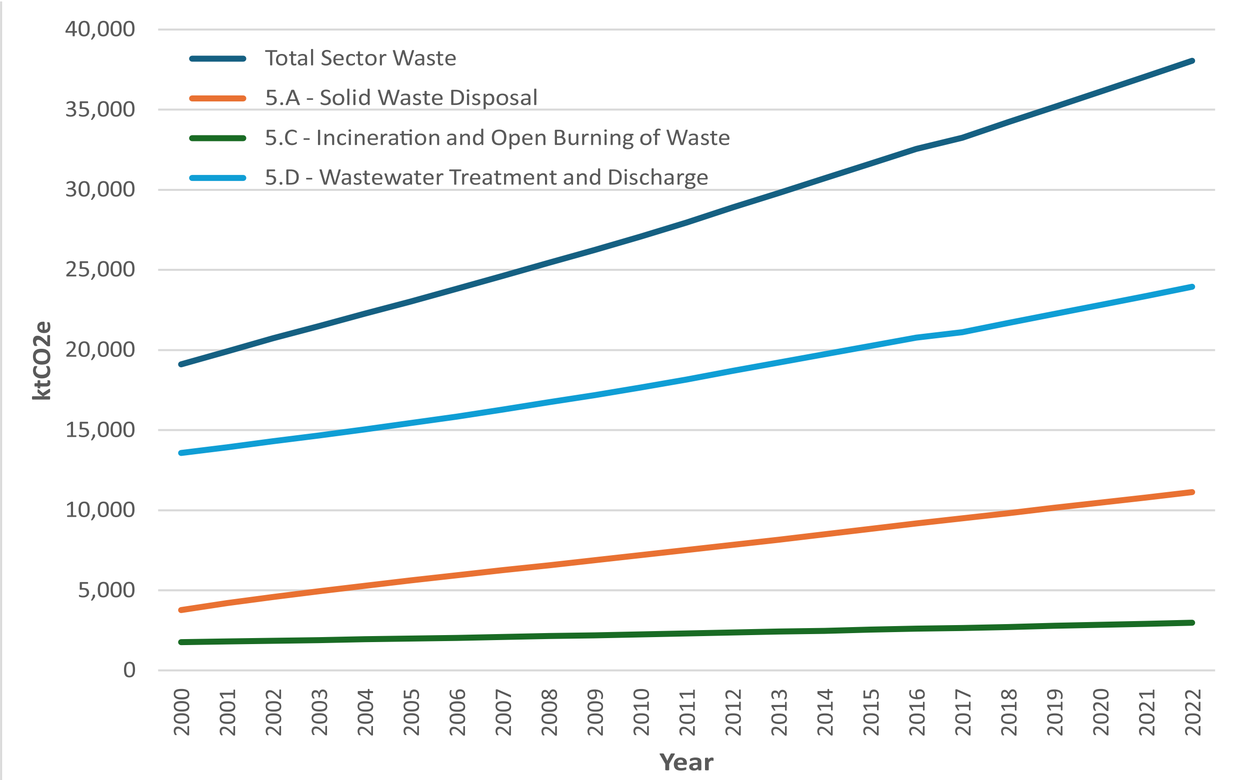

Figure 7.1. Trends of emissions (kt CO2 e) for the Waste sector (2000-2022)

Emissions from the 3 categories falling under the Waste sector are provided for selected years in Table 7.1. Over the time series 2000 to 2022, emissions increased by 195% for Solid Waste Disposal, 69% for Incineration and Open Burning and 76% for Wastewater Treatment and Discharge. In 2022, Wastewater Treatment and discharge emitted 63% of the Waste sector emissions followed by Solid Waste Disposal with 29% and Incineration and Open Burning of waste with 9%.

Table 7.1. Emissions (kt CO2 e) of the Waste sector by sub sector for selected years

	2000	2005	2010	2015	2018					2019	2020	2021	2022	2022/ 2010
Waste														99%
5.A. Solid Waste Disposal					34,215 9,819	35,167 10,143	36,124 10,474	37,075 10,795	38,050 11,128					195%
5.C. Incineration and Open Burning of Waste	1,763	1,980	2,242	2,540	2,713					2,779	2,843	2,909	2,975	69%
5.D. Wastewater Treatment and Discharge	13,571	15,435	17,657	20,256	21,682					22,245	22,807	23,371	23,946	76%

The method and Tier level adopted for estimating emissions of the Waste sector categories are provided in Table 7.2. The IPCC 2006 Guidelines and its software (version 2.93) and EMEP/EEA of 2023 have been used at Tier 1 level as applicable.

Table 7.2. Method and Tier level adopted for the Waste sector

Categories							
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SO2
5 - Waste							
5.A - Solid Waste Disposal							
5.A.2 Unmanaged waste disposal sites	NA	DT1	NA	NA	NA	EMEP/EEA T1	NA
5.C - Incineration and Open Burning of Waste							
5.C.1 - Waste incineration	NE	NE	NE	NE	NE	NE	NE
5.C.2 - Open Burning of Waste	DT1	DT1	DT1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1	EMEP/EEA T1
5.D - Wastewater Treatment and Discharge							
5.D.1 - Domestic Wastewater Treatment and Discharge	NA	DT1	NE	NA	NA	NE	NA
5.D.2 - Industrial Wastewater Treatment and Discharge	NA	DT1	NE	NA	NA	EMEP/EEA T1	NA

7.2. Solid waste disposal (CRT 5.A)

7.2.1. Category description

The Solid waste disposal category comprises 3 sub-categories and only one of these, Unmanaged waste disposal sites occur in the country.

The trend of emissions is depicted in Figure 7.2 and Table 7.3. Emissions increased regularly over the time series from 3,768 kt CO2 e in 2000 to 11,128 kt CO2 e in 2022 which represented an increase of 195% over that period.

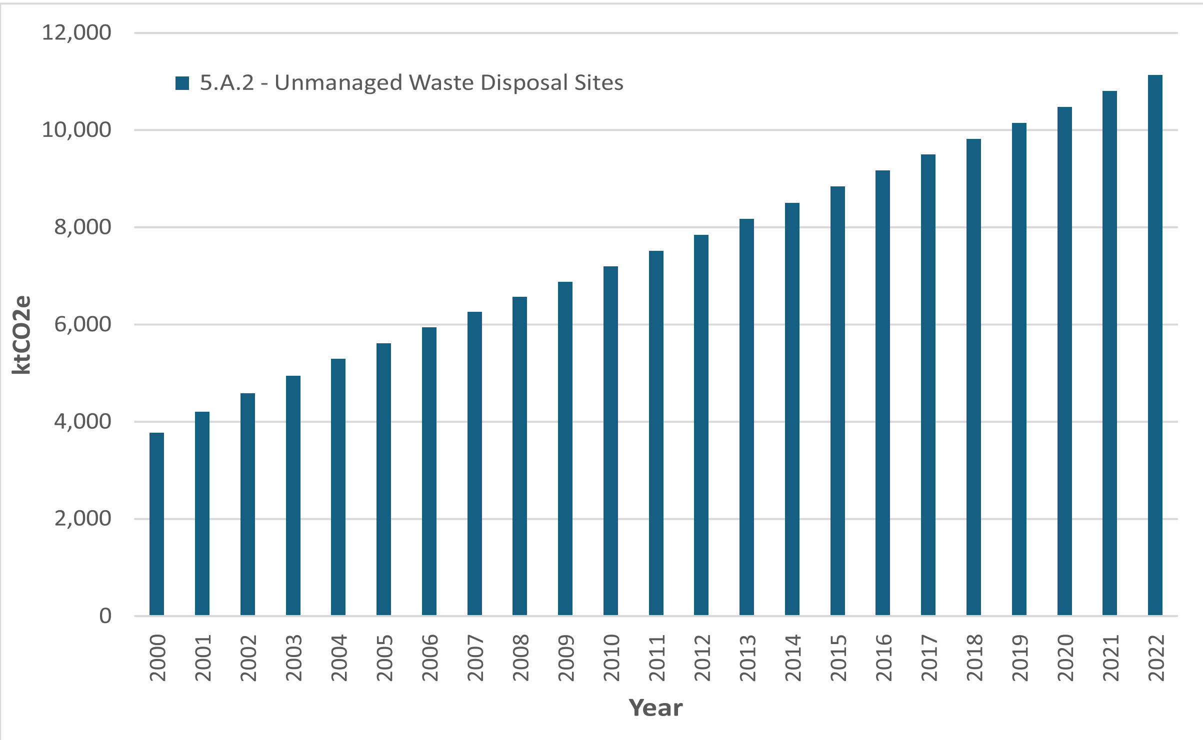

Figure 7.2. Trends of emissions (kt CO2 e) for Solid Waste Disposal (2000-2022)

Table 7.3. Emissions (kt CO2 e) from Solid Waste Disposal by sub-category for selected years

	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022/ 2010
5.A.2 - Unmanaged Waste Disposal Sites	3,768	5,613	7,188	8,836	9,819	10,143	10,474	10,795	11,128	195%

7.2.2. Methodological issues

The Tier 1 method of the IPCC 2006 guidelines was adopted for estimating emissions of solid waste. Given the lack of information on waste composition, estimates were made in the 2006 IPCC software v 2.93 using bulk waste. The population of the country was segregated into urban and rural. The population was then used with the estimated per capita generation rate as a whole to calculate the amount of waste generated. The amounts of waste generated were then fed into the software according to the solid waste management type for estimating emissions. Population statistics are from the official NPC data.

Per capita waste generation rates, estimated by NBS, adopted are 182.5 kg/cap/yr for whole of Nigeria the population respectively. The per capita annual waste generation rates and other information are provided in Table 7.4

Table 7.4. Activity Data used for Solid Waste Disposal (2000-2022)

Year	Total	Fraction population		Fraction waste sent to SWDS	GDP
		Urban	Rural		Constant 2015 USD
2000	122,880,000	43.0%	57.0%	40.8%	179,675
2001	126,010,000	43.0%	57.0%	40.8%	190,308
2002	129,250,000	44.0%	56.0%	41.0%	219,481
2003	132,580,000	45.0%	55.0%	41.3%	235,606
2004	136,030,000	45.0%	55.0%	41.3%	257,401
2005	139,610,000	47.0%	53.0%	41.8%	273,974
2006	143,320,000	47.0%	53.0%	41.8%	290,575
2007	147,150,000	48.0%	52.0%	42.0%	309,728
Year	Total	Fraction population		Fraction waste sent to SWDS	GDP
		Urban	Rural		Constant 2015 USD
2008	151,120,000	48.0%	52.0%	42.0%	330,679
2009	155,210,000	49.0%	51.0%	42.3%	357,255
2010	159,420,000	50.0%	50.0%	42.5%	385,856
2011	163,770,000	51.0%	49.0%	42.8%	406,337
2012	168,240,000	51.0%	49.0%	42.8%	423,525
2013	172,800,000	52.0%	48.0%	43.0%	451,780
2014	177,480,000	53.0%	47.0%	43.3%	480,286
2015	182,200,000	53.0%	47.0%	43.3%	493,027
2016	187,050,000	54.0%	46.0%	43.5%	485,055
2017	190,870,000	55.0%	45.0%	43.8%	488,964
2018	196,042,933	55.6%	44.4%	43.9%	498,366
2019	201,223,493	56.3%	43.7%	44.1%	509,372
2020	206,283,338	57.0%	43.0%	44.2%	500,232
2021	211,493,324	57.7%	42.3%	44.4%	518,477
2022	216,783,381	58.4%	41.6%	44.6%	535,336

The following assumptions and parameters from the BUR2 have been kept and they are as follows:

55% of urban waste and 30% rural waste collected

Industrial waste: 8 tonnes / Million (M) United States Dollar (USD) Gross Domestic Product (GDP)

70 % of all waste sent to waste disposal site

100% sent to unmanaged shallow disposal sites

The waste composition adopted for estimating emissions for Solid waste disposal are given in Table 7.5. **Table 7.5. Waste composition used for Solid Waste Disposal for whole time series**

Waste composition	Fraction
Food	30
Garden waste	20
Paper	10
Wood and straw	2
Textiles	4
Nappies	3
Plastics and other inert	31

The EFs used (Table 7.6) are default ones from the 2006 IPCC guidelines (Volume 5 Chapter 3 Table 3.1 updated).

Table 7.6. EFs used for estimating emissions from unmanaged waste disposal sites

SWDS type	Methane correction factor	Oxidation factor
Unmanaged shallow (less than 5m)	0.4	0

7.2.3. Description of any flexibility applied

Not resorted to.

7.2.4. Uncertainty assessment and time-series consistency

The uncertainties assigned for solid waste systems (Table 7.7) to the AD are -50% to +100% and ±60% for EFs and are from the IPCC 2006 guidelines for the default EFs.

Table 7.7. Uncertainty levels assigned for Solid Waste Disposal

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
4.A Solid Waste Disposal			
4.A.2 - Unmanaged Waste Disposal Sites	CH4	-50 to +100	+/- 60 %

Note 1: Source: 2006 Guidelines, Vol. 5, Chapter 3, page 3.27, Table 3.5
Note 2: Source: 2019 Refinement to 2006 Guidelines, Vol. 5, Chapter 3, page 3.20, Table 3.5 (Updated)

The combined uncertainties determined using the tool developed in an Excel worksheet in line with the methods contained in the IPCC 2006 guidelines are provided in Table 7.8 for this sub-category. The uncertainties for the level assessment for both the base year 2000 and year-t (2022) are 104.4% respectively while the trend assessment with 2000 as base year and 2022 as year-t is 417.7%.

Table 7.8. Uncertainty assessment for Unmanaged waste disposal sites

2006 IPCC Categories	Gas	Base Year (2000) emissions (Kt CO2e)	Year T (2022) emissions (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T - 2022	Uncertainty introduced into the trend in total national emissions or removals (%)
5.A. Solid Waste Disposal									
5.A.2 - Unmanaged Waste Disposal Sites	CH4	3767.6	11128.0	100.0	30.0	104.4	10900.0	10900.0	174474.4
Sum		**3767.6**	**11128.0**			**Sum**	**10900.0**	**10900.0**	**174474.4**
				Uncertainty in level (L) and trend (T) assessment			**L - 104.4**	**L - 104.4**	**T - 417.7**

The time series is consistent as the AD have been calculated using the same methods, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

7.2.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, procedures adopted for generating amounts of waste AD, the appropriate default EFs, timeseries consistency, transcription accuracy, the calculations and reference material. Quality Assurance during the estimation steps was done by independent international experts.

7.2.6. Category-specific recalculations

Not Applicable.

7.2.7. Category-specific planned improvements

Solid Waste Disposal is a key category, and estimates must be improved using a Tier 2 level method. The planned improvement consists of the following activities:

- Determine waste generation rates for the different segments of the population in terms of Urban high, Urban low and Rural
- Review the waste composition and incorporate the effect of recycling activities on the solid waste
- Survey the different waste management systems operating in the country

The timeframe for this category is year 2032 and is subject to the availability of funds to cater for the extensive nature for collecting data and information required.

7.3. Biological treatment of solid waste (CRT 5.B)

This category has not been estimated due to lack of AD.

7.3.1. Category description

Not Applicable as Not estimated.

7.3.2. Methodological issues

Not Applicable as Not estimated.

7.3.3. Description of any flexibility applied

Not Applicable as Not estimated.

7.3.4. Uncertainty assessment and time-series consistency

Not Applicable as Not estimated.

7.3.5. Category-specific QA/QC and verification

Not Applicable as Not estimated.

7.3.6. Category-specific recalculations

Not Applicable as Not estimated.

7.3.7. Category-specific planned improvements

Stakeholder engagement is planned to collect AD with regards to activities onf composting and biogas production. This will enhance the coverage of the inventory.

7.4. Incineration and open burning of waste (CRT 5.C)

5.C.1. Waste incineration

5.C.2. Open burning of waste

Out of these 2 sub-categories, waste incineration has not been estimated and Open Burning of waste addressed. Hence only this sub-category is being detailed in this inventory, but Waste Incineration will be considered in the improvement plan.

7.4.1. Category description

Open burning of waste has been addressed in past inventories and this continued for this inventory.

The trend of emissions for Incineration and open burning for all years of the time series is depicted in Figure 7.3 and Table 7.8 for selected years. Emissions increased from 1,763 kt CO2 e in 2000 to 2,975 kt CO2 e in 2022, which represented an increase of 69%.

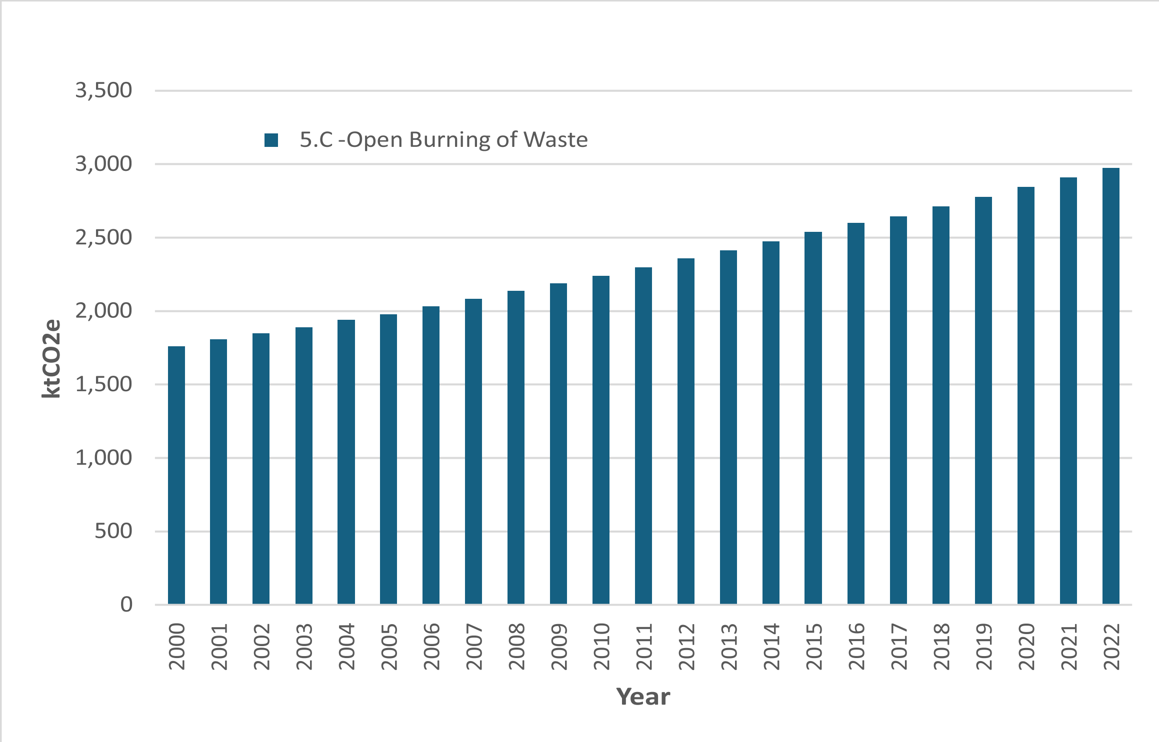

Figure 7.3. Trends of emissions (kt CO2 e) for Incineration and Open Burning of Waste (2000-2022)

Table 7.8. Emissions (kt CO2 e) from Incineration and Open Burning of Waste by sub-category for selected years

	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022/ 2010
5.C.2. -Open Burning of Waste	1,763	1,980	2,242	2,540	2,713	2,779	2,843	2,909	2,975	69%

7.4.2. Methodological issues

Substantial amounts of waste in Nigeria are collected and treated in unmanaged landfills. A significant portion of the rural population and to lesser extent some in urban regions do not have collection services at their disposal. They thus individually dispose of their waste that is mostly organic and also in smaller amounts. The Tier 1 method of the IPCC 2006 guidelines was adopted for estimating emissions of the Open burning of waste sub-category. A fraction of the urban population also practices Open Burning of waste. The assumption from the BUR1 i.e. about 30% of urban population and 40% of rural population practicing open burning, has been kept.

The AD generated and used in the 2006 IPCC software are given in Table 7.9.

Table 7.9. Activity Data used for Open Burning of Waste (2000-2022)

Year	2000	2001	2002	2003	2004	2005	2006	2007
Fraction of population practicing open burning of waste	0.357	0.357	0.356	0.355	0.355	0.353	0.353	0.352
Amount of waste open burned (kt)	8,006	8,210	8,397	8,590	8,813	8,994	9,233	9,453

Year	2008	2009	2010	2011	2012	2013	2014	2015
Fraction of population practicing open burning of waste	0.352	0.351	0.350	0.349	0.349	0.348	0.347	0.347
Amount of waste open burned (kt)	9,708	9,942	10,183	10,431	10,716	10,975	11,239	11,538

Year	2016	2017	2018	2019	2020	2021	2022	-
Fraction of population practicing open burning of waste	0.346	0.345	0.344	0.344	0.343	0.342	0.342	-
Amount of waste open burned (kt)	11,811	12,018	12,323	12,623	12,913	13,212	13,514	-

Some of the parameters used for estimating emissions of Open Burning of waste are provided in Table 7.10.

Table 7.10. Parameters used for Open Burning of Solid Waste

Dry matter content	Fraction of carbon in dry matter	Fraction of fossil carbon	Oxidation factor
0.57	0.32	0.04	0.58

Emission factors adopted are defaults from the IPCC 2006 guidelines and are given in Table 7.11.

Table 7.11. Emission factors used for Open Burning of Solid Waste

Gas	EF	Unit	Source
NOx	3.18	kg/Mg of waste	
CO	55.83	kg/Mg of waste	
NMVOC	1.23	kg/Mg of waste	
CH4	6500	Kg CH4 / Kg wet waste	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 5 Chapter 5, Page 5.3
N2O	150	Kg N2O / Kg wet waste	2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 5 Chapter 5, Table 5.6
EMEP/EEA air pollutant emission inventory guidebook 2023, 5.C.2 - Open burning of waste, Table 3.1			
SO2	0.11	kg/Mg of waste	

7.4.3. Description of any flexibility applied

Not Applicable.

7.4.4. Uncertainty assessment and time-series consistency

The uncertainties assigned (Table 7.12) to the AD are -50% to +100% and for the default EFs ±40% for CO2 and ±100% for CH4 and N2O. These values are from the ranges of the IPCC 2006 guidelines

Table 7.12. Uncertainty levels assigned for Open Burning of Waste

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
5.C.2 - Open burning of waste	CO2	-50 to +100	±40

5.C.2 - Open burning of waste	CH_4	-50 to +100	±100
5.C.2 - Open burning of waste	N_2O	-50 to +100	±100

1: Source - IPCC 2006 Guidelines, Vol. 5, Chapter 5, page 5.24, paragraph 5.7.2

2: Source – IPCC 2006 Guidelines, Vol. 5, Chapter 5, page 5.23, paragraph 5.7.1

The combined uncertainties determined using the tool developed in an Excel worksheet in line with the methods contained in the IPCC 2006 guidelines are provided in Table 7.13 for this sub-category. The uncertainty for the level assessment for both the base year 2000 and the year-t 2022 is 118% and the trend from the base year 2000 to yeart 2022 is 199.6%.

Table 7.13. Uncertainty assessment for Open Burning of Waste

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO_2e)	Year T (2022) emissions or removals (Kt CO_2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution introduced to Variance by Category in Year T - 2022	Uncertainty into the trend in total national emissions (%)
5.C. Incineration and Open Burning of Waste									
5.C.2 - Open Burning of Waste	CO_2	124.2	209.7	100.0	40.0	107.7	57.6	57.6	283.0
5.C.2 - Open Burning of Waste	CH_4	1457.1	2459.5	100.0	100.0	141.4	13666.0	13666.0	38938.9
5.C.2 - Open Burning of Waste	N_2O	181.4	306.2	100.0	100.0	141.4	211.8	211.8	603.5
Sum		**1762.7**	**2975.4**			**Sum**	**13935.4**	**13935.4**	**39825.4**
			Uncertainty in level (L) and trend (T) assessment				**L - 118.0**	**L - 118.0**	**T - 199.6**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

7.4.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, generation of AD, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations and reference material. Quality Assurance during the estimation steps was done by independent international experts.

7.4.6. Category-specific recalculations Not

Applicable.

7.4.7. Category-specific planned improvements

The planned improvement is to extend the scope of the inventory by addressing Incineration. It is planned to capture the required AD and other information to achieve this in the inventory of 2028.

7.5. Wastewater treatment and discharge (CRT 5.D)

7.5.1. Category description

Wastewater treatment and discharge comprises 3 subcategories and 2 of these have been addressed, namely Domestic wastewater and Industrial wastewater.

Total emissions from wastewater treatment and discharge (Figure 7.4) depicts a constant increase over the time series. It increased by 76% from 13,571 kt CO2 e in 2000 to 23,946 kt CO2 e in 2022 (table 7.14). Domestic wastewater treatment vastly dominated emissions of this category.

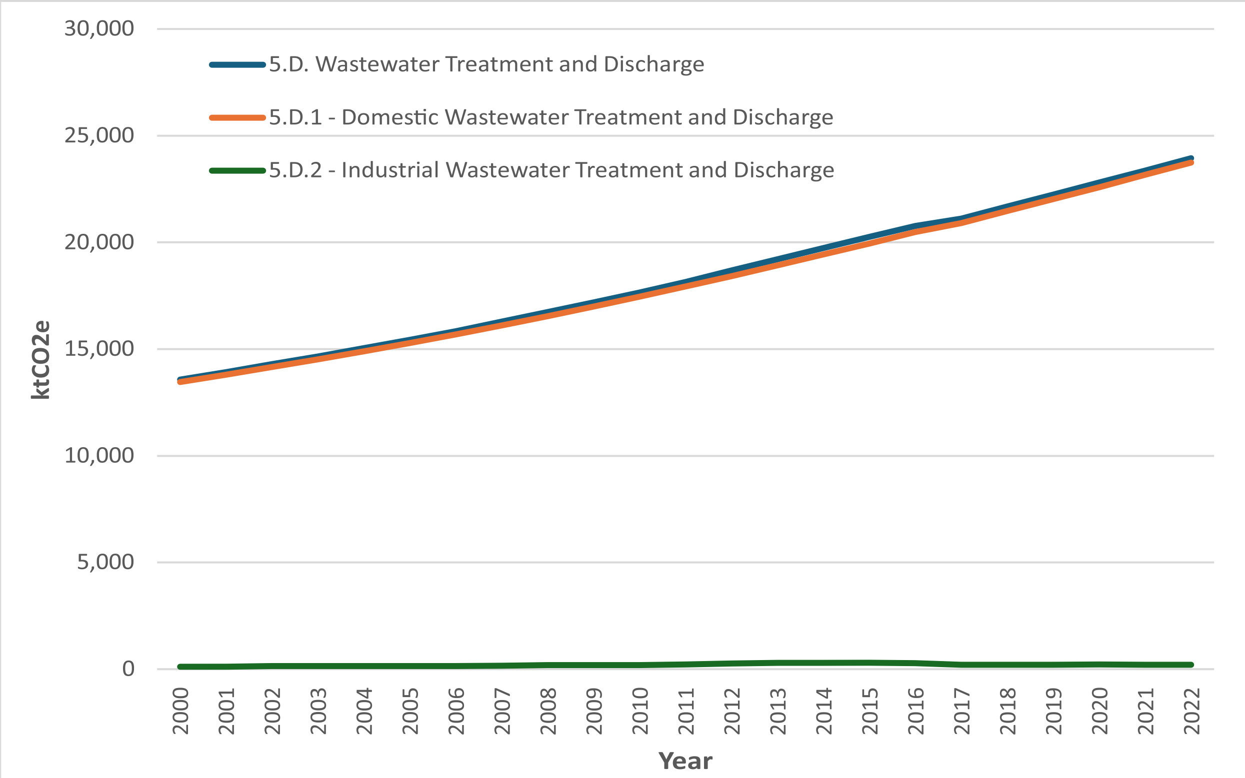

Figure 7.4. Trends of emissions (kt CO2 e) for Wastewater Treatment and Discharge (2000-2022)

Emissions of the wastewater treatment and discharge and its 2 sub-categories are given in Table 7.14 for selected years. Emissions from Domestic wastewater increased by 76% from 13,457 kt CO2 e in 2000 to 23,741 kt CO2 e in 2022. Industrial wastewater emission increased by 80% from 114 kt CO2 e in 2000 to 205 kt CO2 e in 2022. Industrial wastewater emissions contributes minimally as they are at around 1% of Wastewater category emissions.

Table 7.14. Emissions (kt CO2 e) from Wastewater Treatment and Discharge by sub-category for selected years

	2000	2005	2010	2015	2018	2019	2020	2021	2022	2022/ 2010
5.D. Wastewater Treatment and Discharge	13,571	15,435	17,657	20,256	21,682	22,245	22,807	23,371	23,946	76%
5.D.1 - Domestic Wastewater Treatment and Discharge	13,457	15,290	17,459	19,954	21,470	22,037	22,592	23,162	23,741	76%
5.D.2 - Industrial Wastewater Treatment and Discharge	114	145	198	302	212	207	216	209	205	80%

7.5.2. Methodological issues

GHG emissions originating from the Waste Sector were estimated following a Tier 1 methodological approach as per the IPCC 2006 Guidelines for National GHG Inventories and computed using the IPCC Inventory Software. The AD for domestic wastewater was derived from population statistics and wastewater system used through census data.

The wastewater system assigned to the different fractions of the population which is fed in the software for estimating emissions are provided in Table 7.15. Data from NBS and NPC were compared before adoption. Same distribution used across time series. The centralized system previously quoted from IPCC Guidelines were from a UN projection of 2005 published in 2002 as mentioned in the IPCC 2006 Guidelines. This system is not included anymore pending improvement in the data collection.

Table 7.15. Information used for Domestic wastewater treatment and discharge

Wastewater treatment system	Fraction population using system
Latrine	51.6
Septic tank	24.3
No system	24.1

AD on industrial production used to generate wastewater within the software were obtained from FAOSTATS and are provided in Table 7.16.

Table 7.16. Activity Data (t) used for Industrial Wastewater Treatment and Discharge (2000-2022)

Year	Beer	Palm oil	Coconut oil	Groundnut oil	Sesame oil	Cotton seed oil	Total vegetable oil
2000	919,500	12,800	476,000	899,000	8,000	14,400	1,410,200
2001	956,000	7,000	440,000	903,000	8,000	18,400	1,376,400
2002	1,171,000	7,000	468,000	961,000	8,000	17,800	1,461,800
2003	1,170,000	9,000	498,000	1,022,000	8,000	16,100	1,553,100
2004	1,199,000	9,000	533,000	1,094,000	7,200	19,800	1,663,000
2005	1,180,000	9,000	570,000	1,170,000	7,200	21,400	1,777,600
2006	1,150,000	10,200	627,000	1,287,000	4,400	19,000	1,947,600
2007	1,380,000	9,000	625,000	1,309,000	3,600	17,200	1,963,800
2008	1,540,000	10,600	630,000	1,330,000	3,200	20,200	1,994,000
2009	1,600,000	10,500	276,100	1,233,050	2,400	12,700	1,534,750
2010	1,760,000	11,600	286,000	970,820	6,124	8,800	1,283,344
2011	1,959,600	11,550	288,200	930,000	22,148	12,300	1,264,198
2012	2,400,000	12,000	300,200	940,000	176,342	14,700	1,443,242
2013	2,650,000	10,146	312,500	880,000	90,139	14,500	1,307,285
2014	2,700,000	12,000	272,500	1,350,095	55,602	13,800	1,703,997
2015	2,700,000	10,417	326,700	1,432,103	49,810	14,000	1,833,030
2016	2,600,000	9,492	331,100	960,000	80,804	12,500	1,393,896
2017	1,750,000	9,588	342,000	1,529,315	92,368	12,400	1,985,671
2018	1,800,000	10,748	368,500	1,564,599	64,165	12,000	2,020,012
2019	1,800,000	10,766	375,100	1,220,000	51,565	10,900	1,668,331
2020	1,880,000	9,518	364,100	1,280,000	33,382	10,000	1,697,001
2021	1,799,800	9,315	364,100	1,350,000	58,628	16,900	1,798,943
2022	1,739,273	NA	NA	NA	NA	NA	1,949,959

EFs adopted from the IPCC 2006 guidelines (Volume 5 Chapter 6 Table 6.3 updated) for Domestic wastewater are given in Table 7.17.

Table 7.17. Emission factors and other information used for Domestic Wastewater Treatment and Discharge

System	Whole Nigeria	Information
Septic system	0.5	-
Latrines	0.7	Wet climate/Flush water use, ground water table higher than latrine

The Chemical Oxygen Demand (COD) adopted from the IPCC 2006 guidelines (Volume 5 Chapter 6 Table 6.9) for Industrial wastewater is given in Table 7.18.

Table 7.18. Emission factors and other information used for Industrial Wastewater Treatment and Discharge

	Wastewater generated (m3/t)	COD (kg COD/m3)	CH4 EF (Kg Ch4/kg COD)
Beer	6.3	2.9	0.2
Vegetable Oil	3.1	0.8	0.2

7.5.3. Description of any flexibility applied

Not resorted to.

7.5.4. Uncertainty assessment and time-series consistency

All uncertainty values assigned are from the 2019 Refinement of the IPCC 2006 guidelines and provided in Table 7.19. The uncertainties assigned to the AD and the default EFs for Domestic wastewater are ±50% for both. Those assigned to Industrial Wastewater Treatment and Discharge are -50% to +100% for AD and ±30% EF.

Table 7.19. Uncertainty levels assigned for Wastewater Treatment and Discharge

2006 IPCC Categories	Gas	Uncertainty assigned (%)	
		AD[1]	EF[2]
5.D.1 - Domestic Wastewater Treatment and Discharge	CH4	+/-50	±50
5.D.2 - Industrial Wastewater Treatment and Discharge	N2O	-50 to +100	±30

Note 1: Source: 2019 Refinement to 2006 Guidelines, Vol. 5, Chapter 6, page 6.29, Table 6.7 (Updated)

Note 2: Source: 2019 Refinement to 2006 Guidelines, Vol. 5, Chapter 6, page 6.23, Table 6.10

The combined uncertainty determined using the tool developed in an Excel worksheet in line with the methods contained in the IPCC 2006 guidelines is provided in Table 7.20 for this category. The uncertainty for the level assessment for the base year 2000 and year-t (2022) are 70.1%. The trend uncertainty with base year 2000 and yeart 2022 is 123.7%.

Table 7.20. Uncertainty assessment for Wastewater Treatment and Discharge

2006 IPCC Categories	Gas	Base Year (2000) emissions or removals (Kt CO2e)	Year T (2022) emissions or removals (Kt CO2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in base year-2000	Contribution to Variance by Category in Year T-2022	Uncertainty introduced into the trend in total national emissions (%)
5.D. Wastewater Treatment and Discharge									
5.D.1 - Domestic Wastewater Treatment and Discharge	CH4	13457.4	23741.4	50.0	50.0	70.7	4916.6	4914.7	15302.2

5.D.2 - Industrial Wastewater Treatment and Discharge	CH4	113.7	205.0	100.0	30.0	104.4	0.8	0.8	4.6
Sum		**13571.1**	**23946.5**			**Sum**	**4917.4**	**4915.5**	**15306.8**
						Uncertainty in level (L) and trend (T) assessment	**L - 70.1**	**L - 70.1**	**T - 123.7**

The time series is consistent as the AD have always been sourced from the same institution, the default EFs of IPCC used as well as a common methodology for all the years of the time series.

7.5.5. Category-specific QA/QC and verification

The quality control checks were consistent with those of the 2006 IPCC Guidelines which served for developing the QA/QC plan of Nigeria. Elements of the QC checks included a review of the estimation models for choice of the most appropriate method, the process adopted for generating AD, the appropriate default EFs, time-series consistency, transcription accuracy, the calculations and reference material. Quality Assurance during the estimation steps was done by independent international experts.

7.5.6. Category-specific recalculations

Recalculations have been performed for all years of the time series following the upgrade in methodology available in the 2019 refinements of the IPCC 2006 guidelines, change in the wastewater treatment system assigned and the inclusion of industrial wastewater subcategory which was not estimated previously. The new methods resulted in small changes in the emissions, varying from -1.2% to +3.3%.

Table 7.21. Comparison of previous and recalculated emissions (kt CO2 e) for Wastewater Treatment and Discharge

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BUR2 - NIR1	13,135	13,470	13,816	14,233	14,665	15,179	15,583	15,999	16,500	17,018	17,625	18,106
BTR1 - NID1	13,571	13,917	14,295	14,661	15,043	15,435	15,841	16,284	16,735	17,183	17,657	18,154
% change	3.3	3.3	3.5	3.0	2.6	1.7	1.7	1.8	1.4	1.0	0.2	0.3

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	-
BUR2 - NIR1	18,600	19,184	19,785	20,478	21,023	21,330	-	-	-	-	-	-
BTR1 - NID1	18,691	19,214	19,737	20,256	20,771	21,110	21,682	22,245	22,807	23,371	23,946	-
% change	0.5	0.2	-0.2	-1.1	-1.2	-1.0	-	-	-	-	-	-

7.5.7. Category-specific planned improvement

Wastewater Treatment and Discharge is a key category, and estimates must be improved using a Tier 2 level method. The planned improvement consists of the following activities:

- Determine the existing wastewater treatment systems as per the IPCC nomenclature and their use rate by the different segments of the population.
- Collect information on the characteristics of the wastewater treatment systems, if any, existing in the country for both domestic and industrial wastewater.
- Review the ground water table level for the different ecological zones to assign the appropriate EFs for latrines.

The timeframe for this category is year 2032 and is subject to the availability of funds to cater for the extensive nature of data collection.

7.6. Other (CRT 5.e) (specify)

Not Occurring

7.7. Memo item

It has not been possible to report on carbon stored in Solid Waste Disposal Sites due to time constraints. This is planned as an improvement for the next reporting cycle.

Chapter 8. Other (CRT sector 6)

Not mandatory and has not been estimated due to time constraints. Mandatory elements of the inventory prioritized.

Chapter 9. Indirect carbon dioxide and nitrous oxide emissions

Not Estimated because of lack of time and resources. Mandatory elements of the inventory prioritized.

Chapter 10. Recalculations and improvements

10.1. Explanations and justifications for recalculations

Details on recalculations and improvements are provided under each category as applicable. All recalculations and improvements are Party decisions.

Recalculations were performed following changes in activity data sets, methodology, including EFs when adopting the 2019 Refinements to the 2006 IPCC Guidelines.

Improvements addressed estimation of sub-categories in lieu of bulked data under the category only, widening the scope of the inventory through the inclusion of additional categories for enhanced completeness, improving accuracy through the adoption of better-quality data and plant-based information.

10.2. Implications for emission and removal levels

The implications on the emissions and removal levels for each category are provided whenever recalculations have been performed. Tables 10.1 and 10.2 summarize the implications for net emissions/removals at national level through a comparison of the previous and latest inventory results with and without LULUCF respectively.

When considering the “with LULUCF” data set, net emissions are lower for all years of the timeseries 2000 to 2017, varying between 61,347 kt CO2 e to 110,384 kt CO2 e.

Table 10.1. Comparison of previous and latest national net emissions/removals (kt CO2 e) levels with LULUCF

Year	Previous	Latest	Change	
			Latest - Previous	%
2000	458,508	368,499	-90,009	-24%
2001	482,088	382,653	-99,435	-26%
2002	475,850	393,675	-82,175	-21%
2003	504,778	410,172	-94,606	-23%
2004	519,055	420,759	-98,296	-23%
2005	543,460	433,076	-110,384	-25%
2006	545,930	441,392	-104,538	-24%
2007	555,448	468,556	-86,892	-19%
2008	564,328	473,549	-90,779	-19%
2009	558,222	454,688	-103,534	-23%
2010	591,375	489,424	-101,951	-21%
2011	598,292	514,807	-83,485	-16%
2012	613,052	543,477	-69,575	-13%
2013	627,993	560,528	-67,465	-12%
2014	653,416	582,521	-70,895	-12%
2015	671,810	587,016	-84,794	-14%
2016	656,469	595,122	-61,347	-10%
2017	673,640	600,435	-73,205	-12%

The same trend is observed with the “without LULUCF” dataset as per Table 10.2. The difference ranges between 47,514 kt CO2 e and 80,331 kt CO2 e in terms of emissions.

Table 10.2. Comparison of previous and latest national net emissions (kt CO2 e) levels without LULUCF

Year	Previous	Latest	Change	
			Latest - Previous	%
2000	207,742	159,824	-47,918	-30%
2001	228,233	169,403	-58,830	-35%
2002	218,730	175,336	-43,394	-25%
2003	244,134	186,387	-57,747	-31%
2004	254,524	190,846	-63,678	-33%
2005	274,860	196,261	-78,599	-40%
2006	273,643	197,486	-76,157	-39%
2007	279,447	201,498	-77,949	-39%
2008	286,292	211,585	-74,707	-35%
2009	275,174	200,276	-74,898	-37%
2010	304,600	224,269	-80,331	-36%
2011	307,924	238,272	-69,652	-29%
2012	318,094	252,729	-65,365	-26%
2013	329,744	274,502	-55,242	-20%
2014	350,406	290,742	-59,664	-21%
2015	363,964	290,739	-73,225	-25%
2016	345,283	297,769	-47,514	-16%
2017	358,212	299,819	-58,393	-19%

10.3. Implications for emission and removal trends, including time-series consistency

Recalculations always resulted in a decrease in emissions for all years of the time series, irrespective of whether LULUCF is included or not.

Under the With LULUCF situation, the decrease represents a range of 10% to 26%.

Under the Without LULUCF situation, the reduction ranges between 16% to 40%.

Whenever recalculations have been performed, they have been applied over the full time series of the previous inventory and the same method applied for all years of the previous and new inventories to ensure consistency.

10.4. Areas of improvement and/or capacity-building in response to the review process

Not Applicable as NID is yet to be reviewed.

10.5. Areas of improvement and/or capacity-building related to the flexibility provisions applied with self-determined estimated time frames for improvements

Nigeria has resorted to the flexibility provisions under paragraph 57 of the MPGS for extending the time series through the inclusion of estimates for the period 1990 to 1999 and paragraph 48 of the MPGS relative to widening the scope of coverage of direct GHGs, namely HFCs, PFCs and SF6 that are recognised as occurring but not NF3 that is not emitted in the country. More details are provided in Table 10.3.

Table 10.3. Description on flexibility provisions

Flexibility provision	Year	Sector	Category	Gas	Description	Capacity constraint	Timeline
Para. 57 of MPGs	1990 to 1999	Energy, IPPU, Agriculture, LULUCF, Waste	All occurring categories	CO2, CH4, N2O,	There is no AD collected for this period	Difficult to undertake data collection for this period from files	2030
Flexibility provision	**Year**	**Sector**	**Category**	**Gas**	**Description**	**Capacity constraint**	**Timeline**
				HFCs, PFCs, SF6, NF3	estimating emissions as per the MPGs	if existent coupled with lack of resources	
Para. 48 of MPGs	2000 to 2022	IPPU	2.F. Product uses as substitutes for ODS	HFCs, PFCs, SF6	Inability to cover N2O, HFCs, PFCs and SF6 from the sub-categories 2.F.1. Refrigeration and air conditioning, 2.F.3. Fire protection, 2.F.4. Aerosols and 2.F.5. Solvents	Unavailability of activity data and an appropriate system to collect same	2032
Para. 48 of MPGs	2000 to 2022	IPPU	2.G. Other product manufacture and use	HFCs, PFCs, SF6	Inability to cover HFCs, PFCs and SF6 from the sub-categories 2.G.1. Electrical equipment, 2.G.2. SF6 and PFCs from other product use and 2.G.3. N2O from product uses	Unavailability of activity data and an appropriate system to collect same	2032

Annex I. Key categories

The IPCC Tier 1 approach has been adopted. Since the tool included in the IPCC 2006 software could be only partially used as it does not provide results with and without LULUCF which is mandatory for reporting according to the MPGs of Decision 18/CMA, a new tool was designed for undertaking this exercise. Furthermore, the equation used in the IPCC Software has not been updated with the most recent one recommended in the 2019 Refinements of the 2006 IPCC Guidelines. Hence, equations from the 2019 Refinements of the 2006 IPCC Guidelines were used and programmed in an Excel workbook to enable the analysis to be performed with and without LULUCF.

Key categories were truncated at the 95% level for the level assessments for the base year and the last year of the time series, and the trend assessment between the base year to the latest year of the inventory. Both exercises were performed with and without LULUCF.

The results follow and are provided in the following sequence.

1. Table A1.1 KCA Level Assessment for base year 2000 with LULUCF
2. Table A1.2. KCA Level Assessment for base year 2022 with LULUCF
3. Table A1.3. KCA Level Assessment for year-t 2000 without LULUCF
4. Table A1.4. KCA Level Assessment for year-t 2022 without LULUCF
5. Table A1.5. KCA Trend Assessment for time series 2000 - 2022 with LULUCF
6. Table A1.6. KCA Trend Assessment for time series 2000 - 2022 without LULUCF

Table A I.1. Key Category Analysis for the year 2000 - Approach 1 - Level Assessment – With LULUCF

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	GHG	"2000 E_{xt}. (Gg CO2 e)"	"|E_{xt}| (Gg CO2 e)"	Lx,t	Cumulative Total of Column F
4.A.1	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	214,488	214,488	0.564	0.564
3.A	Enteric Fermentation	METHANE (CH4)	23,340	23,340	0.061	0.626
1.A.4	Other Sectors - Biomass - solid	METHANE (CH4)	23,080	23,080	0.061	0.686
1.A.3.b	Road Transportation - Liquid Fuels	CARBON DIOXIDE (CO2)	19,983	19,983	0.053	0.739
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	13,770	13,770	0.036	0.775
5.D	Wastewater Treatment and Discharge	METHANE (CH4)	13,571	13,571	0.036	0.811
1.B.2.a	Oil	METHANE (CH4)	10,526	10,526	0.028	0.839
3.D.1	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	9,749	9,749	0.026	0.864
1.B.2.b	Natural Gas	METHANE (CH4)	7,361	7,361	0.019	0.884
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	6,837	6,837	0.018	0.902
4.G	Harvested Wood Products	CARBON DIOXIDE (CO2)	-5,813	5,813	0.015	0.917
3.C	Rice cultivation	METHANE (CH4)	5,752	5,752	0.015	0.932
5.A	Solid Waste Disposal	METHANE (CH4)	3,768	3,768	0.010	0.942
3.D.2	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	3,044	3,044	0.008	0.950
1.A.4	Other Sectors - Biomass - solid	NITROUS OXIDE (N2O)	2,897	2,897	0.008	0.958

Table A I.2. Key Category Analysis for the year 2022 - Approach 1 - Level Assessment – With LULUCF

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	GHG	"2022 E_{xt}. (Gg CO2 e)"	"|E_{xt}| (Gg CO2 e)"	Lx,t	Cumulative Total of Column F

4.A.1	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	349,774	349,774	0.436	0.436
4.B.1	Cropland Remaining Cropland	CARBON DIOXIDE (CO2)	-111,179	111,179	0.139	0.574
1.A.3.b	Road Transportation - Liquid Fuels	CARBON DIOXIDE (CO2)	55,743	55,743	0.069	0.644
1.A.4	Other Sectors - Biomass - solid	METHANE (CH4)	39,580	39,580	0.049	0.693
3.A	Enteric Fermentation	METHANE (CH4)	38,369	38,369	0.048	0.741
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	33,029	33,029	0.041	0.782
5.D	Wastewater Treatment and Discharge	METHANE (CH4)	23,946	23,946	0.030	0.812
1.B.2.b	Natural Gas	METHANE (CH4)	17,758	17,758	0.022	0.834
3.D.1	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	17,174	17,174	0.021	0.856
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	16,811	16,811	0.021	0.877
3.C	Rice cultivation	METHANE (CH4)	12,017	12,017	0.015	0.892
5.A	Solid Waste Disposal	METHANE (CH4)	11,128	11,128	0.014	0.905
2.A.1	Cement production	CARBON DIOXIDE (CO2)	10,924	10,924	0.014	0.919
4.E.1	Settlements Remaining Settlements	CARBON DIOXIDE (CO2)	-8,876	8,876	0.011	0.930
1.B.2.a	Oil	METHANE (CH4)	6,741	6,741	0.008	0.938
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	6,472	6,472	0.008	0.947
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	6,136	6,136	0.008	0.954

Table A I.3. Key Category Analysis for the year 2000 - Approach 1 - Level Assessment – Without LULUCF

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	GHG	"2000 Ext. (Gg CO2 e)"	"|Ext| (Gg CO2 e)"	Lx,t	Cumulative Total of Column F
3.A	Enteric Fermentation	METHANE (CH4)	23,340	23,340	0.146	0.146
1.A.4	Other Sectors - Biomass - solid	METHANE (CH4)	23,080	23,080	0.144	0.290
1.A.3.b	Road Transportation - Liquid Fuels	CARBON DIOXIDE (CO2)	19,983	19,983	0.125	0.415
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	13,770	13,770	0.086	0.502
5.D	Wastewater Treatment and Discharge	METHANE (CH4)	13,571	13,571	0.085	0.587
1.B.2.a	Oil	METHANE (CH4)	10,526	10,526	0.066	0.652
3.D.1	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	9,749	9,749	0.061	0.713
1.B.2.b	Natural Gas	METHANE (CH4)	7,361	7,361	0.046	0.759
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	6,837	6,837	0.043	0.802
3.C	Rice cultivation	METHANE (CH4)	5,752	5,752	0.036	0.838
5.A	Solid Waste Disposal	METHANE (CH4)	3,768	3,768	0.024	0.862
A	B	C	D	E	F	G
IPCC Category code	IPCC Category	GHG	"2000 Ext. (Gg CO2 e)"	"|Ext| (Gg CO2 e)"	Lx,t	Cumulative Total of Column F

3.D.2	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	3,044	3,044	0.019	0.881
1.A.4	Other Sectors - Biomass - solid	NITROUS OXIDE (N2O)	2,897	2,897	0.018	0.899
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	2,529	2,529	0.016	0.915
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CARBON DIOXIDE (CO2)	1,825	1,825	0.011	0.926
5.C	Incineration and Open Burning of Waste	METHANE (CH4)	1,457	1,457	0.009	0.935
1.B.1.b	Fuel transformation	METHANE (CH4)	1,381	1,381	0.009	0.944
1.A.1	Energy Industries - Liquid Fuels	CARBON DIOXIDE (CO2)	1,339	1,339	0.008	0.952

Table A I.4. Key Category Analysis for the year 2022 - Approach 1 - Level Assessment – Without LULUCF

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	GHG	"2022 E_{xt}. (Gg CO2 e)"	"$\|E_{xt}\|$ (Gg CO2 e)"	Lx,t	Cumulative Total of Column F
1.A.3.b	Road Transportation - Liquid Fuels	CARBON DIOXIDE (CO2)	55,743	55,743	0.170	0.170
1.A.4	Other Sectors - Biomass - solid	METHANE (CH4)	39,580	39,580	0.120	0.290
3.A	Enteric Fermentation	METHANE (CH4)	38,369	38,369	0.117	0.407
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	33,029	33,029	0.101	0.508
5.D	Wastewater Treatment and Discharge	METHANE (CH4)	23,946	23,946	0.073	0.580
1.B.2.b	Natural Gas	METHANE (CH4)	17,758	17,758	0.054	0.634
3.D.1	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	17,174	17,174	0.052	0.687
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	16,811	16,811	0.051	0.738
3.C	Rice cultivation	METHANE (CH4)	12,017	12,017	0.037	0.775
5.A	Solid Waste Disposal	METHANE (CH4)	11,128	11,128	0.034	0.808
2.A.1	Cement production	CARBON DIOXIDE (CO2)	10,924	10,924	0.033	0.842
1.B.2.a	Oil	METHANE (CH4)	6,741	6,741	0.021	0.862
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	6,472	6,472	0.020	0.882
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	6,136	6,136	0.019	0.901
3.D.2	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	5,631	5,631	0.017	0.918
1.B.1.b	Fuel transformation	METHANE (CH4)	5,548	5,548	0.017	0.935
1.A.4	Other Sectors - Biomass - solid	NITROUS OXIDE (N2O)	4,931	4,931	0.015	0.950
5.C	Incineration and Open Burning of Waste	METHANE (CH4)	2,460	2,460	0.007	0.957

Table A I.5. Key Category Analysis for the period 2000 - 2022 - Approach 1 - Trend Assessment with LULUCF

A	B	C	D	E	F	G	H
IPCC Category code	IPCC Category	GHG	2000 Year Estimate E_{x0} (Gg CO2 e)	2022 Year Estimate E_{xt} (Gg CO2 e)	Trend Assessment (T_{xt})	% Contribution to Trend	Cumulative Total of Column G

4.A.1	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	214,488	349,774	0.729	0.311	0.311
4.B.1	Cropland Remaining Cropland	CARBON DIOXIDE (CO2)	0	-111,179	0.599	0.255	0.566
1.A.3.b	Road Transportation - Liquid Fuels	CARBON DIOXIDE (CO2)	19,983	55,743	0.193	0.082	0.648
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	13,770	33,029	0.104	0.044	0.692
1.A.4	Other Sectors - Biomass - solid	METHANE (CH4)	23,080	39,580	0.089	0.038	0.730
3.A	Enteric Fermentation	METHANE (CH4)	23,340	38,369	0.081	0.035	0.765
1.B.2.b	Natural Gas	METHANE (CH4)	7,361	17,758	0.056	0.024	0.789
5.D	Wastewater Treatment and Discharge	METHANE (CH4)	13,571	23,946	0.056	0.024	0.812
2.A.1	Cement production	CARBON DIOXIDE (CO2)	845	10,924	0.054	0.023	0.836
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	6,837	16,811	0.054	0.023	0.859
4.E.1	Settlements Remaining Settlements	CARBON DIOXIDE (CO2)	0	-8,876	0.048	0.020	0.879
3.D.1	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	9,749	17,174	0.040	0.017	0.896
5.A	Solid Waste Disposal	METHANE (CH4)	3,768	11,128	0.040	0.017	0.913
3.C	Rice cultivation	METHANE (CH4)	5,752	12,017	0.034	0.014	0.927
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	737	6,136	0.029	0.012	0.940
1.B.1.b	Fuel transformation	METHANE (CH4)	1,381	5,548	0.022	0.010	0.949
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	2,529	6,472	0.021	0.009	0.958

Table A I.6. Key Category Analysis for the period 2000 - 2022 - Approach 1 - Trend Assessment without LULUCF

A	B	C	D	E	F	G	H
IPCC Category code	IPCC Category	GHG	2000 Year Estimate E_{x0} (Gg CO2 e)	2022 Year Estimate E_{xt} (Gg CO2 e)	Trend Assessment (T_{xt})	% Contribution to Trend	Cumulative Total of Column G
1.A.3.b	Road Transportation - Liquid Fuels	CARBON DIOXIDE (CO2)	19,983	55,743	0.212	0.200	0.200
1.A.1	Energy Industries - Gaseous Fuels	CARBON DIOXIDE (CO2)	13,770	33,029	0.114	0.108	0.308
1.A.4	Other Sectors - Biomass - solid	METHANE (CH4)	23,080	39,580	0.098	0.092	0.401
3.A	Enteric Fermentation	METHANE (CH4)	23,340	38,369	0.089	0.084	0.485
1.B.2.b	Natural Gas	METHANE (CH4)	7,361	17,758	0.062	0.058	0.543

5.D	Wastewater Treatment and Discharge	METHANE (CH4)	13,571	23,946	0.062	0.058	0.602
2.A.1	Cement production	CARBON DIOXIDE (CO2)	845	10,924	0.060	0.057	0.658
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	6,837	16,811	0.059	0.056	0.714
3.D.1	Direct N2O Emissions from managed soils	NITROUS OXIDE (N2O)	9,749	17,174	0.044	0.042	0.756
5.A	Solid Waste Disposal	METHANE (CH4)	3,768	11,128	0.044	0.041	0.797
3.C	Rice cultivation	METHANE (CH4)	5,752	12,017	0.037	0.035	0.832
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO2)	737	6,136	0.032	0.030	0.862
1.B.1.b	Fuel transformation	METHANE (CH4)	1,381	5,548	0.025	0.023	0.886
1.A.2	Manufacturing Industries and Construction - Gaseous Fuels	CARBON DIOXIDE (CO2)	2,529	6,472	0.023	0.022	0.908
1.B.2.a	Oil	METHANE (CH4)	10,526	6,741	0.022	0.021	0.929
3.D.2	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	3,044	5,631	0.015	0.014	0.943
1.A.4	Other Sectors - Biomass - solid	NITROUS OXIDE (N2O)	2,897	4,931	0.012	0.011	0.955

Annex II. Uncertainty assessment

As per the MPGs contained in Decision 18/CMA.1, countries must assess and present Uncertainties at a category level. The tool embedded in the IPCC 2006 software does not perform this disaggregated level of assessment as it provides the Uncertainty at the national level only with all categories and sectors merged, both for the level and trend assessments. Hence, a tool was developed in an Excel workbook, reflecting exactly the equations of the IPCC 2006 Guidelines, to perform the Uncertainty assessments at the category and whole of inventory (national) levels.

The results for categories have been presented when reporting on them individually. Table AII.1 gives the full inventory assessments for the base year 2000 and for year-t 2022. The base year 2000 assessment provides the level assessment only whereas the year-t one gives the level results for year 2022 and the trend assessment for the full time series 2000 to 2022.

Table A II.1 Assessment of uncertainty for base year (2000), year T (2022) and in trend (2000-2022)

A	B	C	D	E	F	G		H	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals Gg CO2 equivalent	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Base Year 2000	Contribution to Variance by Category in Year T (2022)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A - Fuel Combustion Activities											
1.A.1.a.i - Electricity Generation - Gaseous Fuels	CO2	7,460.010	18,213.370	2	3.9	4.4	0.008	0.021	0.07	0.14	0.02
1.A.1.a.i - Electricity Generation - Gaseous Fuels	CH4	3.723	9.090	2	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.1.a.i - Electricity Generation - Gaseous Fuels	N2O	3.524	8.603	2	200.0	200.0	0.000	0.000	0.00	0.00	0.00

1.A.1.b - Petroleum Refining - Gaseous Fuels	CO2	37.082	248.748	2	3.9	4.4	0.000	0.000	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Gaseous Fuels	CH4	0.019	0.124	2	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Gaseous Fuels	N2O	0.018	0.118	2	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Liquid Fuels	CO2	1,339.332	728.473	2	6.1	6.5	0.001	0.000	0.02	0.01	0.00
1.A.1.b - Petroleum Refining - Liquid Fuels	CH4	1.200	0.715	2	228.8	228.8	0.000	0.000	0.00	0.00	0.00
1.A.1.b - Petroleum Refining - Liquid Fuels	N2O	2.079	1.300	2	228.8	228.8	0.000	0.000	0.00	0.00	0.00
1.A.1.c.ii - Other Energy Industries - Gaseous Fuels	CO2	6,273.046	14,567.268	2	3.9	4.4	0.006	0.013	0.05	0.11	0.02
1.A.1.c.ii - Other Energy Industries - Gaseous Fuels	CH4	3.131	7.271	2	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.1.c.ii - Other Energy Industries - Gaseous Fuels	N2O	2.963	6.881	2	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.2.a - Iron and Steel - Gaseous Fuels	CO2	190.067	675.947	3	3.9	4.9	0.000	0.000	0.00	0.01	0.00
1.A.2.a - Iron and Steel - Gaseous Fuels	CH4	0.095	0.337	3	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.2.a - Iron and Steel - Gaseous Fuels	N2O	0.090	0.319	3	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.2.c - Chemicals - Gaseous Fuels	CO2	1,023.320	1,115.836	3	3.9	4.9	0.000	0.000	0.00	0.01	0.00
1.A.2.c - Chemicals - Gaseous Fuels	CH4	0.511	0.557	3	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.2.c - Chemicals - Gaseous Fuels	N2O	0.483	0.527	3	200.0	200.0	0.000	0.000	0.00	0.00	0.00
1.A.2.f - Non-Metallic Minerals - Solid Fuels	CO2	737.085	6,135.566	15	12.5	19.5	0.002	0.046	0.17	0.35	0.15
1.A.2.f - Non-Metallic Minerals - Solid Fuels	CH4	2.182	18.160	15	200.0	200.6	0.000	0.000	0.01	0.00	0.00
1.A.2.f - Non-Metallic Minerals - Solid Fuels	N2O	3.097	25.781	15	222.2	222.7	0.000	0.000	0.01	0.00	0.00

A	B	C	D	E	F	G		H	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO_2 equivalent)	Year T emissions or removals (Gg CO_2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Base Year 2000	Contribution to Variance by Category in Year T (2022)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A.2.m - Non-specified Industry - Biomass - solid	CO2	0.000	0.000	60	17.6	62.5	0.000	0.000	0.00	0.00	0.00
1.A.2.m - Non-specified Industry - Biomass - solid	CH4	70.090	153.416	60	222.2	230.2	0.002	0.004	0.03	0.04	0.00
1.A.2.m - Non-specified Industry - Biomass - solid	N2O	87.383	190.615	60	275.0	281.5	0.004	0.009	0.04	0.04	0.00
1.A.2.m - Non-specified Industry - Gaseous Fuels	CO2	1,315.826	4,679.916	9	3.9	9.8	0.001	0.007	0.03	0.16	0.03
1.A.2.m - Non-specified Industry - Gaseous Fuels	CH4	0.657	2.336	9	200.0	200.2	0.000	0.000	0.00	0.00	0.00
1.A.2.m - Non-specified Industry - Gaseous Fuels	N2O	0.622	2.211	9	200.0	200.2	0.000	0.000	0.00	0.00	0.00
1.A.2.m - Non-specified Industry - Liquid Fuels	CO2	1,825.243	2,058.347	9	6.1	10.9	0.003	0.002	0.01	0.07	0.01
1.A.2.m - Non-specified Industry - Liquid Fuels	CH4	2.076	2.279	9	228.8	229.0	0.000	0.000	0.00	0.00	0.00
1.A.2.m - Non-specified Industry - Liquid Fuels	N2O	3.928	4.311	9	228.8	229.0	0.000	0.000	0.00	0.00	0.00
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CO2	583.333	1,849.088	20	4.2	20.4	0.001	0.005	0.01	0.14	0.02
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CH4	0.114	0.362	20	100.0	102.0	0.000	0.000	0.00	0.00	0.00
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	N2O	4.324	13.707	20	150.0	151.3	0.000	0.000	0.00	0.00	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CO2	411.416	313.670	20	4.2	20.4	0.001	0.000	0.00	0.02	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	CH4	0.081	0.061	20	100.0	102.0	0.000	0.000	0.00	0.00	0.00
1.A.3.a.ii - Domestic Aviation - Liquid Fuels	N2O	3.050	2.325	20	150.0	151.3	0.000	0.000	0.00	0.00	0.00
1.A.3.b.i - Cars - Liquid Fuels	CO2	10,905.104	32,945.016	5	3.1	5.9	0.030	0.120	0.14	0.63	0.41
1.A.3.b.i - Cars - Liquid Fuels	CH4	143.363	434.823	5	244.7	244.7	0.009	0.037	0.14	0.01	0.02
1.A.3.b.i - Cars - Liquid Fuels	N2O	133.736	403.778	5	209.9	210.0	0.006	0.023	0.11	0.01	0.01
1.A.3.b.ii - Light-duty trucks - Liquid Fuels	CO2	3,984.797	10,672.342	5	3.1	5.9	0.004	0.013	0.04	0.20	0.04
1.A.3.b.ii - Light-duty trucks - Liquid Fuels	CH4	33.427	99.343	5	244.7	244.7	0.000	0.002	0.03	0.00	0.00
1.A.3.b.ii - Light-duty trucks - Liquid Fuels	N2O	51.603	136.790	5	209.9	210.0	0.001	0.003	0.03	0.00	0.00
1.A.3.b.iii - Heavy-duty trucks and buses - Liquid Fuels	CO2	3,952.714	8,665.804	5	3.4	6.1	0.004	0.009	0.03	0.17	0.03
1.A.3.b.iii - Heavy-duty trucks and buses - Liquid Fuels	CH4	6.501	14.823	5	244.7	244.7	0.000	0.000	0.00	0.00	0.00
1.A.3.b.iii - Heavy-duty trucks and buses - Liquid Fuels	N2O	55.032	120.569	5	209.9	210.0	0.001	0.002	0.02	0.00	0.00
1.A.3.b.iv - Motorcycles - Liquid Fuels	CO2	1,140.317	3,460.328	5	3.1	5.9	0.000	0.001	0.01	0.07	0.00
1.A.3.b.iv - Motorcycles - Liquid Fuels	CH4	15.204	46.138	5	244.7	244.7	0.000	0.000	0.02	0.00	0.00
1.A.3.b.iv - Motorcycles - Liquid Fuels	N2O	0.000	0.000	5	209.9	210.0	0.000	0.000	0.00	0.00	0.00
1.A.3.c - Railways - Liquid Fuels	CO2	114.707	164.843	5	2.0	5.4	0.000	0.000	0.00	0.00	0.00

A	B	C	D	E	F	G		H	K	L	M
IPCC Categories 2006	Gas	Base Year emissions or removals (Gg CO_2 equivalent)	Year T emissions or removals Gg CO_2 equivalent	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Base Year 2000	Contribution to Variance by Category in Year T (2022)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A.3.c - Railways - Liquid Fuels	CH4	0.180	0.258	5	150.6	150.7	0.000	0.000	0.00	0.00	0.00
1.A.3.c - Railways - Liquid Fuels	N2O	11.732	16.860	5	200.0	200.1	0.000	0.000	0.00	0.00	0.00
1.A.3.d.i - International waterborne navigation (International bunkers) - Liquid Fuels	CO2	1,207.814	930.663	25	4.3	25.4	0.007	0.002	0.01	0.09	0.01
1.A.3.d.i - International waterborne navigation (International bunkers) - Liquid Fuels	CH4	3.101	2.390	25	50.0	55.9	0.000	0.000	0.00	0.00	0.00
1.A.3.d.i - International waterborne navigation (International bunkers) - Liquid Fuels	N2O	8.386	6.462	25	140.0	142.2	0.000	0.000	0.00	0.00	0.00
1.A.3.d.ii - Domestic Waterborne Navigation - Liquid Fuels	CO2	464.593	1,531.157	25	4.3	25.4	0.001	0.005	0.01	0.15	0.02
1.A.3.d.ii - Domestic Waterborne Navigation - Liquid Fuels	CH4	1.293	4.292	25	50.0	55.9	0.000	0.000	0.00	0.00	0.00
1.A.3.d.ii - Domestic Waterborne Navigation - Liquid Fuels	N2O	3.496	11.606	25	140.0	142.2	0.000	0.000	0.00	0.00	0.00
1.A.4.a - Commercial/Institutional - Biomass - solid	CO2	0.000	0.000	60	17.6	62.5	0.000	0.000	0.00	0.00	0.00
1.A.4.a - Commercial/Institutional - Biomass - solid	CH4	487.547	1,049.055	60	200.0	208.8	0.076	0.155	0.17	0.24	0.09
1.A.4.a - Commercial/Institutional - Biomass - solid	N2O	59.100	121.666	60	250.0	257.1	0.002	0.003	0.02	0.03	0.00
1.A.4.a - Commercial/Institutional - Liquid Fuels	CO2	39.712	2,608.203	15	6.1	16.2	0.000	0.006	0.04	0.15	0.02
1.A.4.a - Commercial/Institutional - Liquid Fuels	CH4	0.126	9.655	15	200.0	200.6	0.000	0.000	0.01	0.00	0.00
1.A.4.a - Commercial/Institutional - Liquid Fuels	N2O	0.058	5.375	15	228.8	229.3	0.000	0.000	0.00	0.00	0.00
1.A.4.b - Residential - Biomass - solid	CO2	0.000	0.000	60	17.6	62.5	0.000	0.000	0.00	0.00	0.00
1.A.4.b - Residential - Biomass - solid	CH4	22,592.137	38,531.142	60	200.0	208.8	162.286	208.718	2.46	8.83	84.00
1.A.4.b - Residential - Biomass - solid	N2O	2,837.545	4,809.640	60	250.0	257.1	3.881	4.930	0.37	1.10	1.35
1.A.4.b - Residential - Liquid Fuels	CO2	6,736.309	14,127.660	15	6.1	16.2	0.087	0.169	0.07	0.81	0.66
1.A.4.b - Residential - Liquid Fuels	CH4	26.505	53.192	15	200.0	200.6	0.000	0.000	0.01	0.00	0.00
1.A.4.b - Residential - Liquid Fuels	N2O	15.018	28.648	15	236.4	236.8	0.000	0.000	0.00	0.00	0.00
1.A.4.c.i - Stationary - Liquid Fuels	CO2	32.665	45.208	15	6.1	16.2	0.000	0.000	0.00	0.00	0.00
1.A.4.c.i - Stationary - Liquid Fuels	CH4	0.125	0.174	15	200.0	200.6	0.000	0.000	0.00	0.00	0.00

A	B	C	D	E	F	G		H	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Base Year 2000	Contribution to Variance by Category in Year T (2022)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A.4.c.i - Stationary - Liquid Fuels	N2O	0.071	0.099	15	236.4	236.8	0.000	0.000	0.00	0.00	0.00
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CO2	27.976	30.348	100	3.9	100.1	0.000	0.000	0.00	0.01	0.00
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	CH4	0.044	0.048	100	150.2	180.5	0.000	0.000	0.00	0.00	0.00
1.A.4.c.ii - Off-road Vehicles and Other Machinery - Liquid Fuels	N2O	2.861	3.104	100	200.0	223.6	0.000	0.000	0.00	0.00	0.00
1.B - Fugitive Emissions from Fuels						0.0	0.000	0.000	0.00	0.00	0.00
1.B.1.a.ii.1 - Mining	CO2	0.293	2.956	10	200.0	200.2	0.000	0.000	0.00	0.00	0.00
1.B.1.a.ii.1 - Mining	CH4	8.158	82.205	10	150.0	150.3	0.000	0.000	0.03	0.00	0.00
1.B.1.a.ii.2 - Post-mining seam gas emissions	CO2	0.000	0.000	10	200.0	200.2	0.000	0.000	0.00	0.00	0.00
1.B.1.a.ii.2 - Post-mining seam gas emissions	CH4	0.680	6.850	10	150.0	150.3	0.000	0.000	0.00	0.00	0.00
1.B.1.c.i - Charcoal and Biochar production	CO2	0.000	0.000	60	60.0	84.9	0.000	0.000	0.00	0.00	0.00
1.B.1.c.i - Charcoal and Biochar production	CH4	1,381.413	5,548.289	60	121.0	135.1	0.254	1.811	1.13	1.27	2.90
1.B.1.c.i - Charcoal and Biochar production	N2O	25.954	104.239	60	163.0	173.7	0.000	0.001	0.03	0.02	0.00
1.B.2.a.i - Venting	CO2	27.816	17.767	3	75.0	75.1	0.000	0.000	0.00	0.00	0.00
1.B.2.a.i - Venting	CH4	8,578.294	5,498.620	3	75.0	75.1	3.023	0.549	1.50	0.06	2.25
1.B.2.a.ii - Flaring	CO2	898.098	574.221	3	75.0	75.1	0.033	0.006	0.16	0.01	0.02
1.B.2.a.ii - Flaring	CH4	452.447	289.283	3	75.0	75.1	0.008	0.002	0.08	0.00	0.01
1.B.2.a.ii - Flaring	N2O	2.727	1.744	3	1000.0	000.0	0.000	0.000	0.01	0.00	0.00
1.B.2.a.iii.2 - Production and Upgrading	CH4	1,470.476	940.185	5	30.0	30.4	0.015	0.003	0.10	0.02	0.01
1.B.2.a.iii.3 - Transport	CO2	0.064	0.041	3	100.0	100.0	0.000	0.000	0.00	0.00	0.00
1.B.2.a.iii.3 - Transport	CH4	19.786	12.651	3	100.0	100.0	0.000	0.000	0.00	0.00	0.00
1.B.2.a.iii.4 - Refining	CO2	33.748	1.698	3	130.0	130.0	0.000	0.000	0.02	0.00	0.00
1.B.2.a.iii.4 - Refining	CH4	4.846	0.244	3	130.0	130.0	0.000	0.000	0.00	0.00	0.00
1.B.2.a.iii.4 - Refining	N2O	0.134	0.007	3	100.0	100.0	0.000	0.000	0.00	0.00	0.00
1.B.2.b.i - Venting	CO2	14.556	28.964	3	250.0	250.0	0.000	0.000	0.00	0.00	0.00
1.B.2.b.i - Venting	CH4	5,141.125	10,561.593	3	250.0	250.0	12.049	22.483	1.91	0.12	3.66
1.B.2.b.ii - Flaring	CO2	129.366	217.745	3	75.0	75.1	0.001	0.001	0.00	0.00	0.00
1.B.2.b.ii - Flaring	N2O	0.648	1.044	3	1000.0	000.0	0.000	0.000	0.00	0.00	0.00
1.B.2.b.iii.2 - Production	CO2	1.366	2.057	5	20.0	20.6	0.000	0.000	0.00	0.00	0.00
1.B.2.b.iii.2 - Production	CH4	708.155	1,127.164	5	20.0	20.6	0.002	0.002	0.00	0.02	0.00
1.B.2.b.iii.2 - Production	N2O	0.000	0.000	5	1000.0	000.0	0.000	0.000	0.00	0.00	0.00
1.B.2.b.iii.3 - Processing	CH4	51.964	169.258	5	10.0	11.2	0.000	0.000	0.00	0.00	0.00
1.B.2.b.iii.4 - Transmission and Storage	CO2	0.767	3.183	3	30.0	30.1	0.000	0.000	0.00	0.00	0.00
1.B.2.b.iii.4 - Transmission and Storage	CH4	649.067	2,576.768	3	30.0	30.1	0.003	0.019	0.13	0.03	0.02
1.B.2.b.iii.5 - Distribution	CO2	0.892	3.658	3	120.0	120.0	0.000	0.000	0.00	0.00	0.00
1.B.2.b.iii.5 - Distribution	CH4	810.320	3,323.135	3	120.0	120.0	0.069	0.513	0.68	0.04	0.47
2.A - Mineral Industry						0.0	0.000	0.000	0.00	0.00	0.00
2.A.1 - Cement production	CO2	844.818	10,924.200	35	30.0	46.1	0.011	0.818	0.78	1.46	2.74
2.A.4.a - Ceramics	CO2	0.000	7.070	5	2.5	5.6	0.000	0.000	0.00	0.00	0.00
2.B - Chemical Industry						0.0	0.000	0.000	0.00	0.00	0.00
2.B.1 - Ammonia Production	CO2	1.466	716.452	2	7.0	7.3	0.000	0.000	0.01	0.01	0.00

A	B	C	D	E	F	G		H	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Base Year 2000	Contribution to Variance by Category in Year T (2022)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
2.C - Metal Industry						0.0	0.000	0.000	0.00	0.00	0.00
2.C.1 - Iron and Steel Production	CO2	304.136	396.000	10	10.0	14.1	0.000	0.000	0.00	0.02	0.00
3.A - Livestock						0.0	0.000	0.000	0.00	0.00	0.00
3.A.1.a.i - Dairy Cows	CH4	0.000	0.000	0	0.0	0.0	0.000	0.000	0.00	0.00	0.00
3.A.1.a.ii - Other Cattle	CH4	13,122.684	18,180.167	20	40.0	44.7	2.512	2.131	0.17	1.39	1.96
3.A.1.c - Sheep	CH4	3,640.000	6,877.437	20	40.0	44.7	0.193	0.305	0.15	0.53	0.30
3.A.1.d - Goats	CH4	5,950.000	12,361.109	20	40.0	44.7	0.516	0.985	0.37	0.94	1.03
3.A.1.e - Camels	CH4	103.040	364.185	20	40.0	44.7	0.000	0.001	0.02	0.03	0.00
3.A.1.f - Horses	CH4	102.816	51.674	20	40.0	44.7	0.000	0.000	0.01	0.00	0.00
3.A.1.g - Mules and Asses	CH4	280.000	274.357	20	40.0	44.7	0.001	0.000	0.02	0.02	0.00
3.A.1.h - Swine	CH4	141.333	260.388	20	40.0	44.7	0.000	0.000	0.01	0.02	0.00
3.A.1.i - Poultry	CH4	0.000	0.000	0	0.0	0.0	0.000	0.000	0.00	0.00	0.00
3.A.1.j - Other (please specify)	CH4	0.000	0.000	0	0.0	0.0	0.000	0.000	0.00	0.00	0.00
3.A.2.a.i - Dairy cows	CH4	0.000	0.000	0	0.0	0.0	0.000	0.000	0.00	0.00	0.00
3.A.2.a.i - Dairy cows	N2O	0.000	0.000	0	0.0	0.0	0.000	0.000	0.00	0.00	0.00
3.A.2.a.ii - Other cattle	CH4	423.312	586.457	20	30.0	36.1	0.002	0.001	0.00	0.04	0.00
3.A.2.a.ii - Other cattle	N2O	125.226	173.487	20	100.0	102.0	0.001	0.001	0.00	0.01	0.00
3.A.2.c - Sheep	CH4	145.600	275.097	20	30.0	36.1	0.000	0.000	0.00	0.02	0.00
3.A.2.c - Sheep	N2O	194.197	366.916	20	100.0	102.0	0.003	0.005	0.02	0.03	0.00
3.A.2.d - Goats	CH4	261.800	543.889	20	30.0	36.1	0.001	0.001	0.01	0.04	0.00
3.A.2.d - Goats	N2O	398.250	827.363	20	100.0	102.0	0.012	0.023	0.06	0.06	0.01
3.A.2.e - Camels	CH4	5.734	20.268	20	30.0	36.1	0.000	0.000	0.00	0.00	0.00
3.A.2.e - Camels	N2O	0.607	2.145	20	100.0	102.0	0.000	0.000	0.00	0.00	0.00
3.A.2.f - Horses	CH4	12.509	6.287	20	30.0	36.1	0.000	0.000	0.00	0.00	0.00
3.A.2.f - Horses	N2O	11.881	5.971	20	100.0	102.0	0.000	0.000	0.00	0.00	0.00
3.A.2.g - Mules and Asses	CH4	33.600	32.923	20	30.0	36.1	0.000	0.000	0.00	0.00	0.00
3.A.2.g - Mules and Asses	N2O	13.634	13.359	20	100.0	102.0	0.000	0.000	0.00	0.00	0.00
3.A.2.h - Swine	CH4	141.333	260.388	20	30.0	36.1	0.000	0.000	0.00	0.02	0.00
3.A.2.h - Swine	N2O	63.072	116.201	20	100.0	102.0	0.000	0.000	0.01	0.01	0.00
3.A.2.i - Poultry	CH4	91.284	144.770	20	30.0	36.1	0.000	0.000	0.00	0.01	0.00
3.A.2.i - Poultry	N2O	33.783	53.238	20	100.0	102.0	0.000	0.000	0.00	0.00	0.00
3.A.2.j - Other (please specify)	CH4	0.000	0.000	0	0.0	0.0	0.000	0.000	0.00	0.00	0.00
3.A.2.j - Other (please specify)	N2O	0.000	0.000	0	0.0	0.0	0.000	0.000	0.00	0.00	0.00
3.B - Land						0.0			0.00	0.00	0.00
3.B.1.a - Forest land Remaining Forest land	CO2	214,487.945	349,773.770	17.32	52.0	54.8	2	0.000 1183.436	3.80	23.14	549.72
3.B.2.a - Cropland Remaining Cropland	CO2	0.000	-111,178.860	50	30.0	58.3	0.000	135.510	9.01	21.23	531.83
3.B.5.a - Settlements Remaining Settlements	CO2	0.000	-8,876.494	50	30.0	58.3	0.000	0.864	0.72	1.69	3.39
3.C - Aggregate sources and non-CO2 emissions sources on land						0.0	0.000	0.000	0.00	0.00	0.00
3.C.1.b - Burning in Cropland	CH4	0.943	3.349	20	50.0	53.9	0.000	0.000	0.00	0.00	0.00
3.C.1.b - Burning in Cropland	N2O	0.232	0.822	20	140.0	141.4	0.000	0.000	0.00	0.00	0.00
3.C.3 - Urea application	CO2	184.950	590.779	50	20.0	53.9	0.001	0.003	0.02	0.11	0.01
3.C.4 - Direct N2O Emissions from managed soils	N2O	9,748.709	17,173.789	64.03	400.5	405.6	14.009	156.440	2.72	4.20	25.02
3.C.5 - Indirect N2O Emissions from managed soils	N2O	3,044.420	5,630.625	34.64	692.8	693.7	32.525	49.191	1.97	0.74	4.43
3.C.6 - Indirect N2O Emissions from manure management	N2O	453.299	765.904	34.64	692.8	693.7	0.721	0.910	0.16	0.10	0.04

A	B	C	D	E	F	G		H	K	L	M
IPCC Categories 2006	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Base Year 2000	Contribution to Variance by Category in Year T (2022)	Uncertainty in trend in national emissions introduced by emission factor uncertainty (%)	Uncertainty in trend in national emissions introduced by activity data uncertainty (%)	Uncertainty introduced into the trend in total national emissions (%)
3.C.7 - Rice cultivation	CH4	5,752.014	12,017.237	20	48.0	52.0	0.652	1.259	0.44	0.92	1.03
3.D - Other						0.0	0.000	0.000	0.00	0.00	0.00
3.D.1 - Harvested Wood Products	CO2	-5,813.445	-4,119.507	50	50.0	70.7	1.232	0.274	0.62	0.79	1.01
4.A - Solid Waste Disposal						0.0	0.000	0.000	0.00	0.00	0.00
4.A.2 - Unmanaged Waste Disposal Sites	CH4	3,767.611	11,127.995	100	30.0	104.4	1.128	4.352	0.44	4.25	18.26
4.C - Incineration and Open Burning of Waste						0.0	0.000	0.000	0.00	0.00	0.00
4.C.2 - Open Burning of Waste	CO2	124.221	209.685	100	40.0	107.7	0.001	0.002	0.00	0.08	0.01
4.C.2 - Open Burning of Waste	CH4	1,457.081	2,459.543	100	100.0	141.4	0.310	0.390	0.07	0.94	0.89
4.C.2 - Open Burning of Waste	N2O	181.395	306.193	100	100.0	141.4	0.005	0.006	0.01	0.12	0.01
4.D - Wastewater Treatment and Discharge						0.0	0.000	0.000	0.00	0.00	0.00
4.D.1 - Domestic Wastewater Treatment and Discharge	CH4	13,457.438	23,741.445	50	50.0	70.7	6.603	9.087	0.47	4.53	20.78
4.D.2 - Industrial Wastewater Treatment and Discharge	CH4	113.661	205.029	100	30.0	104.4	0.001	0.001	0.00	0.08	0.01
Total		**370,306**	**556,898**								
						SUM	**1348.8**	**1785.7**		**SUM**	**1258.74**
						Uncertainty - Level	**36.7**	**42.3**		**Uncertainty - Trend**	**35.5**

Annex III. Detailed description of the reference approach

This annex covers the methodology used for the reference approach and shows a comparison of the energy consumption and CO_2 emission from the reference approach (RA) with those of the sectoral approach (SA).

Methodology used for the Reference Approach

The reference approach follows the 2006 IPCC Guideline's designated method. That is, a top-down approach as opposed to the bottom-up approach used for making estimates of emission at the sectoral level. The RA is based on the country's energy statistics for production, imports, exports, international bunkers and stock change to estimate the "apparent consumption" of the different fuels by the country. The IPCC energy conversion factors as well as the carbon content of fuels from the 2006 IPCC guidelines (Table AIII.1) combined with an oxidation factor assumed to be 1 for all fuels were then used to calculate the CO2 emissions.

Table A III.1. Conversion factors and carbon contents adopted for calculating emissions under the Reference Approach

Fuel	Conversion factor (TJ/Gg)	n content (t C/TJ)
Crude oil	42.3	20.0
Gas/Diesel oils	43.0	20.2
Jet Kerosene	44.1	19.5
Liquefied Petroleum Gas	47.3	17.2
Motor Gasoline	44.3	18.9
Other Kerosene	43.8	19.6
Natural gas (Dry)	48.0	15.3
Residual Fuel Oil	40.4	21.1
Other Petroleum Products	40.2	20.0
Petroleum coke	32.5	26.6
Bitumen	40.2	22.0
Naphta	44.5	20.0
Refinery gas	49.5	15.7
Other Bituminous Coal	25.8	25.8
Wood/wood waste	15.6	30.5
Charcoal	29.5	30.5
Other primary solid biomass	11.6	27.3

As well-developed national energy balances are not yet produced on an annual basis by Nigeria which may be due to lack of regular data collection, inadequate capacity and lack of resources, data on the energy statistics have been sourced from the UN statistics data portal, Nigeria Oil and Gas Industry Reports (2018), Nigerian Upstream Petroleum Regulatory Commission (NUPRC) annual report of 2023, Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) for petroleum imports data, NNPC Annual Statistical bulletin for years 2000 to 2017. These data were used to construct a yearly energy balance for all years of the time series. The annual data from these sources were then compared before adoption with the activity data of the previous NIR. In case of inconsistencies in data series, data gaps and outliers have been adjusted using the splicing techniques recommended by IPCC, namely extrapolation and interpolation as appropriate.

It should be noted that the time series 2000 to 2022 for most of the categories have been recalculated using the latest data sets from the UN database and from the different annual reports on petroleum products from the Nigerian authorities.

The previous consumption data for the RA together with the recalculated consumption data and the consumption data for the SA are given in Table A III.2. Positive as well as negative differences have been noted between the RA and SA approaches both for fuel consumption and CO2 emissions during the time series 2000 to 2022.

Emissions increased over time though under both approaches. The % difference varied between -40.9% and 37.7% over the time series 2000 to 2022.

Comparison of Reference Approach with Sectoral Approach

The comparison of fuels consumed and emissions estimates, shown in Table A III.2, from the RA and the SA, serves as a check of energy available versus that consumed by all sectors. A comparison of RA and SA results for all years from 2000 to 2022 constitutes an integral part of the reporting process to the UNFCCC as per the MPGs contained in the Annex to Decision 18/CMA.1.

Table A III.2 Comparison of fuel consumed (TJ) and emissions (kt CO2) under the Reference and Sectoral Approaches

Year	Reference Approach			Sectoral Approach		Comparison (RA & SA) (% difference)	
	Previous fuel fuel consumption (TJ)	Recalculated consumption (TJ)	Emissions (kt CO2)	Recalculated fuel consumption (TJ)	Emissions (kt CO2)	Consumption	Emissions
2000	447,363	428,425	28,357	735,446	48,011	-41.7%	-40.9%
2001	728,185	629,604	42,596	796,635	52,564	-21.0%	-19.0%
2002	784,672	670,284	44,415	878,079	57,978	-23.7%	-23.4%
2003	793,025	714,335	47,574	955,610	62,429	-25.2%	-23.8%
2004	897,916	799,444	51,599	948,198	61,960	-15.7%	-16.7%
2005	1,154,558	1,063,239	66,853	965,885	63,089	10.1%	6.0%
2006	1,153,486	1,103,732	67,668	920,622	59,510	19.9%	13.7%
2007	1,237,693	1,198,606	72,762	903,555	57,916	32.7%	25.6%
2008	1,430,435	1,381,193	85,516	991,138	64,920	39.4%	31.7%
2009	1,250,427	861,669	52,512	842,861	55,324	2.2%	-5.1%
2010	1,280,167	1,429,161	85,602	1,004,651	66,036	42.3%	29.6%
2011	1,336,112	1,383,006	83,524	1,186,605	76,755	16.6%	8.8%
2012	1,380,940	1,401,278	84,413	1,262,800	82,313	11.0%	2.6%
2013	1,676,893	1,673,769	107,059	1,543,447	102,412	8.4%	4.5%
2014	1,928,049	2,000,974	126,489	1,707,320	112,915	17.2%	12.0%
2015	2,072,321	2,146,664	133,170	1,623,312	106,829	32.2%	24.7%
2016	1,949,940	1,324,536	88,367	1,703,299	112,346	-22.2%	-21.3%
2017	2,101,955	1,364,999	91,097	1,654,295	109,349	-17.5%	-16.7%
2018	NA	2,013,232	132,997	1,715,836	113,573	17.3%	17.1%
2019	NA	1,956,908	128,119	1,784,723	118,311	9.6%	8.3%
2020	NA	2,213,833	147,754	1,637,290	107,307	35.2%	37.7%
2021	NA	2,394,059	160,147	1,776,907	117,188	34.7%	36.7%
2022	NA	1,827,868	118,462	1,868,463	122,988	-2.2%	-3.7%

The trends of fuel consumed under the Reference and Sectoral Approaches are presented in Figure A III.1 . Generally, fuel consumed increased annually from about 428,425 TJ to 1,827, 868 TJ under the RA as opposed to 735,446 to 1,868,463 TJ under the SA.

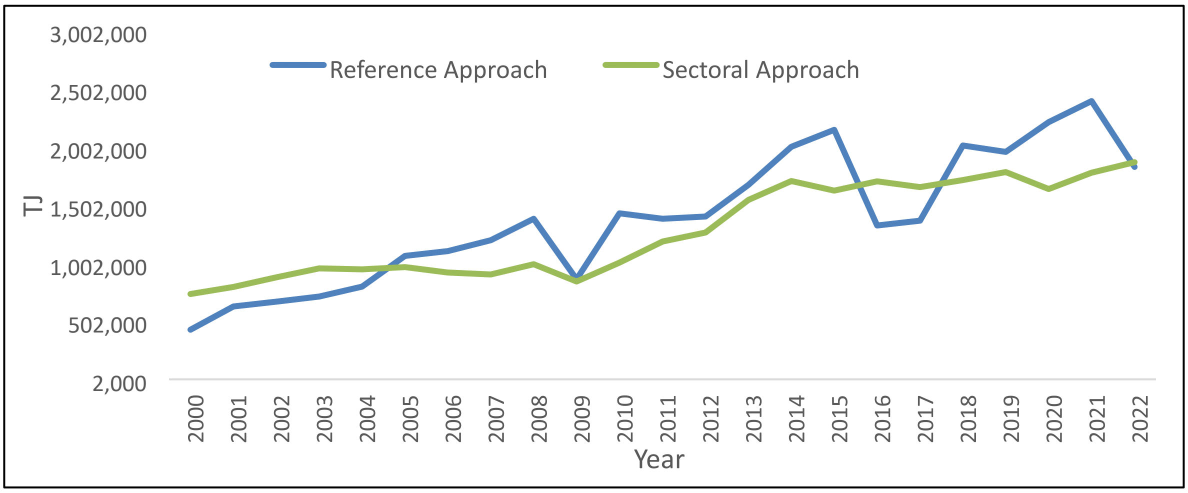

Figure A III.1 Trend in fuel consumption (TJ) for Reference and Sectoral Approach (2000-2022)

The trends of emissions under the Reference and Sectoral approaches are presented in Figure A III.2 . The RA recorded an increase of about 90,100 kt CO2 from 28,357 in 2000 to 118,462 in 2022 compared to about 75,000 kt CO2, from 48,011in 2000 to 122,988 in 2022 for the SA.

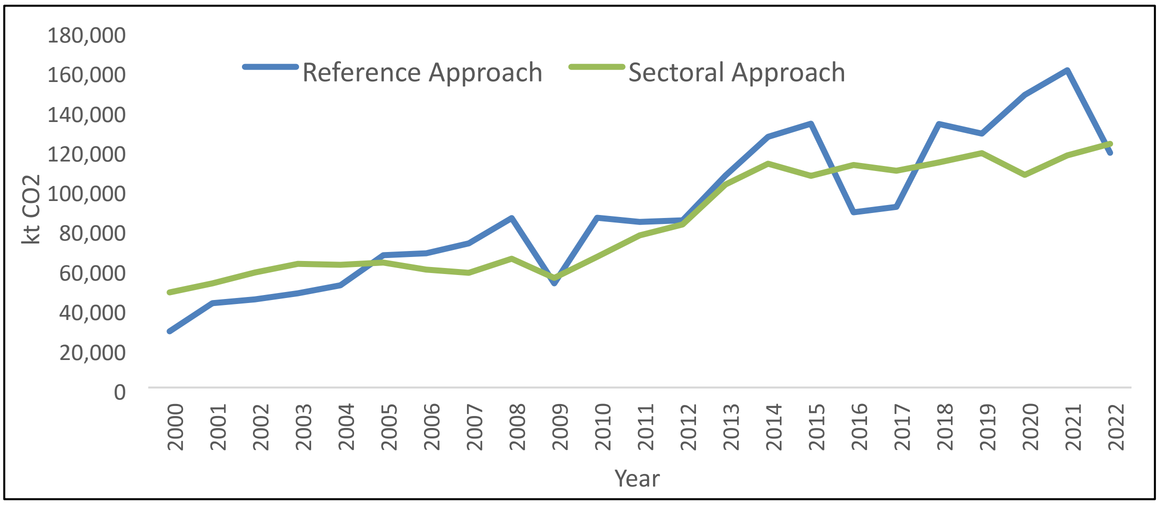

Figure A III.2 Trend in CO2 emissions (kt CO2) from the Reference and Sectoral Approach (2000-2022)

The AD for the RA used in the calculation of the CO2 emissions for the time series 2000 to 2022 are provided in Tables Table A III.3.

Table A III.3 AD used estimating emissions for the Reference Approach for years (2000-2022)

2000									

Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0		0	0
Crude Oil	110,945		96,295		9,758	4,892		4,892	206,932
Gas/Diesel Oil		2,277	0	118	1,231	929		929	39,926
Jet Kerosene		208	0	136	60	13		13	587
Liquefied Petroleum Gases		9	0		-34	43		43	2,010
Motor Gasoline		5,737	0		4,346	1,391		1,391	61,617
Naphtha						0	357	-357	-15,873
Other Kerosene		1,208	0		1,264	-55		-55	-2,422
Other Petroleum Products		125				125		125	5,029
Refinery Gas						0	58	-58	-2,870
Residual Fuel Oil		0	1,146	67	-202	-1,010		-1,010	-40,820
Other Bituminous Coal	302					302		302	7,792
Natural Gas (Dry) - TJ	424,581		258,063		-30,821	197,339	30,821	166,518	166,518
Charcoal	1,224					1,224		1,224	36,108
Other Primary Solid Bio	136,211					136,211		136,211	1,580,048
Wood/Wood Waste	78,587					78,587		78,587	1,225,957
Total fossil fuels									428,425

2001									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen	0					0		0	0
Crude Oil	116,433		105,157		288	10,988		10,988	464,792
Gas/Diesel Oil		544	42	2	790	-290		-290	-12,487
Jet Kerosene		225	0		-29	255		255	11,223
Liquefied Petroleum Gases			6		26	-31		-31	-1,471
Motor Gasoline		5,661	0		3,386	2,275		2,275	100,760
Naphtha						0	357	-357	-15,873
Other Kerosene		522	0		487	35		35	1,542

Other Petroleum Products		109				109		109	4,370
Refinery Gas						0	58	-58	-2,870
Residual Fuel Oil		1	2,127	13	320	-2,460		-2,460	-99,364
Other Bituminous Coal	290					290		290	7,482
Natural Gas (Dry) - TJ	578,920		298,322		56,049	224,549	53,049	171,500	171,500
Charcoal	1,366					1,366		1,366	40,297
Other Primarym Solid Bio	139,773					139,773		139,773	1,621,367
Wood/Wood Waste	80,783					80,783		80,783	1,260,215
Total fossil fuels									629,604

2002

Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen	0					0		0	0
Crude Oil	97,846		89,416		-2,298	10,728		10,728	453,794
Gas/Diesel Oil		575	14		642	-82		-82	-3,526
Jet Kerosene		244	0		-34	278		278	12,238
Liquefied Petroleum Gases		94	17		125	-48		-48	-2,251
Motor Gasoline		6,079	15		2,863	3,200		3,200	141,773
Naphtha						0	413	-413	-18,362
Other Kerosene		476	15		1,832	-1,371		-1,371	-60,028
Other Petroleum Products		59				59		59	2,352
Refinery Gas						0	111	-111	-5,514
Residual Fuel Oil		1	2,127		215	-2,341		-2,341	-94,572
Other Bituminous Coal	254					254		254	6,553
Natural Gas (Dry) - TJ	649,517		295,707		57,991	295,819	57,991	237,828	237,828
Charcoal	1,525					1,525		1,525	44,988
Other Primarym Solid Bio	143,573					143,573		143,573	1,665,447
Wood/Wood Waste	82,931					82,931		82,931	1,293,724

Total fossil fuels									670,284

2003									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU(kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	3	-3	-101
Crude Oil	113,785		106,629		1,115	6,041		6,041	255,534
Gas/Diesel Oil		1,731	20	0	951	760		760	32,697
Jet Kerosene		263	0	292	-58	29		29	1,270
Liquefied Petroleum Gases		0	3		-24	22		22	1,036
Motor Gasoline		7,717	10		3,709	3,999		3,999	177,160
Naphtha						0	403	-403	-17,951
Other Kerosene		721	2		540	178		178	7,814
Other Petroleum Produ	249					249		249	10,002
Refinery Gas						0	28	-28	-1,378
Residual Fuel Oil		2	118	0	17	-133		-133	-5,373
Other Bituminous Coal	278					278		278	7,172
Natural Gas (Dry) - TJ	810,806		472,425		45,964	292,417	45,964	246,453	246,453
Charcoal	1,705					1,705		1,705	50,298
Other Primary Solidm Bio	147,469					147,469		147,469	1,710,640
Wood/Wood Waste	85,531					85,531		85,531	1,334,284
Total fossil fuels									714,336

2004									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0		0	0
Crude Oil	122,689		118,365		-802	5,126		5,126	216,830
Gas/Diesel Oil		2,414	0		1,947	467		467	20,077
Jet Kerosene		496	0	250	424	-178		-178	-7,832
Liquefied Petroleum Gases		170	0		114	56		56	2,663
Motor Gasoline		8,316	10		2,767	5,540		5,540	245,400
Naphtha						0		0	0
Other Kerosene		515	2		9	503		503	22,045
Other Petroleum Products						0		0	0
Refinery Gas (TJ)						0	15	-15	-15
Residual Fuel Oil		3	879		414	-1,290		-1,290	-52,112

Other Bituminous Coa	278					278		278	7,172
Natural Gas (Dry) - TJ	879,781		418,174		58,195	403,412	58,195	345,217	345,217
Charcoal	1,908					1,908		1,908	56,286
Other Primary Solid Bi	151,498					151,498		151,498	1,757,377
Wood/Wood Waste	87,737					87,737		87,737	1,368,697
Total fossil fuels									799,444

2005									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU(kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	42	-42	-1,688
Crude Oil	123,835		113,792		522	9,521		9,521	402,738
Gas/Diesel Oil		865	30	13	902	-81	19	-100	-4,308
Jet Kerosene		308	0	207	80	21		21	904
Liquefied Petroleum Gases		0	0		-30	30		30	1,419
Motor Gasoline		8,450	0		4,500	3,950		3,950	174,972
Naphtha						0	509	-509	-22,662
Other Kerosene		784	10		919	-145		-145	-6,351
Other Petroleum Products		510				510		510	20,494
Refinery Gas						0	98	-98	-4,838
Residual Fuel Oil		6	2,060	0	426	-2,479		-2,479	-100,168
Other Bituminous Coa	327					327		327	8,437
Natural Gas (Dry) - TJ	900,798		190,943		57,783	652,072	57,783	594,289	594,289
Charcoal	2,135					2,135		2,135	62,983
Other Primary Solid Bi	155,634					155,634		155,634	1,805,354
Wood/Wood Waste	90,507					90,507		90,507	1,411,909
Total fossil fuels									1,063,239

2006									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)

Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0		0	0
Crude Oil	117,168		110,266		1,045	5,857		5,857	247,751
Gas/Diesel Oil		1,052	0	123	682	247	1	246	10,585
Jet Kerosene		333	0	209	102	21		21	917
Liquefied Petroleum Gases		0	0		-50	50		50	2,356
Motor Gasoline		8,768	5		4,167	4,596		4,596	203,603
Naphtha						0	130	-130	-5,773
Other Kerosene		1,302	8		1,421	-127		-127	-5,558
Other Petroleum Products		130				130		130	5,214
Refinery Gas						0	28	-28	-1,365
Residual Fuel Oil		12	1,870	0	151	-2,009		-2,009	-81,176
Other Bituminousa Co	399					399		399	10,294
Natural Gas (Dry) - TJ	1,069,218		245,618		53,358	770,242	53,359	716,884	716,884
Charcoal	2,388					2,388		2,388	70,446
Other Primary Solid B	159,985					159,985		159,985	1,855,826
Wood/Wood Waste	93,455					93,455		93,455	1,457,898
Total fossil fuels									1,103,732

2007									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0		0	0
Crude Oil	108,244		106,738		-1,063	2,569		2,569	108,669
Gas/Diesel Oil		1,280	11		669	599	11	588	25,293
Jet Kerosene		360	0	253	81	25		25	1,103
Liquefied Petroleum Gases			0		-60	60		60	2,838
Motor Gasoline		9,598	0		4,011	5,587		5,587	247,504
Naphtha						0	220	-220	-9,804
Other Kerosene		1,486	5		1,382	99		99	4,327
Other Petroleum Products		220				220		220	8,856
Refinery Gas						0	13	-13	-644
Residual Fuel Oil		23	1,245	0	-377	-845		-845	-34,150

Other Bituminousa Co	568					568		568	14,654
Natural Gas (Dry) - TJ	1,296,312		375,822		45,265	875,225	45,265	829,960	829,960
Charcoal	3,362					3,362		3,362	99,179
Other Primary Solid B	164,457					164,457		164,457	1,907,701
Wood/Wood Waste	97,079					97,079		97,079	1,514,432
Total fossil fuels									1,198,606

2008									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	22	-22	-897
Crude Oil	103,627		97,660		674	5,293		5,293	223,894
Gas/Diesel Oil		1,557	0	109	1,366	82	9	73	3,125
Jet Kerosene		389	0	298	-462	553		553	24,387
Liquefied Petroleum Gases			0		-24	24		24	1,154
Motor Gasoline		8,906	0		3,212	5,693		5,693	252,209
Naphtha						0	408	-408	-18,150
Other Kerosene		1,085	10		955	120		120	5,260
Other Petroleum Products		408				408		408	16,382
Refinery Gas						0	49	-49	-2,426
Residual Fuel Oil		44	759	0	244	-959		-959	-38,740
Other Bituminous C	1,209					1,209		1,209	31,192
Natural Gas (Dry) T -	1,284,775		338,041		31,465	915,269	31,465	883,804	883,804
Charcoal	3,062					3,062		3,062	90,329
Other Primary Solid	168,876					168,876		168,876	1,958,962
Wood/Wood Waste	100,899					100,899		100,899	1,574,024
Total fossil fuels									1,381,193

2009									

Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU(kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen								0	0
Crude Oil	105,191		103,688		-889	2,392		2,392	101,182
Gas/Diesel Oil		1,894	0	7	1,431	456	1	454	19,523
Jet Kerosene		420	0	305	-225	340		340	15,007
Liquefied Petroleum Gases		14	0		-35	49		49	2,332
Lubricants						0		0	0
Motor Gasoline		10,869	0		4,744	6,125		6,125	271,320
Naphtha						0	200	-200	-8,880
Other Kerosene		1,375	0		1,176	198		198	8,677
Other Petroleum Products		200				200		200	8,024
Refinery Gas						0	19	-19	-935
Residual Fuel Oil		84	307	3,344	9	-3,576		-3,576	-144,474
Other Bituminous C	1,209					1,209		1,209	31,192
Natural Gas (Dry)T -	935,999		274,349		51,474	610,176	51,474	558,703	558,703
Waste Oils						0		0	0
Charcoal	2,650					2,650		2,650	78,175
Other Primary Solid	173,597					173,597		173,597	2,013,725
Wood/Wood Waste	105,066					105,066		105,066	1,639,030
Total fossil fuels									861,669

2010

Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	11	-11	-454
Crude Oil	120,787		116,962		-476	4,301		4,301	181,932
Gas/Diesel Oil		2,304	0	17	2,502	-215	55	-270	-11,591
Jet Kerosene		454	0	152	288	15		15	662
Liquefied Petroleum Gases		18	0		-16	34		34	1,618
Motor Gasoline		10,558	0		7,105	3,454		3,454	152,994

Naphtha						0	937	-937	-41,715
Other Kerosene		1,845	0		1,961	-116		-116	-5,081
Other Petroleum Products		937				937		937	37,647
Refinery Gas						0	12	-12	-615
Residual Fuel Oil		171	498	9	340	-676		-676	-27,306
Other Bituminous Co	1,209					1,209		1,209	31,192
Natural Gas (Dry) - T	1,343,687		170,454		31,678	1,141,555	31,678	1,109,877	1,109,877
Charcoal	3,056					3,056		3,056	90,152
Other Primary Solid	178,400					178,400		178,400	2,069,440
Wood/Wood Waste	110,344					110,344		110,344	1,721,366
Total fossil fuels									1,429,161

2011									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU(kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	33	-33	-1,344
Crude Oil	116,936		110,817		807	5,312		5,312	224,698
Gas/Diesel Oil		1,663	0	71	1,796	-204	56	-259	-11,158
Jet Kerosene		479	0	169	294	17		17	732
Liquefied Petroleum Gases		23	0		23	0		0	-19
Motor Gasoline		10,347	0		7,342	3,005		3,005	133,113
Naphtha						0	780	-780	-34,707
Other Kerosene		1,643	0		1,645	-2		-2	-79
Other Petroleum Products		780				780		780	31,352
Refinery Gas						0	18	-18	-879
Residual Fuel Oil		104	687	3	404	-990		-990	-39,992
Other Bituminous Co	1,451					1,451		1,451	37,436
Natural Gas (Dry) - T	1,461,012		319,199		48,980	1,092,833	48,980	1,043,853	1,043,853
Charcoal	3,524					3,524		3,524	103,958
Other Primary Solid	183,397					183,397		183,397	2,127,405
Wood/Wood Waste	115,322					115,322		115,322	1,799,023
Total fossil fuels									1,383,006

2012									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	23	-23	-944
Crude Oil	114,954		111,988		-1,567	4,533		4,533	191,746
Gas/Diesel Oil		1,775	0	125	1,885	-235	47	-282	-12,127
Jet Kerosene		525	0	242	481	-198		-198	-8,727
Liquefied Petroleum Gases		7	0		-133	140		140	6,608
Motor Gasoline		11,855	0		9,554	2,301		2,301	101,925
Naphtha						0	375	-375	-16,681
Other Kerosene		2,502	0		2,563	-61		-61	-2,685
Other Petroleum Products		375				375		375	15,071
Refinery Gas						0		0	0
Residual Fuel Oil		88	332	6	182	-432		-432	-17,441
Other Bituminous C	1,935					1,935		1,935	49,923
Natural Gas (Dry) - T	1,558,462		336,302		63,775	1,158,385	63,775	1,094,610	1,094,610
Charcoal	4,045					4,045		4,045	119,328
Other Primary Solid	188,443					188,443		188,443	2,185,939
Wood/Wood Waste	123,199					123,199		123,199	1,921,904
Total fossil fuels									1,401,278

2013									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	23	-23	-944
Crude Oil	107,906		102,724		433	4,749		4,749	200,883
Gas/Diesel Oil		2,199	0	115	684	1,400	47	1,353	58,191
Jet Kerosene		413	0	315	67	31		31	1,372
Liquefied Petroleum Gases		39	0		-128	167		167	7,880
Motor Gasoline		11,905	0		1,354	10,551		10,551	467,392
Naphtha						0	375	-375	-16,681
Other Kerosene		2,970	0		1,549	1,421		1,421	62,244

Other Petroleum Products		559				559		559	0
Refinery Gas						0		0	0
Residual Fuel Oil		15	721	0	70	-776		-776	-31,334
Other Bituminous C	2,419					2,419		2,419	62,410
Natural Gas (Dry) - T	1,302,252		306,751		66,572	928,929	66,572	862,357	862,357
Charcoal	3,797					3,797		3,797	112,012
Other Primary Solid	193,594					193,594		193,594	2,245,690
Wood/Wood Waste	123,207					123,207		123,207	1,922,029
Total fossil fuels									1,673,769

2014									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	5	-5	-213
Crude Oil	107,643		107,389		-2,895	3,149		3,149	133,203
Gas/Diesel Oil		6,410	0	117	4,156	2,137	1	2,135	91,810
Jet Kerosene		344	0	281	36	28		28	1,222
Liquefied Petroleum Gases		82	0		-99	181		181	8,552
Motor Gasoline		13,473	0		1,549	11,924		11,924	528,233
Naphtha						0	559	-559	-24,866
Other Kerosene		3,145	0		1,304	1,841		1,841	80,653
Other Petroleum Products		248				248		248	9,958
Refinery Gas						0	68	-68	-3,385
Residual Fuel Oil		153	303	260	-212	-197		-197	-7,963
Other Bituminous Coa	2,419					2,419		2,419	62,410
Natural Gas (Dry) - TJ	1,621,915		399,009		50,773	1,172,133	50,773	1,121,360	1,121,360
Charcoal	3,913					3,913		3,913	115,434
Other Primary Solid Bi	198,714					198,714		198,714	2,305,082
Wood/Wood Waste	118,499					118,499		118,499	1,848,584
Total fossil fuels									2,000,974

2015									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU(kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	15	-15	-589
Crude Oil	104,262		105,202		-2,017	1,077		1,077	45,557
Gas/Diesel Oil		3,768	0	116	1,463	2,189	80	2,109	90,689
Jet Kerosene		441	0	315	95	31		31	1,372
Liquefied Petroleum Gases		163	0		-141	304		304	14,398
Motor Gasoline		14,154	0		3,105	11,049		11,049	489,466
Naphtha						0	310	-310	-13,779
Other Kerosene		2,145	0		188	1,958		1,958	85,747
Other Petroleum Products		298				298		298	11,972
Refinery Gas						0		0	0
Residual Fuel Oil		64	84		77	-97		-97	-3,931
Other Bituminous Coa	2,540					2,540		2,540	65,532
Natural Gas (Dry) - TJ	1,897,352		429,416		53,853	1,414,083	53,853	1,360,230	1,360,230
Charcoal	4,018					4,018		4,018	118,531
Other Primary Solid Bi	203,878					203,878		203,878	2,364,985
Wood/Wood Waste	119,311					119,311		119,311	1,861,252
Total fossil fuels									2,146,664

2016									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	7	-7	-285
Crude Oil	90,316		87,005		278	3,033		3,033	128,296
Gas/Diesel Oil		3,828	0	97	1,081	2,651	11	2,640	113,529
Jet Kerosene		539	0	394	106	39		39	1,715
Liquefied Petroleum Gases		48	0		-324	372		372	17,596
Motor Gasoline		14,272	0		2,124	12,148		12,148	538,161

Naphtha						0	475	-475	-21,129
Other Kerosene		589	0		244	345		345	15,124
Other Petroleum Products		475				475		475	19,087
Refinery Gas						0		0	0
Residual Fuel Oil		297	154		471	-328		-328	-13,243
Other Bituminous Coal	2,660					2,660		2,660	68,628
Natural Gas (Dry) - TJ	1,751,126		1,027,589		133,240	590,297	133,240	457,057	457,057
Charcoal	4,020					4,020		4,020	118,590
Other Primary Solidm Bio	209,068					209,068		209,068	2,425,189
Wood/Wood Waste	119,852					119,852		119,852	1,869,691
Total fossil fuels									1,324,536

2017									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	7	-7	-281
Crude Oil	92,977		88,966		38	3,973		3,973	168,058
Gas/Diesel Oil		3,652	0	98	1,022	2,532	11	2,521	108,407
Jet Kerosene		517	0	373	106	38		38	1,671
Liquefied Petroleum Gases			0		-319	319		319	15,089
Motor Gasoline		12,461	0		374	12,087		12,087	535,445
Naphtha						0	475	-475	-21,129
Other Kerosene		265	0		-390	655		655	28,689
Other Petroleum Products		496				496		496	19,939
Refinery Gas						0	61	-61	-3,029
Residual Fuel Oil		30	511	218	-437	-262		-262	-10,589
Other Bituminous Coal	2,298					2,298		2,298	59,288
Natural Gas (Dry) - TJ	1,822,753		1,141,505		108,904	572,344	108,904	463,440	463,440
Charcoal	4,099					4,099		4,099	120,921
Other Primary Solidm Bio	214,435					214,435		214,435	2,487,446
Wood/Wood Waste	120,414					120,414		120,414	1,878,458

Total fossil fuels									1,364,999

2018									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	15	-15	-603
Crude Oil	104,300		94,447		756	9,097		9,097	384,803
Gas/Diesel Oil		3,384	0	103	-264	3,545	38	3,507	150,801
Jet Kerosene		658	0	650	-189	197		197	8,688
Liquefied Petroleum Gases		57	0		-56	113		113	5,345
Motor Gasoline		14,585	0		1,634	12,951		12,951	573,743
Naphtha						0	535	-535	-23,808
Other Kerosene		295	0		-137	432		432	18,900
Other Petroleum Products		492				492		492	19,778
Refinery Gas						0	40	-40	-1,980
Residual Fuel Oil		9	528	228	-845	98		98	3,959
Other Bituminous Co	2,692					2,692		2,692	69,454
Natural Gas (Dry) - T	J2,002,770		1,038,540		59,939	904,291	100,139	804,153	804,153
Charcoal	4,189					4,189		4,189	123,576
Other Primary Solid	B 219,870					219,870		219,870	2,550,492
Wood/Wood Waste	120,997					120,997		120,997	1,887,553
Total fossil fuels									2,013,232

2019									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	15	-15	-603
Crude Oil	106,601		100,558		1,073	4,970		4,970	210,231
Gas/Diesel Oil		4,415	0	106	87	4,222	38	4,184	179,912

Jet Kerosene		706	0	652	-5	59		59	2,602
Liquefied Petroleum Gases			0		-288	288		288	13,622
Motor Gasoline		15,370	0		1,041	14,329		14,329	634,770
Naphtha						0	535	-535	-23,808
Other Kerosene		92	0		-563	655		655	28,693
Other Petroleum Products		0				0		0	0
Refinery Gas						0	40	-40	-1,980
Residual Fuel Oil		32	67	237	-549	277		277	11,191
Other Bituminous Co	2,723					2,723		2,723	70,253
Natural Gas (Dry) - T	2,036,317		1,041,200		61,277	933,840	101,816	832,024	832,024
Charcoal	4,257					4,257		4,257	125,582
Other Primary Solid	225,288					225,288		225,288	2,613,341
Wood/Wood Waste	121,601					121,601		121,601	1,896,976
Total fossil fuels									1,956,909

2020									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	15	-15	-603
Crude Oil	92,939		77,003		1,490	14,446		14,446	611,066
Gas/Diesel Oil		4,661	0	80	1,231	3,350	38	3,312	142,416
Jet Kerosene		340	0	303		37		37	1,632
Liquefied Petroleum Gases		564	0		25	539		539	25,495
Motor Gasoline		15,035	0		2,269	12,766		12,766	565,521
Naphtha						0	535	-535	-23,808
Other Kerosene		36	0		-689	725		725	31,755
Other Petroleum Products		0				0		0	0
Refinery Gas						0	40	-40	-1,980
Residual Fuel Oil		65	61	177	-631	458		458	18,503
Other Bituminous Co	2,351					2,351		2,351	60,656
Natural Gas (Dry) - TJ	1,992,447		1,048,040		61,603	882,804	99,622	783,182	783,182

Charcoal	4,335					4,335		4,335	127,883
Other Primary Solic B	225,288					225,288		225,288	2,613,341
Wood/Wood Waste	122,227					122,227		122,227	1,906,741
Total fossil fuels									2,213,834

2021									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	15	-15	-603
Crude Oil	85,341		64,533		5,150	15,658		15,658	662,333
Gas/Diesel Oil		3,865	0	66	-65	3,864	38	3,826	164,518
Jet Kerosene		499	0	456		43		43	1,896
Liquefied Petroleum Gases		416	0		21	395		395	18,684
Motor Gasoline		16,494	0		2,162	14,332		14,332	634,921
Naphtha						0	535	-535	-23,808
Other Kerosene		20	0		-706	726		726	31,799
Other Petroleum Products						0		0	0
Refinery Gas						0	40	-40	-1,980
Residual Fuel Oil		32	73	147	-616	428		428	17,291
Other Bituminous Co	2,506					2,506		2,506	64,655
Natural Gas (Dry) - TJ	1,854,474		865,640		72,207	916,627	92,274	824,353	824,353
Charcoal	4,351					4,351		4,351	128,355
Other Primary Solic B	236,474					236,474		236,474	2,743,098
Wood/Wood Waste	122,879					122,879		122,879	1,916,912
Total fossil fuels									2,394,060

2022									
Fuel	Production (kt)	Imports (kt)	Exports (kt)	International Bunkers (kt)	Stock change (kt)	Apparent Consumption (kt)	NEU (kt)	Apparent consumption excl. NEU (kt)	Apparent consumption excl. NEU (TJ)
Bitumen						0	15	-15	-603

Crude Oil	70,935		68,292		2,117	526		526	22,250
Gas/Diesel Oil		3,426		89	-622	3,959	38	3,921	168,603
Jet Kerosene		621		586	-65	100		100	4,410
Liquefied Petroleu ı Gases		345			-164	509		509	24,076
Motor Gasoline		17,318			2,187	15,131		15,131	670,303
Naphtha						0	535	-535	-23,808
Other Kerosene					-644	644		644	28,194
Other Petroleumoducts Pr						0		0	0
Refinery Gas						0	40	-40	-1,980
Residual Fuel Oil		43	67	187	-554	343		343	13,857
Other Bituminouso C	3,133					3,133		3,133	80,831
Natural Gas (Dry) - T	1,736,187		743,888		63,756	928,543	86,809	841,734	841,734
Charcoal	4,917					4,917		4,917	145,052
Other Primary Solid	238,239					238,239		238,239	2,763,572
Wood/Wood Waste	130,262					130,262		130,262	2,032,087
Total fossil fuels									1,827,868

Annex IV. QA/QC plan

See following pages for the plan.

FEDERAL REPUBLIC OF NIGERIA

QA/QC and Verification system

March 2024

Preface

Quality Control and Quality Assurance (QA/QC) is one of the critical components which must be implemented during the successive steps of compilation of an inventory cycle and final verification are good practices to support the Accuracy principle. Often, insufficient capacity of national experts of developing countries to successfully complete the QA/QC activities when using the 2006 IPCC Guidelines for compiling GHG inventories. Availing a user-friendly adapted version of the QA/QC procedures in line with the 2006 IPCC Guidelines to national experts, accompanied with appropriate hands-on capacity building is usually very supportive to them and the country.

When considering Article 13 of the Paris Agreement and the Modalities, Procedures and Guidelines provided in Decision 18/CMA.1 of the Conference of the Parties for reporting the GHG inventory, executing appropriate QA/QC and reporting thereon in the National Inventory Report (NIR) is crucial. Nigeria has the obligation to comply to this decision and the development of a QA/QC manual to facilitate implementation of the QA/QC system, including the plan was most urgent and relevant. Climagric Ltd was contracted to develop a QA/QC system and its plan, including checklists and support implementation during the compilation of the GHG inventory of the First Biennial Update Report (BUR1) within the framework of the first Biennial Transparency Report (BTR1) and combined second Biennial Transparency Report and fourth National Communication (BTR2-NC4) project funded by the Global Environment Facility.

Climagric Ltd developed this QA/QC and Verification system for Nigeria, a version adapted to its national circumstances, in close consultation with all concerned stakeholders and trained the GHG inventory working group team members on its use for implementation. The QA/QC and Verification system fully aligns with the 2006 IPCC Guidelines (Vol1_6_Ch 6). It is under test for data collection and compilation of the GHG inventory. It will thereafter be assessment and challenges encountered will be addressed during the preparation of the BTR1-BTR2/NC4.

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Table of Contents

1. Introduction

An important goal of the Intergovernmental Panel for Climate Change (IPCC) inventory guidance is to support Parties to develop national greenhouse gas (GHG) inventories that can be readily assessed in terms of quality. It is good practice to implement quality assurance/quality control (QA/QC) and verification procedures in the development of national GHG inventories to meet this goal. QA/QC procedures also serve to improve the inventory.

This manual is designed to guide and facilitate Nigeria in performing the QA/QC and Verification of its future GHG inventories in a well-structured and smooth manner. A QA/QC and Verification system contributes to the objectives of good practice in inventory development, namely, to improve transparency, consistency, comparability, completeness, and accuracy of national GHG inventories.

1.1. Quality Control

Quality Control refers to a system of routine technical activities to assess and maintain the quality of the inventory by personnel compiling the inventory through the following procedures:

(i) Provides routine and consistent checks to ensure data integrity, correctness, and completeness.

(ii) Identifies and addresses errors and omissions.

(iii) Documents and archives inventory material and records of all QC activities.

QC activities include general methods such as accuracy checks on data acquisition and calculations, and the use of approved standardized procedures for emission and removal calculations, measurements, estimating uncertainties, archiving information and reporting. QC activities also include technical reviews of categories, activity data, emission factors, other estimation parameters, and methods.

1.2. Quality Assurance

Quality Assurance refers to a planned system of review procedures conducted by personnel not directly involved in the compilation of the inventory, preferably by independent experts upon a completed inventory after implementation of QC procedures.

The QA exercise reviews and verifies that:

- Measurable objectives (data quality objectives and QA/QC plan) were met.
- Ensures that the inventory represents the best possible estimates of emissions and removals.
- Support the effectiveness of the QC programme.

1.3. Verification

Verification refers to the collection of activities and procedures conducted during the planning and development steps, or after completion of an inventory that can help to establish its reliability for the intended applications of the inventory. In this manual, verification refers specifically to those methods that are external to the inventory and apply independent data, including comparisons with inventory estimates made by other bodies or through alternative methods. Verification activities may be constituents of both QA and QC, depending on the methods used and the stage at which independent information is used.

2. Practical Considerations of a QA/QC and Verification system

Key factors guiding the compilation of GHG inventories of Non-Annex I countries are:

(i) Compilers have limited resources.

(ii) QC requirements, improved accuracy and lower uncertainty must be balanced against timeliness and cost effectiveness.

2.1. Considerations to fit above situation

- Resources allocated to QA/QC for different categories and the compilation process.
- Time allocated to conduct the checks and reviews of emissions and removal estimates.
- Frequency of QA/QC checks and reviews on different parts of the inventory.
- Level of QA/QC appropriate for each category.
- Availability and access to information on AD, EFs, other parameters such as uncertainties and documentation.
- Collection of additional data specifically required, e.g., alternative data sets for comparisons and checks.
- Procedures to ensure confidentiality of inventory and category information.
- Requirements for documenting and archiving information.
- Whether increased effort on QA/QC will result in improved estimates and reduced uncertainties.
- Whether sufficient independent data and expertise are available to conduct verification activities.

2.2. Drivers for prioritizing categories within the QA/QC and Verification system

- A key category identified quantitatively (KCA) or qualitatively? For example:

  - Considerable uncertainty associated with the estimates.
  - Important changes in the characteristics of the category (technology changes or management practices).
  - Significant changes occurred recently in the estimation methodology for the category.
  - Significant changes in the trend of emissions or removals for this category.
- Use of complex modelling or large inputs from outside databases.
- EFs or other parameters used significantly differ from IPCC defaults or data used in other inventories.
- Long period since EFs or other parameters have been updated for this category.
- Significant amount of time since this category last underwent thorough QA/QC and verification.
- Major change in the way data are processed or managed for this category.
- Overlap with estimates of other categories (use of common AD) that can result in double counting or underestimation.

3. Elements of a QA/QC and Verification system

- Participation of an inventory compiler who is also responsible for coordinating QA/QC and verification activities and definition of roles/responsibilities within the inventory.
- A QA/QC plan.
- General QC procedures that apply to all inventory categories.
- Category-specific QC procedures.
- QA and review procedures.

- Interaction of the QA/QC system with uncertainty analyses.
- Verification activities.
- Reporting, documentation, and archiving procedures.

4. Roles and Responsibilities

The inventory compiler should be responsible for coordinating the institutional and procedural arrangements for inventory activities. It is *good practice* for the inventory compiler to define specific responsibilities and procedures for the planning, preparation, and management of inventory activities, including: Discuss and agree/nominate Officers during workshop for items below

- Inventory coordination (NCCC).
- Data collection (NCCC supported by State Desk Officers and MDAs).
- Selection of methods, emission factors, activity data and other estimation parameters (Working groups led by NCCC in collaboration with State Desk Officers and MDAs).
- Estimation of emissions or removals (Working groups led by NCCC in collaboration with State Desk Officers and MDAs).
- Uncertainty assessment (Inventory compiler (NCCC) supported by Working groups at National level and State Desk Officers for their respective state).
- KCA with and without LULUCF (Inventory compiler (NCCC) supported by Working groups at National level and State Desk Officers for their respective state).
- QA/QC and verification activities (QA/QC Coordinator from NCCC supported by working groups and International expert/GSP for QA).
- Documentation and archiving (NCCC in partnership with NBS).

5. The QA/QC plan

5.1. A fundamental element of the system

The QA/QC plan is a fundamental element of the system and comprises the following characteristics:

- Should outline the activities to be implemented according to the GHGIMS/inventory cycle.
- Should include a scheduled time frame for the activities as earmarked in the inventory cycle.

5.2. Key features

Key features of the QA/QC plan are:

- An internal document to track QA/QC and verification activities.
- The inventory meets the IPCC reporting standards, inclusive of improvements.
- Once developed, it can be documented for use in subsequent inventories after necessary modifications.

An important component of the QA/QC plan is the data quality objectives, against which an inventory is assessed during a review. Data quality objectives may be based upon and refined from the following inventory principles:

- Timeliness
- Completeness
- Consistency

- Comparability
- Accuracy
- Transparency
- Improvement

6. General QC procedures

General QC procedures include generic quality checks related to calculations, data processing, completeness, and documentation that are applicable to all inventory source and sink categories. Table 1, General inventory level QC procedures, lists the general QC checks that the inventory compiler should use routinely throughout the preparation of the inventory. The checks in Table 1 should be applied irrespective of the type of data used to develop the inventory estimates. They are equally applicable to categories where default values or national data are used as the basis for the estimates. The results of these QC activities and procedures should be documented as set out in the Section 11.1, Internal Documentation and Archiving.

Although general QC procedures are designed to be implemented for all categories and on a routine basis, it may not be necessary or possible to check all aspects of inventory input data, parameters and calculations every year. Checks may be performed on selected sets of data and processes. A representative sample of data and calculations from every category may be subjected to general QC procedures each year. In establishing criteria and processes for selecting sample data sets and processes, it is good practice for the inventory compiler to plan to undertake QC checks on all parts of the inventory over an appropriate period of time as determined in the QA/QC plan.

Table 1. General QC procedures

QC Activity	Procedures
Assumptions and criteria for the selection of AD, EFs and other estimation parameters are documented	• Cross-check descriptions of AD, EFs, and other estimation parameters with information on categories and ensure that these are properly recorded and archived
Transcription errors in data input and references	• Confirm that bibliographical data references are properly cited in the internal documentation • Cross-check a sample of input data from each category (either measurements or parameters used in calculations) for transcription errors
Emissions and removals are calculated correctly	• Reproduce a set of emissions and removals calculations (Excel or CRT) • Use a simple approximation method that gives similar results to the original and more complex calculation to ensure that there is no data input error or calculation error
Parameters and units are correctly recorded and appropriate conversion factors are used	• Units are properly labelled in calculation sheets • Units are correctly carried through from beginning to end of calculations

QC Activity	Procedures
	• Conversion factors are correct • Temporal and spatial adjustment factors are used correctly
Integrity of database files	• Examine the included intrinsic documentation to: - confirm that the appropriate data processing steps are correctly represented in the database - confirm that data relationships are correctly represented in the database - ensure that data fields are properly labelled and have the correct design specifications - ensure that adequate documentation of database and model structure and operation are archived
Consistency in data between categories	• Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emission/removal calculations
Movement of inventory data through processing steps is correct	• Emissions and removals data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries • Emissions and removals data are correctly transcribed between different intermediate products
Review of internal documentation and archiving	• There is detailed internal documentation to support the estimates and enable reproduction of the emissions, removals and uncertainty estimates • Inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review • The archive is closed and retained in a secure place following completion of the inventory • The integrity of any data archiving arrangements of outside organisations involved in inventory preparation is ensured

Other considerations

When estimates are prepared by outside consultants or agencies, the inventory compiler should ensure that the QC procedures are performed and recorded.

When the inventory relies upon official national statistics, the QC procedures implemented on these national data are equivalent with those of the 2006 IPCC Guidelines.

Particular attention should be given to categories that rely on external, and shared databases (e.g., livestock, No. of vehicles) to ensure that adequate QC has been conducted by the data provider.

Due to the quantity of data that needs to be checked for some categories, automated checks are encouraged where possible. An automated range check for the input values as recorded in the database (integrated in data portal system) could be implemented.

7. Category specific QC procedures

Category-specific QC complements general inventory QC procedures and encompasses the following:

- Requires knowledge of the specific category, the types of data available and the parameters associated with emissions or removals, and are performed in addition to the general QC checks.
- Applies on a case-by-case basis, focusing on key categories and on categories where significant methodological and data revisions have taken place such as adoption of higher tier methods.
- Includes both emissions (or removals) calculations and activity data.

7.1. QC of Emission Factors

7.1.1. IPCC Defaults

- When using IPCC default emission factors, it is good practice to assess their applicability to national circumstances and their impact on the uncertainty levels.
- Default EFs can be compared with site or plant-level factors to determine their representativeness even if information is available for a small percentage of sites or plants only.

7.1.2. Country-specific EFs

These may be developed at a national or sub-national level based on prevailing technology, science, local characteristics and other criteria, after appropriate checks to evaluate the quality of data used in its development.

QC checks on the background data used to develop EFs

- If EFs are based on site-specific or source-level testing, the inventory compiler should check if the measurement programme included appropriate QC procedures.
- When EFs are based on secondary data sources, such as published studies or other literature, the compiler could attempt to determine whether QC activities conducted during the original preparation of the data are consistent with applicable IPCC procedures and published studies have undergone peer review.
- It is important to investigate any potential conflict-of-interest, when these might influence results, e.g., financial interests.

QC checks on Models

Models are means of extrapolating and/or interpolating a limited set of known data, requiring assumptions and procedural steps to represent the entire process. If QA/QC associated with models is inadequate or not transparent, the inventory compiler should attempt to establish checks on the models and data, in particular,

- Appropriateness of model assumptions, extrapolations, interpolations, calibration-based modifications, data characteristics, and their applicability to the GHG inventory methods and national circumstances.
- Availability of model documentation, including descriptions, assumptions, rationale, and scientific evidence and references supporting the approach and parameters used for modelling.

- Types and results of QA/QC procedures, including model validation steps, performed by model developers and data suppliers.
- Plans to periodically evaluate and update or replace assumptions with appropriate new measurements.

Comparison with IPCC default factors

Inventory compilers should compare country-specific factors with relevant IPCC default emission factors, taking into consideration the characteristics and properties on which the default factors have been developed. The intent of this comparison is to determine whether country-specific factors are reasonable, given similarities or differences between the national source/sink category and the 'average' category represented by the defaults.

Comparison of emission factors between countries

When using between-country emission factor comparisons as a QC check, it is important to investigate similarities and differences in national circumstances for the relevant category. This comparison could be made for each source/sink category and possible aggregations. Comparisons between countries can also be made using aggregate emissions divided by activity data (implied emission factors).

Comparison to plant-level emission factors

An additional step is to compare the country specific factors with site-specific or plant-level factors if these are available. For example, if there are emission factors available for a few plants (but not enough to support a bottom-up approach) these plant-specific factors could be compared with the aggregated factor used in the inventory to provide an indication of the appropriateness of the country-specific factor.

7.1.3. Direct Emission Measurements

Emissions from a category may be estimated using direct measurements in the following ways:

- Sample emissions measurements from a facility to develop a representative emission factor for that individual site, or for the entire category (i.e., for development of a national emission factor).
- Continuous emissions monitoring (CEM) data to compile an annual estimate of emissions for a particular process.

7.2. QC of Activity Data

7.2.1. National Level AD

QC checks of reference source for national activity data

- When using national AD from secondary sources, it is good practice to evaluate and document the associated QA/QC activities since most AD are originally prepared for purposes other than as input to estimates of GHG emissions.
- Determine if the level of QC associated with secondary AD includes, at a minimum, the QC procedures. If the QA/QC is adequate, then the inventory compiler can simply reference the data source and document the applicability of the data used.
- Establish QA/QC checks on the secondary data if the associated QC is inadequate or if the data have been collected using standards/definitions that deviate from the IPCC Guidelines.
- If no alternative data sources are available, the inventory compiler should document the inadequacies associated with the secondary data QC as part of its summary report on QA/QC

Comparisons with independently compiled data sets

Where possible, a comparison of the national AD with independently compiled AD (other) sources should be undertaken.

Examples

- Many of the agricultural source-categories rely on government statistics for AD such as livestock populations and production by crop type. Comparisons can be made to similar statistics prepared by the FAO.
- Similarly, the IEA maintains a database on national energy production and usage that can be used for checks in the energy sector.
- Industry trade associations, university research, and scientific literature are also possible sources of independently derived AD to use in comparison checks.
- AD may also be derived from balancing approaches.

Ascertain whether alternative AD sets are really based on independent data. International information is often based on national reporting which is not independent from the data used in the inventory.

Comparisons with samples

The availability of partial data sets at sub-national levels may provide opportunities to check the reasonableness of national activity data. For example, if national production data are being used to calculate the inventory for an industrial category, it may also be possible to obtain plant-specific production or capacity data for a subset of the total population of plants. Extrapolation of the sample production data to a national level can then be done using a simple approximation method. The effectiveness of this check depends on how representative the sub-sample is of the national population, and how well the extrapolation technique captures the national population.

Trend checks of activity data

National activity data should be compared with previous year's data for the category being evaluated. Activity data for most categories tend to exhibit relatively consistent changes from year to year without sharp increases or decreases. If the national activity data for any year diverge greatly from the historical trend, they should be checked for errors. If a calculation error is not detected, the reason for the sharp change in activity should be confirmed and documented.

7.2.2. Site specific AD

QC checks of measurement protocol

The inventory compiler should establish whether individual sites carried out measurements using recognized national or international standards.

- If the measurements conform to recognized national or international standards and a QA/QC process is in place, then no further QA/QC will be necessary. Acceptable QC procedures in use at the site may be directly referenced.
- If the measurements do not conform to standard methods and QA/QC is not acceptable, then the inventory compiler should carefully evaluate use of these activity data

Comparisons between sites and with national data

Comparisons of activity data from different reference sources and geographic scales can play a role in confirming activity data.

For example, a comparison of production data across different sites, possibly with adjustments made for plant capacities, can indicate the reasonableness of the production data. Any identified outliers should be investigated to determine if the difference can be explained by the unique characteristics of the site or if there is an error in the reported activity data.

Production and consumption balances

Site-specific or activity data checks may be applied to methods based on product usage.

Example: Estimation of SF6 emissions from the use in electrical equipment or ozone depleting substances

- Relies on an account balance of gas purchases, gas sales for recycling, the amount of gas stored on site (outside of equipment), handling losses, refills for maintenance, and the total holding capacity of the equipment system. This account balance system should be used at each facility where the equipment is in place.
- A QC check of overall national activity could be made by performing the same kind of account balancing procedure on a national basis. This national account balancing would consider national sales of SF6 for the use in electrical equipment, the nation-wide increase in the total handling capacity of the equipment that may be obtained from equipment manufacturers, and the quantity of SF6 destroyed in the country.
- The results of the bottom-up and top-down account balancing analyses should agree, or large differences should be explained.

7.2.3. Calculation-related QC

Checks of the calculation algorithm will safeguard against duplication of inputs, unit conversion errors, or similar calculation errors. Independent 'back-of-the-envelope' calculations, based on simplified algorithms, can be used. If the original calculation and the simple approximate method disagree, examine both approaches to find the reason for the discrepancy.

It is a prerequisite that all calculations leading to emission or removal estimates be fully reproducible.

- Discriminate between input data, the conversion algorithm of a calculation and the output
- The input, output and calculation procedure should be recorded in a spreadsheet which is documented and archived

Documentation of calculations

When using spreadsheets:

- Clearly reference the data source of any numbers typed into the spreadsheet.
- Provide subsequent calculations, in the form of formulas, so that auditing tools can be used to track back from a result to the source data, and calculations can be evaluated by analyzing the formulae.
- Clearly mark cells in the spreadsheet containing derived data as 'results' and annotate them as to how and where they are then used.
- Document the spreadsheet itself specifying its name, version, authors, updates, intended use and checking procedures so that it can be used as a data source of the derived results and referenced further on in the inventory process.

When using databases:

- Clearly reference the source data tables using a referencing column that links to the data source.

- Use queries when processing the data, where practical, as these provide the means to track back to the source data tables.
- Where queries are not practical and new tables of data need to be generated, make sure that scripts or macros of the commands used to derive the new data set are recorded and referenced in a referencing column of the dataset.
- Document the database itself specifying its name, version, authors, intended use and checking procedures so that it can be used as a data source.

8. QA Procedures

QA comprises activities outside of the inventory compilation. It includes reviews and audits to assess the quality of the inventory, determine the conformity of the procedures and identify areas where improvements need to be made.

QA procedures may be applied at different levels (internal/external) and are used in addition to the general and category-specific QC procedures. The inventory may be reviewed in full or in parts.

Objective: Conduct an unbiased review of the inventory by independent experts from other agencies or national or international experts or groups not closely connected with the national inventory compilation.

- When independent reviewers from the inventory compiler are not available, persons who are at least not involved in the portion being reviewed can also perform QA.
- Conduct a basic expert peer review of all categories before completing the inventory to identify potential problems and correct these where possible. Key categories should be prioritized as well as those with significant changes in methods or data.

8.1. Expert peer review

Consists of a review of calculations and assumptions by experts in relevant technical fields. The objective of the expert peer review is to ensure that the inventory's results, assumptions, and methods are reasonable as judged by those knowledgeable in the specific field.

There are no standard tools or mechanisms for expert peer review, and its use should be considered on a case-by-case basis.

The results of expert analyses from the UNFCCC processes should also be considered as part of the overall QA improvement process.

All expert peer reviews should be well documented, preferably in a report or checklist format that shows the findings and recommendations for improvement.

8.2. Audits

Audits may be used to evaluate how effectively the inventory complies with the minimum QC specifications outlined in the QC plan.

It is important that the auditor be independent of the inventory compiler as much as possible to be able to provide an objective assessment of the processes and data evaluated.

Audits may be conducted during the preparation of an inventory, following inventory preparation, or on a previous inventory.

They provide an in-depth analysis of the respective procedures taken to develop an inventory, and of the documentation available. It is good practice for the inventory compiler to develop a schedule of audits at strategic points in inventory development.

Audits related to initial data collection, measurement work, transcription, calculation and documentation may be conducted.

Audits can be used to verify that the QC steps have been implemented, that category-specific QC procedures have been implemented according to the QC plan, and that the data quality objectives are met.

9. QA/QC and Uncertainty estimates

The QA/QC process and uncertainty analyses provide valuable feedback to one another.

The uncertainty analysis provides insights into weaknesses in the estimate, the sensitivity of the estimate to different variables, and the greatest contributors to uncertainty, all of which can assist in setting priorities for improving data sources or methodologies.

- It is good practice to apply QC procedures to uncertainty estimation to confirm that calculations are correct, and that data and calculations are well documented.
- The assumptions on which uncertainty estimation has been based should be documented for each category.
- Calculations of category-specific and aggregated uncertainty estimates should be checked, and any error addressed.

For uncertainty estimates involving expert judgement, the qualifications of experts should also be checked and documented, as should the process of eliciting expert judgement, including information on the data considered, literature references, assumptions made, and scenarios considered.

10. Verification

Includes comparisons with emissions or removals estimates prepared by other bodies and from fully independent assessments, e.g., atmospheric concentration measurements.

Provides information for countries to improve their inventories and is part of the overall QA/QC and verification system.

The considerations for selecting verification approaches include scale of interest, costs, desired level of accuracy and precision, complexity of design and implementation of the verification approaches, availability of data, and the required level of expertise needed for implementation

Where verification techniques are used, they should be reflected in the QA/QC plan. The limitations and uncertainties associated with the verification technique itself should be thoroughly investigated prior to its implementation so that the results can be properly interpreted.

10.1. Comparison of National estimates

Applying lower tier methods

Lower tier IPCC methods are typically based on ‘top-down’ approaches that rely on highly aggregated data. When using higher tier bottom-up approaches, comparisons with lower-tier methods can be used as a simple verification tool such as for CO_2 from fossil fuel combustion when the reference approach estimate can be compared to the sum of sectoral-based estimates.

Applying higher tier methods

Higher tier methods are typically based on detailed bottom-up approaches that rely on highly disaggregated data and a well-defined sub-categorization of sources and sinks. It may be difficult to fully implement a higher tier approach because of lack of sufficient data or resources. However, the availability of even partial estimates for a subcategory of sources may provide a valuable verification tool for the inventory.

Comparison with independently compiled estimates

Comparison with other independently compiled inventory data on national level (if available) are a quick option to evaluate completeness, approximate emission (removal) levels and correct category allocations such as national level CO_2 emissions estimates associated with the combustion of fossil fuel compiled by the International Energy Agency (IEA).

Comparisons of intensity indicators between countries

Emission (removal) intensity indicators may be compared between countries (e.g., emissions per capita, industrial emissions per unit of value added, transport emissions per car, emissions from power generation per kWh of electricity produced, emissions from dairy ruminants per ton of milk produced). These indicators provide a preliminary check and verification of the order of magnitude of the emissions or removals.

11. Documentation, Archiving and Reporting

11.1. Internal documentation and archiving

Document and archive all information on the planning, preparation, and management of inventory activities. This includes:

- Responsibilities, institutional arrangements, and procedures for the planning, preparation, and management of the process.
- Assumptions and criteria for the selection of AD and EFs.
- EFs and other estimation parameters used, including all references.
- AD or sufficient information to enable them to be traced to the referenced source.
- Information on the uncertainty associated with AD and EFs.
- Rationale for choice of methods.
- Methods used, including those used to estimate uncertainty and those used for recalculations.
- Changes in data inputs or methods from previous inventories (recalculations).
- Identification of individuals providing expert judgement for uncertainty estimates and their qualifications to do so.
- Details of electronic databases or software used in the production of the inventory, including versions, operating manuals, hardware requirements and any other information required to enable their later use.
- Worksheets and interim calculations for category estimates, aggregated estimates and any recalculations of previous estimates.
- Final inventory report and any analysis of trends.
- QA/QC plans and outcomes of QA/QC procedures.
- Secure archiving of complete datasets, including shared databases used in inventory development.

11.2. Reporting

Report a summary of implemented QA/QC activities and key findings as a supplement to each country's national inventory. It is not practical or necessary to report all the internal documentation that is retained.

In this summary, the inventory compiler should focus on the following activities:

- Reference to a QA/QC plan, its implementation schedule, and the responsibilities for its implementation should be discussed.
- Activities performed internally and external reviews conducted for each source/sink category and on the entire inventory.
- Presentation of the key findings, describing major issues regarding quality of input data, methods, processing, or estimates for each category and how they were addressed or planned to be addressed in the future.
- Explanation of significant trends in the time series, particularly where trend checks point to substantial divergences. Any effect of recalculations or mitigation strategies should be included in this discussion.

12. Annexes

Annex 1. CHECKLISTS

Thre are two types of checklists.

Annex. 1A. GENERAL QC CHECKLIST

(to be completed for each category of each inventory)

Annex 1B. CATEGORY-SPECIFIC QC CHECKLIST

(checks to be designed for each category)

Part A: Data Gathering and Selection

Part B: Secondary Data and Direct Emission Measurement

Annex 1A. General QC Checklist

Summary of general QC checks and corrective action

Inventory Report: ________________________________ Source/Sink Category: ____

Title(s) and Date(s) of Inventory Spreadsheet(s): ____

Source (sink) category estimates prepared by (name/affiliation): ____

Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problem after corrective actions have been taken:

Checklists for general QC checks

Complete tables for each category

DATA GATHERING, INPUT, AND HANDLING ACTIVITIES: QUALITY CHECKS							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
1	A sample of input data for transcription errors						
2	Review of spreadsheets with computerised checks and/or quality check reports						
3	Identification of spreadsheet modifications that could provide additional controls or checks on quality						
4	Other (specify)						

DATA DOCUMENTATION: QUALITY CHECKS							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
1	Project file for completeness						
2	Confirmation that bibliographical data						

DATA DOCUMENTATION: QUALITY CHECKS							
Category:							
No	Item	Check completed			Corrective action		Supporting documents (Provide Reference)
		Date	Individual (Initial and name)	Errors (Y/N)	Date	Individual (Initial and name)	
	references are included (in spreadsheet) for every primary data element						
3	All appropriate citations from the spreadsheets appear in the inventory document						
4	All citations in spreadsheets and inventory are complete (i.e., include all relevant information)						
5	Bibliographical citations for transcription errors						
6	Originals of new citations are in current docket submittal						
7	Originals of citations (including Contact Reports) contain the material & content referenced						
8	Assumptions and criteria for selection of activity data, emission factors and other estimation parameters are documented						

DATA DOCUMENTATION: QUALITY CHECKS							
Category:							
No	Item	Check completed			Corrective action		Supporting documents (Provide Reference)
		Date	Individual (Initial and name)	Errors (Y/N)	Date	Individual (Initial and name)	
9	Changes in data or methodology are documented						
10	Citations in spreadsheets and inventory document conform to acceptable style guidelines						
11	Other (specify						

CALCULATING EMISSIONS AND CHECKING CALCULATIONS							
Category:							
No	Item	Check completed			Corrective action		Supporting documents (Provide Reference)
		Date	Individual (Initial and name)	Errors (Y/N)	Date	Individual (Initial and name)	
1	All calculations are included (instead of presenting results only)						
2	Units, parameters, and conversion factors are appropriately presented						
3	Units are properly labelled and correctly carried through from beginning to end of calculation						

CALCULATING EMISSIONS AND CHECKING CALCULATIONS							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
4	Conversion factors are correct						
5	Temporal and spatial adjustment factors are used correctly						
6	Data relationships (comparability) and data processing steps (e.g., equations) in the spreadsheets						
7	Spreadsheet input data and calculated data are clearly differentiated						
8	A representative sample of calculations, by hand or electronically						
9	Some calculations with abbreviated calculations						
10	Aggregation of data within a category						
11	When methods or data have changed, check consistency of time series inputs and calculations						
12	Current year estimates against previous years (if available) and investigate						

CALCULATING EMISSIONS AND CHECKING CALCULATIONS							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
	unexplained departures from trend						
13	Value of implied emission / removal factors across time series and investigate unexplained outliers						
14	Unexplained or unusual trends for activity data or other calculation parameters in time series						
15	Consistency with IPCC inventory guidelines and good practices, particularly if changes have occurred						
16	Other (specify):						

Annex 1B. CATEGORY-SPECIFIC QC CHECKLIST

Summary of category-specific QC checks and corrective action

Inventory Report: ________________________________ Source/Sink Category: ____

Key category or includes a key subcategory (Y/N): ____

Title(s) and Date(s) of Inventory Spreadsheet(s): ____

Source (sink) category estimates prepared by (name/affiliation): ____

Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problem after corrective actions have been taken:

Checklists for category specific checks

Complete tables for each category

Part A: Data gathering and selection

EMISSION DATA QUALITY CHECKS							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
1	Emission comparisons: historical data for source, significant sub-source categories						
2	Against independent estimates or estimates based on alternative methods						
3	Reference calculations						
4	Completeness						
5	Other (detailed checks)						

EMISSION FACTOR QUALITY CHECK							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
1	Representativeness of emission factors, given national circumstances						

EMISSION FACTOR QUALITY CHECK							
Category:							
No	Item	Check completed			Corrective action		Supporting documents (Provide Reference)
		Date	Individual (Initial and name)	Errors (Y/N)	Date	Individual (Initial and name)	
2	Alternative factors (e.g., IPCC default, cross-country, literature)						
3	Options for more representative data						
4	Other (detailed checks)						

ACTIVITY DATA QUALITY CHECK: NATIONAL LEVEL ACTIVITY DATA							
Category:							
No	Item	Check completed			Corrective action		Supporting documents (Provide Reference)
		Date	Individual (Initial and name)	Errors (Y/N)	Date	Individual (Initial and name)	
1	Historical trends						
2	Compare multiple reference sources						
3	Applicability of data						
4	Methodology for filling gaps in time series for data that are not available annually						
5	Other (detailed checks)						

ACTIVITY DATA QUALITY CHECK: SITE-SPECIFIC ACTIVITY DATA							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
1	Inconsistencies across sites						
2	Compare aggregated and national data						
3	Other (detailed checks)						

Part B: Secondary data and direct emission measurement

ACTIVITY DATA QUALITY CHECK: NATIONAL LEVEL ACTIVITY DATA							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
1	QC activities conducted during the original preparation of the data (either as reported in published literature or as indicated by personal communications) are consistent with and adequate when compared against (as a minimum), general QC activities						
2	The statistical agency has a QA/QC plan that covers the preparation of the data						

ACTIVITY DATA QUALITY CHECK: NATIONAL LEVEL ACTIVITY DATA							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
3	The sampling protocols that were used for surveys and how recently they were reviewed						
4	For site-specific activity data, are any national or international standards applicable to the measurement of the data? If so, have they been employed?						
5	Uncertainties in the data have been estimated and documented						
6	Any limitation of the secondary data has been identified and documented, such as biases or incomplete estimates. Have errors been found?						
7	The secondary data have undergone peer review and, if so, of what nature						
8	Other (detailed checks)						

DIRECT EMISSION MEASUREMENT: CHECKS ON PROCEDURES TO MEASURE EMISSIONS							
Category:							
No	**Item**	**Check completed**			**Corrective action**		**Supporting documents (Provide Reference)**
		Date	**Individual (Initial and name)**	**Errors (Y/N)**	**Date**	**Individual (Initial and name)**	
1	Which variables rely on direct emission measurement						
2	Procedures used to measure emissions, including sampling procedures, equipment calibration and maintenance						
3	Whether standard procedures have been used, where they exist (such as IPCC methods or ISO standards)						
4	Other (detailed checks)						

Annex V. Any additional information, as applicable, including detailed methodological descriptions of source or sink categories and the national emission balance

Not Applicable

Annex VI. Common reporting tables

Link for CRTs:

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