Industrial Processes and Product Use (IPPU) Sector Review Report

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IPPU Sectoral Review Report

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Acronyms And Abbreviations

Acronym	Full Meaning
AD	Activity Data
BAU	Business-as-Usual
BIP	Backward Integration Policy
BUR	Biennial Update Report
BTR	Biennial Transparency Report
BTR1	First Biennial Transparency Report
CBAM	Carbon Border Adjustment Mechanism
CEMS	Continuous Emissions Monitoring Systems
CMAN	Cement Manufacturers Association of Nigeria
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide Equivalent
CRT	Common Reporting Tables
DCC	Department of Climate Change
EF	Emission Factor
EIA	Environmental Impact Assessment
ETF	Enhanced Transparency Framework
EU	European Union
EU-ETS	European Union Emissions Trading System
FEPA	Federal Environmental Protection Agency
FEPSAN	Fertilizer Producers and Suppliers Association of Nigeria
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
FMFBNP	Federal Ministry of Finance, Budget and National Planning
FMITI	Federal Ministry of Industry, Trade and Investment
Gg	Gigagram
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
LT-LEDS	Long-Term Low Emissions Development Strategy
MAN	Manufacturers Association of Nigeria
MDA	Ministry, Department, and Agency
MoU	Memorandum of Understanding
MRV	Measurement, Reporting and Verification
NBS	National Bureau of Statistics
NCCP	National Climate Change Policy
NCCC	National Council on Climate Change
NCS	Nigeria Customs Service
NC	National Communication
NDC	Nationally Determined Contribution
NID	National Inventory Document
NESREA	National Environmental Standards and Regulations Enforcement Agency

NIPC	Nigerian Investment Promotion Commission
N_2O	Nitrous Oxide
QA/QC	Quality Assurance / Quality Control
RAC	Refrigeration and Air Conditioning
SF_6	Sulphur Hexafluoride
SOP	Standard Operating Procedure
SON	Standards Organization of Nigeria
TWG	Technical Working Group
UNFCCC	United Nations Framework Convention on Climate Change
WAEMU	West African Economic and Monetary Union

Executive Summary

Nigeria's Industrial Processes and Product Use (IPPU) Sectoral Review Report provides a comprehensive assessment of the emissions profile, future trajectory, governance context, data systems, and improvement priorities required to strengthen Nigeria's IPPU reporting and MRV readiness under the Enhanced Transparency Framework. It positions IPPU as a sector that is still smaller than Energy and LULUCF in absolute national totals, but one that is structurally important because it is directly linked to industrialization, infrastructure delivery, fertilizer production for food security, and the rapidly expanding demand for cooling. The report explains that IPPU emissions are distinct from fuel-combustion emissions because they arise primarily from physical and chemical transformations during production and from the use of certain products, and it emphasizes that Nigeria's IPPU system must be "MRV-ready" in a practical sense capable of routinely generating credible activity data, applying consistent methodologies, maintaining transparent archives and recalculation records, and supporting both inventory reporting and mitigation tracking over successive reporting cycles.

The report clarifies Nigeria's current IPPU coverage in the national inventory and situates it within IPCC 2006/2019 Refinement structure and the Common Reporting Tables. It notes that Nigeria's quantified emissions are currently concentrated in mineral industry (cement and related carbonate process uses), chemical industry (dominated by ammonia production and with potential relevance of nitric acid where operational), and metal industry (iron and steel), while other categories that clearly occur in the Nigerian economy non-energy use of fuels and solvents (2D), fluorinated gases in product uses (2F), and other product manufacture and use including SF_6 (2G) remain largely unestimated due to activity data constraints, weak administrative datasets, and limited institutionalized reporting pipelines. A key message across the report is that these "not estimated" categories are not marginal in future risk terms: the cooling economy, refrigerant markets, servicing practices, and electricity grid expansion can create a material future IPPU emissions driver and uncertainty burden unless Nigeria establishes fit-for-purpose data systems and protocols.

In its sector overview, the report describes the structure and economic significance of Nigeria's major IPPU subsectors and highlights the dominance of cement manufacturing in both industrial output and emissions contribution. It documents Nigeria's transformation into a regional cement production powerhouse, anchored by backward integration policy reforms and rapid capacity build-out, and provides current installed capacity figures (approximately 62.8 million metric tons per annum) and the market structure dominated by the three major producers Dangote Cement, BUA Cement, and Lafarge Africa (now under Huaxin Cement). The report links the geographic dispersion of plants and export-oriented terminals to domestic infrastructure demand and regional trade dynamics, while also noting the environmental implications of process emissions from clinker production, the significance of supply chains and employment footprints, and the relevance of co-processing and alternative fuels (while distinguishing that combustion-related benefits are accounted under the Energy sector rather than IPPU). In parallel, the report characterizes the chemical industry as an emissions-relevant subsector primarily through ammonia production (with rapid changes associated with major new plant commissioning) and it notes the potential significance of nitric acid emissions because of N_2O's high global warming potential even where

production volumes are relatively smaller. For iron and steel, it explains the sector's importance for industrialization and infrastructure, acknowledges the structural challenges of legacy integrated facilities, and highlights the growing role of private mini-mills and scrap-based production routes, which affect the nature of process and energy emissions and therefore influence both inventory design and future mitigation pathways. For product use, the report explains why refrigeration and air conditioning demand is rising quickly urbanization, heat stress, rising incomes, cold chain needs and it identifies key refrigerants used in the Nigerian market, the informalities in servicing and end-of-life handling, the relevance of Nigeria's Kigali obligations, and the fact that weak enforcement and poor tracking systems can turn high-GWP leakage into a major future emissions driver that remains poorly captured unless reporting systems are strengthened.

A central analytical contribution of the report is its presentation of historical and current emissions trends over 2000–2022, supported by figures and tables that disaggregate emissions by IPPU subcategory and track the changing sectoral shares. It reports rapid growth in total IPPU emissions over the full time series and emphasizes that the mineral industry dominates the emissions profile across years, typically accounting for the large majority share, with chemical industry gaining importance in the last decade in line with expansion in ammonia production capacity and utilization patterns, and metal industry contributing a smaller but non-negligible share with its own dynamics. The report also explains, in practical inventory terms, that observed fluctuations over time can reflect both real economic/production changes and methodological improvements or recalculations required for time-series consistency, underscoring why robust archiving, recalculation documentation, and transparent QA/QC are essential under the ETF. It further draws attention to the implications of the emissions profile for prioritization: because the mineral industry (cement) dominates, improvements in clinker activity data quality, clinker-to-cement ratio tracking, and plant-level reporting can disproportionately improve overall IPPU inventory accuracy; at the same time, because chemical and product-use categories can shift quickly with plant commissioning, market dynamics, and policy interventions, Nigeria needs systems that can detect and explain structural breaks in emissions time series.

Responding to reviewer expectations that the assessment should look forward and not only backward, the report introduces and develops a future dynamics section that uses a scenario-based framing to examine business-as-usual demand-side drivers, supply-side capacity realities, the interaction between demand and supply, and the emissions implications of different development pathways through 2030. It provides a demand-side outlook that links IPPU subsectors to Nigeria-specific drivers and practical proxies: infrastructure delivery and construction demand for cement; fertilizer policy, gas availability, and agro-industrial needs for ammonia; manufacturing growth, import substitution ambitions, energy reliability, and scrap system maturity for steel; and appliance penetration, cold-chain expansion, and servicing market growth for refrigerants. It then assesses whether Nigeria can supply BAU demand across subsectors, identifying where domestic supply is likely to meet demand (e.g., cement under many plausible BAU conditions) and where constraints and import dependence remain more likely (notably in iron and steel, and in refrigerants and equipment supply chains). The demand–supply intercomparison is used to explain what BAU means for both industrial strategy and inventory integrity: where domestic production expands, domestic IPPU emissions rise and inventory systems must capture facility-level activity more precisely; where imports fill gaps, Nigeria's domestic IPPU inventory may under-represent the consumption-based footprint of industrial materials even as domestic economic and policy decisions remain affected by global supply chains, and this becomes increasingly relevant in a world where embedded emissions and product carbon footprints are becoming trade-sensitive. Building on this, the report lays out mitigation pathways that can "bend" BAU without undermining productivity, emphasizing process-relevant interventions such as clinker ratio reduction through blended cement scale-up, best-available technique adoption where it affects process yield and material efficiency, carbon capture and storage options for calcination CO_2 as a deep decarbonization lever, lower-carbon ammonia pathways (blue/green) subject to infrastructure and investment readiness, N_2O abatement for nitric acid where applicable, circular steel and route optimization, Kigali-aligned refrigerant transition and servicing reforms, and SF_6 inventory management and leakage control in the power system. Across these scenarios, the report consistently highlights that mitigation ambition in IPPU is inseparable from MRV capability because these interventions require measurement of the parameters that drive emissions outcomes clinker ratios, production routes, abatement status and performance, refrigerant flows and equipment stocks, and asset-based SF_6 banking and leakage.

The report's governance analysis explains how Nigeria's climate commitments, legal frameworks, and international obligations intersect with IPPU sector reporting needs. It situates IPPU within the broader climate governance architecture created by the Climate Change Act 2021 and the operational mandate of the National Council on Climate Change, and it links inventory improvements to Nigeria's ability to meet BTR requirements and to credibly track mitigation measures under an MRV-oriented approach. The policy and regulatory framework section inventories sector-relevant NESREA regulations that govern air quality and sectoral environmental performance in non-metallic minerals, base metals and recycling, and chemical manufacturing, and it identifies ozone layer protection regulations as foundational for refrigerant governance as Nigeria implements Kigali-related reforms. It also reflects on incentives and barriers, noting that many existing fiscal and investment instruments that influence industrial investment decisions are not explicitly climate-targeted and do not yet function as dedicated IPPU decarbonization mechanisms; at the same time, the report emphasizes that high financing costs, infrastructure deficits, inconsistent enforcement capacity, and lack of integrated reporting systems remain key barriers to both mitigation action and transparent measurement. On international commitments, it explains how the Paris Agreement's ETF creates expectations around transparency, time-series consistency, and reviewability for IPPU estimates, how Kigali creates a direct imperative to improve fluorinated gas management and reporting, and how emerging trade measures such as the EU Carbon Border Adjustment Mechanism increase the strategic value of credible facility-level data and embedded emissions accounting for Nigeria's industrial competitiveness, particularly for products linked to cement, iron and steel, and fertilizer value chains.

Institutionally, the report maps the roles and relationships among core actors and explains that effective IPPU reporting requires both climate governance leadership and sectoral industrial coordination. It presents Nigeria's evolving institutional architecture in which the National Council on Climate Change provides apex coordination and alignment to carbon budgeting and international reporting, while technical roles for inventory compilation and sector engagement are distributed across the Federal Ministry of Environment and relevant sector institutions, with NESREA serving as a key compliance and permitting authority whose facility registries and monitoring functions can be leveraged for inventory verification and facility enumeration. The National Bureau of Statistics is identified as a cornerstone provider of production and industrial statistics that support activity data time series and cross-checks, while the Federal Ministry of Industry, Trade and Investment is positioned as a critical interface for engaging major industrial operators and aligning inventory needs with industrial governance realities. The report extends institutional coverage to include fiscal and investment institutions that shape feasibility of mitigation investments, customs authorities whose administrative records are essential for trade-sensitive categories and for product-use emissions (especially refrigerants), and electricity system actors whose asset inventories are central for any future quantification of SF_6 emissions. A key institutional message is that IPPU is unusually well-suited to facility-level reporting because emissions are concentrated in a limited number of identifiable installations; therefore, moving toward facility-based annual reporting supported by clear regulations, standard protocols, confidentiality safeguards, and verification pathways can transform inventory quality more rapidly than in diffuse sectors. The report also emphasizes that coordination mechanisms such as technical working groups and steering arrangements have improved, particularly in the run-up to BTR1, but that coordination remains vulnerable to ad hoc processes, manual data exchange, unclear mandates, and capacity and resourcing constraints, which collectively limit sustainability across reporting cycles.

On data collection and management, the report provides a grounded description of Nigeria's current activity data ecosystem for IPPU, identifying core sources such as industry associations and corporate reporting (cement, fertilizer), national statistical publications and surveys from NBS, administrative datasets from relevant ministries, and import/export records from the Nigeria Customs Service that are particularly important for product-use categories. It adds an important cross-sector consistency layer by noting that the national energy balance and industrial energy-use data, while not used to compute process emissions, are highly relevant for plausibility checks and for preventing double counting between IPPU and Energy sector estimates, especially for cement kilns, ammonia production linked to gas use, and steel production routes linked to electricity consumption profiles. The report explains that data collection is still largely template-based and exchanged manually, with limited digital automation and uneven completeness across subsectors, producing a pattern where cement data are relatively stronger due to industry structure and reporting capacity while data for smaller producers, informal activities, and product-use categories remain weak. It highlights persistent issues around data quality and consistency, including time lags, format incompatibilities, incomplete metadata needed for verification, limited systematic QA/QC application, and weak archiving and version control. It also acknowledges confidentiality constraints as a material barrier, noting that firms often treat production and process data as commercially sensitive and that the absence of robust confidentiality protocols and clear legal mandates constrains access and granularity, thereby limiting the inventory's transparency and the ability to progress toward higher-tier methods.

The challenges and opportunities section consolidates these findings into a diagnosis that is both technical and institutional: the IPPU system faces data fragmentation and limited disaggregation; uneven inter-agency collaboration; constrained technical capacity for higher-tier methods, uncertainty analysis, and software use; a still-developing digital infrastructure for routine reporting; and inconsistent industry engagement driven more by goodwill than by predictable obligations and incentives. At the same time, the report identifies clear opportunities for transformational improvement that align with Nigeria's development and industrial competitiveness agenda: leveraging the concentration of emitters to shift toward facility-level reporting; integrating NESREA's permitting and compliance datasets into inventory systems; using customs and administrative datasets to build credible product-use reporting; embedding stronger QA/QC, archiving, and recalculation procedures consistent with ETF review expectations; and aligning mitigation opportunities with MRV requirements so that industrial efficiency, clinker substitution, refrigerant transitions, and potential deep decarbonization options can be tracked credibly over time. The report underscores that the direction of travel is positive, but that the next phase must focus on institutionalization moving from project-supported compilation toward predictable, mandated, digitally enabled, and verifiable IPPU reporting.

Finally, the recommendations synthesize the assessment into a structured reform agenda across policy and institutional reforms, data systems, methodological improvements, capacity building, stakeholder engagement, and an implementation roadmap. The policy and institutional recommendations focus on establishing durable legal anchoring for industrial emissions reporting within climate governance and integrating GHG reporting into routine regulatory compliance and permitting systems, clarifying mandates and accountability among the principal institutions, and strengthening enforcement credibility so that inventory preparation is no longer dependent on voluntary cooperation alone. The data systems recommendations prioritize creation of a predictable annual data collection cycle aligned to inventory deadlines, progressive transition from aggregated statistics to facility-level datasets for major emitters, interoperability across NBS production statistics, NESREA compliance records, customs trade data, and sectoral administrative datasets, and systematic archiving and version control so that recalculations and methodological updates are fully transparent and reviewable. The methodological recommendations focus on targeted progression from Tier 1 to Tier 2 where it yields the highest returns—especially for cement through improved clinker activity and clinker ratio tracking, for chemical processes through plant-specific technology and abatement status where applicable, for iron and steel through route differentiation, and for product-use categories through more robust stock-change modelling while institutionalizing recalculation management and uncertainty analysis as core elements of inventory credibility. Capacity building is framed as a multi-year priority that must strengthen both government and private-sector competencies in IPCC methodologies, inventory software, data management and QA/QC, and that must address institutional memory risks through training-of-trainers and documentation. Stakeholder engagement recommendations emphasize structured public–private collaboration, confidentiality-respecting data sharing arrangements, and stronger roles for industry associations as aggregators and validators, while the roadmap translates these elements into sequenced milestones to 2030 aligned with Nigeria's broader climate and development timelines. Across all recommendations, the report returns to a consistent conclusion: Nigeria's IPPU emissions will grow with industrialization and cooling demand, and the country's ability to manage this growth through credible reporting, targeted mitigation, and competitiveness in a carbon-constrained global economy depends on institutionalizing MRV-ready systems that can generate high-quality, facility-linked, and reviewable data over time

Section 1: Introduction

The Industrial Processes and Product Use (IPPU) sector covers greenhouse gas (GHG) emissions that arise from industrial processes and from the use of products, rather than from the combustion of fuels for energy. In national inventories, IPPU includes emissions from mineral industries (e.g., cement and lime production), chemical industries (e.g., ammonia, nitric acid and other chemical production), metal industries (e.g., iron and steel), and product uses such as refrigeration and air-conditioning (RAC) and other applications where fluorinated gases (F-gases) are emitted. In Nigeria, these subsectors are particularly important because growth in construction, manufacturing, and cooling demand is likely to increase IPPU emissions over time, while data and reporting systems for industrial activity and product use remain uneven and fragmented.

Despite its growing relevance, Nigeria's IPPU reporting faces persistent challenges that affect both inventory completeness and mitigation transparency. These include limited facility-level reporting, inconsistent access to industrial production statistics, confidentiality concerns, weak administrative datasets for product use (especially RAC servicing and refrigerant markets), and limited country-specific emission factors for priority sources. As a result, IPPU estimates often rely on Tier 1 defaults and proxy data, creating uncertainty and constraining Nigeria's ability to track trends, explain drivers of change, and demonstrate mitigation outcomes credibly over successive reporting cycles.

Within the context of an MRV-focused initiative, these challenges point to a broader problem than estimation alone: Nigeria requires an IPPU MRV-ready system that can routinely generate and verify the underlying data needed for (i) national GHG inventories under the Enhanced Transparency Framework and (ii) tracking mitigation actions and their effects in the industrial and product-use space. An IPPU MRV system is therefore designed to address three linked needs: (a) reliable and recurring activity data pipelines from facilities and regulators, (b) fit-for-purpose protocols and templates that standardize reporting and enable QA/QC and verification, and (c) institutional arrangements that clarify mandates, protect confidential business information appropriately, and sustain reporting beyond ad-hoc projects. Key activities required to address this MRV problem include establishing IPPU-specific data collection protocols, formalizing institutional roles and data-sharing arrangements, developing an improvement plan for tier progression and country-specific emission factors, and integrating QA/QC, archiving, and recalculation procedures into routine sectoral reporting.

A robust inventory system is not an end in itself; it constitutes the evidentiary foundation upon which mitigation performance is measured, policies are evaluated, and progress toward national climate targets is demonstrated. Without consistent, transparent, and methodologically sound IPPU inventory data, it becomes impossible to credibly quantify the impact of industrial efficiency measures, process changes, clinker substitution strategies, refrigerant management reforms, or other mitigation interventions. Strengthening the inventory architecture of the IPPU sector therefore directly enhances Nigeria's capacity to track mitigation outcomes, assess policy effectiveness, and meet its transparency obligations under the Paris Agreement.

1.1 Purpose and Objectives of the Assessment

Against this background, this assessment of the IPPU sector supports Nigeria's ongoing efforts to strengthen a robust and transparent National GHG Inventory Management System aligned with reporting requirements under the UNFCCC and Paris Agreement,[1] and the national climate governance framework established by the Climate Change Act (2021).[2] The assessment aims to:

- Provide a comprehensive understanding of the IPPU sector's current and historical contribution to Nigeria's GHG emissions and assess mitigation-relevant trends and scenarios.
- Evaluate the adequacy and effectiveness of the policy, legal, and institutional frameworks governing GHG emissions from industrial processes and product use.
- Assess data collection arrangements and gaps in the IPPU sector, with a focus on activity data, emission factors, and the functionality of reporting systems.
- Identify practical opportunities to strengthen IPPU MRV readiness, including protocols, institutional roles, QA/QC procedures, and verification pathways.
- Support Nigeria's national reporting obligations through improved inventory quality and sustained readiness for Biennial Transparency Reports (BTRs) under the Enhanced Transparency Framework (ETF).

In doing so, the report establishes a baseline for strengthening IPPU data systems and institutional coordination in a way that improves both **inventory quality** and the **credibility of mitigation tracking** over time.

1.2 Scope of the IPPU Sector Under Nigeria's National GHG Inventory

The Industrial Processes and Product Use (IPPU) sector encompasses greenhouse gas (GHG) emissions arising from industrial activities in which raw materials are chemically or physically transformed, as well as emissions from the use of products that release GHGs during their application, servicing, or disposal. In accordance with the IPCC 2006 Guidelines and the 2019 Refinement, IPPU emissions are distinct from emissions arising from fuel combustion, which are reported under the Energy sector. IPPU therefore includes both process emissions (e.g., calcination in cement production) and product-use emissions (e.g., leakage of fluorinated gases from refrigeration systems).

According to Nigeria's First Biennial Transparency Report (BTR1) and its accompanying National Inventory Document (NID), emissions are currently reported from three principal IPPU categories:[3]

- **2.A Mineral Industry** - primarily cement production;
- **2.B Chemical Industry** - notably ammonia production and selected carbonate processes;
- **2.C Metal Industry** - iron and steel production.

These three categories account for all currently estimated IPPU emissions in Nigeria. Table 4.1 of the NID confirms that these are the only sub-categories from which emissions are presently reported.[4] The Mineral Industry,

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[1] UNFCCC, *Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement* (Decision 18/CMA.1); UNFCCC, *Paris Agreement*.

[2] Federal Republic of Nigeria, *Climate Change Act, 2021*

[3] Federal Republic of Nigeria, *First Biennial Transparency Report – National Inventory Document*, 2024, Chapter 4 (Industrial Processes and Product Use), pp. 126-127

[4] Ibid., Table 4.1, p. 127

particularly cement production, dominates the sector, contributing between 80-90% of IPPU emissions over the time series.[5]

Other IPPU categories are recognized as occurring in Nigeria but are **not currently estimated due to data constraints**. These include:

- **2.D Non-Energy Products from Fuels and Solvent Use** - covering lubricant use, paraffin wax use, and other non-energy applications such as bitumen and solvents;
- **2.F Product Uses as Substitutes for Ozone-Depleting Substances** - including refrigeration and air conditioning, fire protection, aerosols and solvents involving HFCs and other fluorinated gases;
- **2.G Other Product Manufacture and Use** - including SF_6 emissions from electrical equipment and certain other product-related emissions.[6]

For Category 2.D specifically, the NID notes that estimates have not been made due to unavailability of activity data, although lubricant and paraffin wax use are known to occur.[7] A planned improvement is included to collect the necessary activity data for these sub-categories in future inventory cycles.[8]

Similarly, under Categories 2.F and 2.G, several sub-categories are identified as occurring but remain unestimated due to limited activity data and reporting systems.[9] Nigeria has transparently reported these gaps and, where applicable, applied flexibility provisions under the Enhanced Transparency Framework in light of national capacity constraints.[10]

While the IPPU reporting framework structurally includes Categories 2.A through 2.G in line with IPCC classification, Nigeria's currently quantified emissions are concentrated in mineral, chemical, and metal industries. Strengthening data collection systems for non-energy product use and fluorinated gases remains an important area for future MRV development and inventory improvement.

1.3 Relevance to Nigeria's Climate Commitments

Nigeria's climate commitments are anchored in its Nationally Determined Contribution (NDC 3.0), the Climate Change Act (2021), the Biennial Transparency Report (BTR1), and its Long-Term Low Emissions Development Strategy (LT-LEDS). Within this framework, the IPPU sector holds strategic importance due to its growing emissions profile, process-based emission characteristics, and linkage to industrial transformation pathways.1. Nationally Determined Contribution (NDC) 3.0

- Nigeria's updated Nationally Determined Contribution (NDC 3.0) commits to an unconditional reduction of 20% and a conditional reduction of 47% in greenhouse gas emissions by 2030 relative to business-as-usual (BAU) projections.[11] The NDC adopts an economy-wide mitigation approach covering Energy, IPPU, Agriculture, Waste, and LULUCF sectors.

- While the NDC highlights industrial efficiency improvements and cleaner technologies as mitigation strategies, it is important to distinguish that industrial energy efficiency measures fall under the Energy sector (Category 1A2 - Manufacturing Industries and Construction) rather than IPPU. IPPU mitigation contributions arise primarily from process-related interventions, including clinker substitution in cement production, improved process efficiencies in chemical manufacturing, material substitution, and enhanced management of fluorinated gases.

[5] Ibid., p. 127–128 (emission share discussion and Figure 4.2).
[6] Ibid., pp. 127, 139-140.
[7] Ibid., Section 4.5.1, p. 139.
[8] Ibid., Section 4.5.7, p. 139.
[9] Ibid., Sections 4.7 and 4.8, pp. 139-140.
[10] Ibid., Section 10.5 (Flexibility Provisions), pp. 196-197.
[11] Federal Republic of Nigeria, *Nationally Determined Contribution (NDC 3.0)*, 2025

- NDC 3.0 includes economy-wide mitigation modelling based on BAU projections and sectoral mitigation pathways.[12] However, sector-specific quantitative projections for IPPU remain limited compared to the Energy sector. Available modelling suggests that the bulk of Nigeria's mitigation potential toward the 2030 targets is concentrated in energy supply, transport, and AFOLU sectors, with IPPU contributing a smaller but growing share due to anticipated expansion in cement production and cooling demand.[13] Strengthening IPPU MRV systems is therefore critical to credibly quantifying the sector's mitigation contribution under both unconditional and conditional scenarios.

2. Climate Change Act, 2021

- The Climate Change Act (2021) establishes the legal framework for Nigeria's climate governance architecture and creates the National Council on Climate Change (NCCC) as the coordinating body responsible for implementing climate policy.[14] The Act mandates the preparation of carbon budgets, sectoral emission reduction targets, and national climate action plans.[15]

- While the Act does not prescribe specific numerical sectoral targets within the legislation itself, it empowers the NCCC to coordinate sectoral implementation across ministries, departments, and agencies and to ensure alignment with Nigeria's NDC commitments.[16] In this context, the IPPU sector falls within the scope of national carbon budgeting and sectoral mitigation planning, particularly as industrial growth and cement expansion have implications for future emissions trajectories.

3. First Biennial Transparency Report (BTR1)

- Nigeria submitted its First Biennial Transparency Report (BTR1) in December 2024 under the Enhanced Transparency Framework of the Paris Agreement.[17] The BTR1 reports emissions across five main sectors: Energy, IPPU, Agriculture, Waste, and LULUCF.

- According to BTR1, IPPU emissions amounted to 11,618 Gg CO_2-eq in 2017, representing approximately 1.7% of total national emissions in that year.[18] The Mineral Industry particularly cement production accounts for the overwhelming majority of IPPU emissions.[19]

- Although IPPU's share of total emissions remains relatively modest compared to Energy and AFOLU, the BTR1 identifies significant methodological gaps in non-energy product use and fluorinated gases, underscoring the need for improved data systems, country-specific emission factors, and enhanced reporting arrangements.[20] Given projected growth in industrial output and cooling demand, IPPU emissions are expected to increase unless targeted mitigation and improved monitoring are implemented.

4. Long-Term Low Emissions Development Strategy (LT-LEDS)

- Nigeria's Long-Term Low Emissions Development Strategy outlines pathways toward low-carbon development through economic diversification, technology adoption, and structural transformation of high-emission sectors.[21] While much of the decarbonization emphasis is placed on the energy transition, the LT-LEDS also recognizes industrial transformation as critical to long-term emissions reduction.

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[12] Ibid., Mitigation Scenarios and BAU Modelling section.
[13] Ibid., Sectoral Mitigation Contributions and Modelling Assumptions section.
[14] Federal Republic of Nigeria, *Climate Change Act*, 2021, Sections 1-4
[15] Ibid., Sections 19-22 (Carbon Budget and Sectoral Targets provisions).
[16] Ibid., Section 5 (Functions of the National Council on Climate Change).
[17] Federal Republic of Nigeria, *First Biennial Transparency Report*, 2024, Introduction section.
[18] Federal Republic of Nigeria, *National Inventory Document*, 2024, Chapter 4, p. 127.
[19] Ibid., pp. 127-128.
[20] Ibid., Sections 4.5-4.8.
[21] Federal Republic of Nigeria, *Long-Term Low Emissions Development Strategy (LT-LEDS)*, 2021

- For IPPU-relevant activities, this includes promotion of low-clinker cement production, deployment of cleaner production technologies, adoption of alternative materials, and exploration of carbon capture and storage (CCS) options in hard-to-abate industrial processes.[22] These pathways highlight the importance of establishing a credible MRV framework for IPPU, as process emissions cannot be reduced solely through fuel switching and require technology-driven mitigation supported by transparent monitoring systems.

2.0 Overview of the IPPU Sector in Nigeria

The Industrial Processes and Product Use (IPPU) sector encompasses greenhouse gas (GHG) emissions that arise not from fuel combustion for energy purposes (reported under Energy sector Category 1A2 Manufacturing Industries and Construction), but from physical and chemical transformations inherent in industrial production processes, as well as emissions resulting from the use of manufactured products that release greenhouse gases.[23] Under the IPCC 2006 Guidelines and the 2019 Refinement, IPPU emissions are distinguished from energy emissions because they originate from chemical reactions (e.g., calcination of limestone) or product-related releases (e.g., refrigerant leakage), rather than from oxidation of fuels for energy.

Structurally, Nigeria's IPPU sector covers Mineral Industry (2A), Chemical Industry (2B), Metal Industry (2C), Non-Energy Products from Fuels and Solvent Use (2D), Product Uses as Substitutes for Ozone-Depleting Substances (2F), and Other Product Manufacture and Use (2G).[24] However, emissions are currently estimated only for 2A (cement), selected 2B (ammonia), and 2C (iron and steel).[25] Categories 2D, 2F and 2G occur but remain largely unestimated due to data constraints, though improvement plans are recorded in the National Inventory Document (NID).[26]

Cement Industry (Mineral Industry - 2A)

Cement production remains the dominant contributor to IPPU emissions in Nigeria, accounting for approximately 80-90% of total IPPU emissions across the reporting time series.[27] Emissions arise primarily from clinker production through calcination (process emissions under IPPU), while kiln fuel combustion emissions are reported separately

[22] Ibid.,
[23] IPCC, *2006 Guidelines for National Greenhouse Gas Inventories*, Vol. 3; 2019 Refinement.
[24] Federal Republic of Nigeria, *National Inventory Document (NID)*, 2024, Chapter 4.
[25] Ibid., Table 4.1, p. 127.
[26] Ibid., Sections 4.5-4.8.
[27] Ibid., pp. 127-128.

under Energy (1A2).[28]

Cement-related IPPU emissions increased from approximately 714 Gg CO_2 in 2000 to over 5,000 Gg CO_2 by 2017, reflecting rapid industrial expansion.[29] More recent inventory data in BTR1 indicate that total IPPU emissions increased from 2,511 Gg CO_2-eq in 2000 to approximately 26,300 Gg CO_2-eq in 2022, representing a 947% increase over the period.[30] Today, the Nigerian cement industry boasts an installed production capacity of approximately 62.8 million metric tons per annum (MMTPA), with operations spread across five of the country's six geopolitical zones.[31] Installed production capacity dominated by Dangote Cement (over 35 MMTPA), BUA Cement (17 MMTPA), and Lafarge Africa (10.5 MMTPA).[32] The sector is dominated by three major firms Dangote Cement, BUA Cement, and Lafarge Africa (now owned by Huaxin Cement of China). Dangote Cement, the market leader, commands a local capacity of over 35 MMTPA, with major facilities in Kogi (Obajana), Ogun (Ibese), and Benue (Gboko). BUA Cement follows with production hubs in Edo and Sokoto States and an installed capacity of 17 MMTPA,[33] while Lafarge Africa's 10.5 MMTPA capacity is spread across Ogun, Gombe, and Cross River States.[34]

These companies not only cater to local consumption but also support exports to the West African market, further entrenching Nigeria's dominance in the regional cement trade. The Obajana plant in Kogi State, operated by Dangote Cement, is the largest in Sub-Saharan Africa with a single-line capacity of over 10 MMTPA. Other notable facilities include BUA's Kalambaina plant in Sokoto and Lafarge's Ashaka works in Gombe State.[35] The wide geographical distribution of cement plants across the North (Sokoto, Gombe, Kogi), South West (Ogun), South East (Ebonyi), and South-South (Edo, Cross River) enables efficient distribution across Nigeria's vast terrain and mitigates transportation bottlenecks. Additionally, coastal grinding and packaging terminals support exports to ECOWAS markets such as Ghana, Togo, and Sierra Leone.

This distribution pattern also reflects a conscious industrial policy of promoting regional economic balance while supporting national infrastructure needs.

The economic significance of the cement industry extends far beyond its production figures. It is a major employer, providing tens of thousands of direct and indirect jobs and serving as a crucial enabler for the construction, infrastructure, and housing sectors. Beyond emissions, the sector supports large employment chains. Lafarge Africa has pioneered biomass co-processing using oil palm harvesting residues sourced from thousands of smallholder farmers within plant catchment areas, partially displacing fossil kiln fuels (Energy sector mitigation).[36] However, this industrial growth comes at an environmental cost. Cement manufacturing is energy-intensive and emits large quantities of carbon dioxide through the calcination of limestone.[37] Despite its growth, the industry faces challenges, including high cement prices, which have been attributed to monopolistic practices and have impacted infrastructure development.

Current Scale and Production Capacity

As of mid-2024, Nigeria's installed cement production capacity stands at approximately 62.8 million metric tons per annum (MMTPA), making it the largest producer in Sub-Saharan Africa and among the top producers globally. The industry is concentrated around three major players:

- **Dangote Cement Plc**
    - Dominates the market with a local capacity of 35.3 MMTPA.
    - Operates major plants in:

[28] IPCC 2006 Guidelines, Vol. 3.
[29] NID, 2024, p. 127
[30] BTR1, 2024, updated inventory tables through 2022.
[31] https://leadership.ng/cement-firms-post-n984-4bn-pre-tax-profits-on-price-increases/
[32] Industry reports and company disclosures
[33] https://www.marketsreporters.com/2025/03/02/cement-battle-lafarge-outshines-dangote-bua-in-profit-growth/
[34] https://www.verivafrica.com/insights/how-cement-costs-stifle-nigerias-infrastructural-development
[35] https://www.6wresearch.com/industry-report/nigeria-ammonia-market-outlook
[36] Lafarge Africa sustainability disclosures, 2023-2024.
[37] BTR, 2024

  - Obajana (Kogi State) the largest cement plant in Sub-Saharan Africa with a capacity of 10.25 MMTPA.
  - Ibese (Ogun State) 12 MMTPA.
  - Gboko (Benue State) 4 MMTPA.
- Also operates grinding and export terminals in seaports such as Apapa and Onne.

- **BUA Cement Plc**
  - Holds the second-largest market share with 17 MMTPA capacity.
  - Plants include the Sokoto Kalambaina 5 MMTPA, with expansions underway and the Obu Cement (Edo State) – currently 7.5 MMTPA, targeting expansion to 9 MMTPA.
- **Lafarge Africa Plc (now under Huaxin Cement, China)**
  - Capacity of 10.5 MMTPA, with plants in:
    - Ewekoro and Sagamu (Ogun State).
    - Ashaka (Gombe State) historically Nigeria's oldest still-operating cement facility.
    - Calabar (Cross River State).

Collectively, these companies account for over **95%** of national production, while smaller producers and new entrants, such as Ibeto Cement and United Cement, contribute marginally.

Chemical Industry (2B)

Nigeria's reported IPPU emissions under the Chemical Industry category are currently concentrated in ammonia production.[38] Nitric acid production has been limited or inactive in some inventory years, explaining its reduced prominence in recent reporting cycles.[39] Other IPCC 2B subcategories (e.g., methanol, ethylene, carbide production) are either not occurring at industrial scale or lack verifiable activity data, hence not estimated.[40]

Ammonia production emits CO_2 primarily from steam methane reforming of natural gas.[41] With the commissioning of the Dangote Fertilizer Plant, domestic ammonia capacity expanded significantly.[42] Market projections suggest moderate growth in ammonia demand between 2025 and 2029, with growth expected to peak around 2027.[43] Initial projections for additional facilities, including the Morocco-OCP ammonia initiative, have experienced implementation delays beyond earlier expectations due to investment structuring and market conditions.[44]

Although smaller than cement in emission volume, chemical production remains important due to process

[38] NID, 2024, Section 4.2.
[39] Ibid.
[40] Ibid.
[41] IPCC 2006 Guidelines, Vol. 3.
[42] Dangote Fertilizer commissioning announcement, 2022
[43] Industry market outlook reports, 2024.
[44] Public investment updates on Morocco-OCP project, 2024.

emissions and the potential introduction of N_2O emissions if nitric acid production expands.[45]

Metal Industry (2C) - Iron and Steel Production

The iron and steel industry remains pivotal for infrastructure development and industrialization.[46] Inventory data show IPPU emissions from iron and steel increased from approximately 1,791 Gg CO_2 in 2000 to around 6,360 Gg CO_2 by 2017, reflecting expansion in construction and manufacturing demand.[47] BTR1 confirms continued reporting beyond 2017 through 2022.[48]

In 2024, after two years of market contraction, the Nigerian raw steel and pig iron market recorded an 11% increase in value, signalling renewed activity in the sector.[49] Despite this growth, structural challenges persist, including underutilization of legacy facilities, dependence on imported billets and finished products, and infrastructure bottlenecks.[50]

Large integrated plants such as Ajaokuta Steel Complex and Delta Steel Company have faced prolonged operational challenges.[51] While policy discussions on revitalization continue, no confirmed full-scale operational restart timeline has been officially documented.[52] Meanwhile, private mini-mills and scrap-based electric arc furnace (EAF) operations dominate domestic production, altering both energy and process emission characteristics.

There is also growing investor interest in steel expansion. Dangote Industries has publicly indicated interest in entering domestic steel production to reduce reliance on imports and capture domestic demand.[53] Should integrated steel capacity expand significantly, future IPPU emissions could increase unless lower-carbon process routes are adopted.

Product Use (2D, 2F and 2G) - Refrigeration and Air Conditioning (RAC)

The product-use category includes 2D (non-energy products), 2F (fluorinated gases), and 2G (e.g., SF_6 in electrical systems).[54] Although most of these remain unestimated in current inventory cycles, they are strategically important for future emissions trajectories.

The Refrigeration and Air Conditioning (RAC) sector is experiencing rapid growth due to rising temperatures, urbanization, and increasing household incomes.[55] This growth has driven higher demand for cooling systems, leading to increased use of hydrofluorocarbons (HFCs), potent greenhouse gases.[56]

Key characteristics of Nigeria's RAC sector include:

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[45] IPCC 2006 Guidelines, Vol. 3.
[46] https://www.reuters.com/article/business/healthcare-pharmaceuticals/moroccos-ocp-to-commission-nigeria-ghana-plants-in-2024-idUSL8N2E25X0/?
[47] NID, 2024, p. 127., https://www.reuters.com/article/business/healthcare-pharmaceuticals/moroccos-ocp-to-commission-nigeria-ghana-plants-in-2024-idUSL8N2E25X0/?
[48] BTR1, 2024, time series data.
[49] Industry assessment reports, 2024.
[50] Ibid
[51] Federal Government policy briefs on Ajaokuta Steel.
[52] Ministry of Steel Development updates, 2023-2024.
[53] Dangote Industries public investment statements, 2024. https://aloinettadvisors.com/2024/06/dangote-steel-ambitions/
[54] NID, 2024, Sections 4.5-4.8.
[55] National cooling demand assessments.
[56] https://www.undp.org/sites/g/files/zskgke326/files/publications/Nigeria%20-%20HFC%20Emissions%20Assessment.pdf?

- Refrigerant Use: The most common HFCs in the Nigerian market are R-134a (widely used in refrigeration and mobile air conditioning) and R-410A (used in stationary air conditioning systems).[57]

- Manufacturing Activity: Nigeria hosts limited but growing assembly and manufacturing activity for commercial refrigeration and stationary air-conditioning equipment.[58] [59]

Emissions arise primarily from leakage during operation, servicing, and end-of-life disposal.[60] Despite regulations prohibiting venting of refrigerants, enforcement remains weak, contributing to environmental risks.[61] Nigeria has ratified the Kigali Amendment and initiated HFC phase-down planning, but capacity gaps in technician certification, recovery infrastructure, and refrigerant tracking remain constraints.[62]

Additionally, Category 2G emissions particularly SF_6 used in electrical transmission and distribution equipment are relevant given ongoing grid expansion, though reliable data remain limited and are not yet fully quantified.[63]

Nigeria's IPPU sector reflects both industrial dynamism and data system limitations. Cement and steel expansion underpin infrastructure growth; fertilizer production supports food security; RAC growth reflects urban development. While IPPU contributed approximately 1.7% of total national emissions as of 2017,[64] it is among the fastest-growing sectors in absolute terms. The unestimated status of several product-use categories (2D, 2F, 2G) underscores the need for strengthened MRV protocols, improved activity data collection, and institutionalized reporting systems to ensure compliance with the Enhanced Transparency Framework.[65]

2.1 Historical and Current Emission Trends

The trend of emissions for the time series 2000 to 2022 is provided in Figure 1 and in Table 1 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).

This makes IPPU the fastest-growing emissions sector over the full time series, even though it remains smaller in absolute terms than Energy and LULUCF. The growth trajectory is closely linked to sustained industrial expansion, particularly in cement manufacturing, fertilizer production, metal processing, and increasing consumption of fluorinated gases in cooling technologies.

[57] CCAC-supported HFC inventory documentation (Nigeria). https://www.ccacoalition.org/sites/default/files/resources/Nigeria%20HFC%20Inventory_0.pdf
[58] Industry assembly data, 2024.
[59] https://www.undp.org/sites/g/files/zskgke326/files/publications/Nigeria%20-%20HFC%20Emissions%20Assessment.pdf?
[60] NID, 2024, Section 4.7.
[61] NOSDRA 2024
[62] Kigali Amendment ratification and HFC phase-down plan documentation.
[63] NID, 2024, Section 4.8.
[64] NID, 2024, p. 127.
[65] UNFCCC, Decision 18/CMA.1 (Enhanced Transparency Framework).

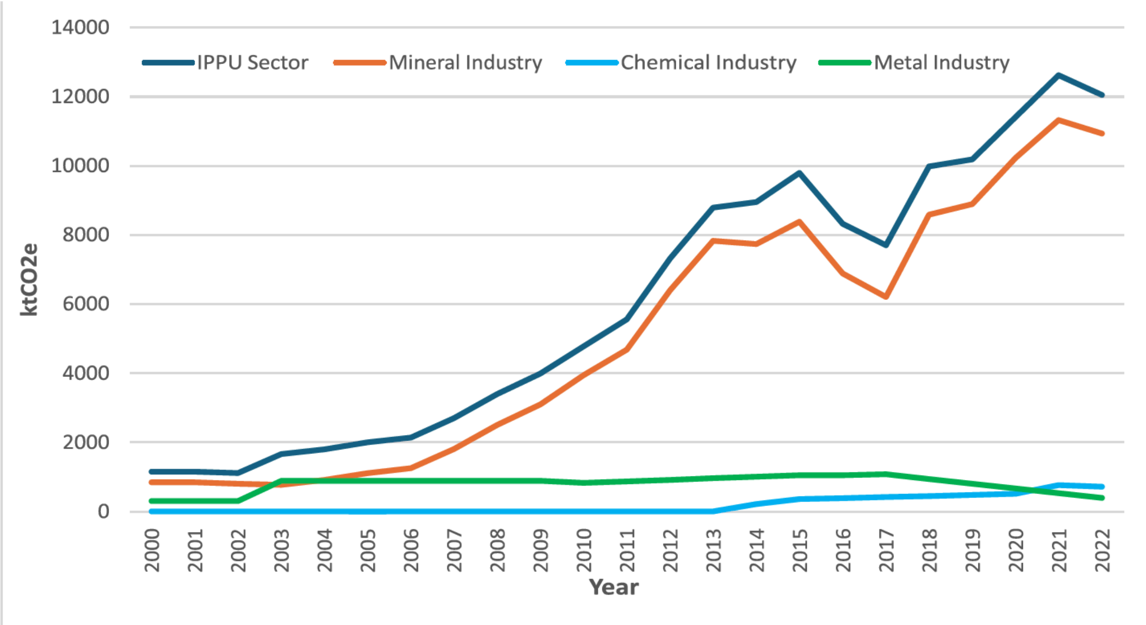

Figure 1: Trends of emissions (kt CO2 e) for the IPPU sector (2000-2022)

Table 1: 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%

Within the mineral industry, cement production remains the dominant source of IPPU emissions. Cement-related CO_2 emissions increased from 714 Gg CO_2 in 2000 to a peak of 7,083 Gg CO_2 in 2015, before declining to 5,240 Gg CO_2 in 2017 following production fluctuations and recalculations. BTR1 inventory tables indicate that emissions rose again through 2022 in line with expanding clinker capacity and domestic infrastructure demand. Cement therefore continues to account for the largest share of process-related CO_2 emissions within the IPPU sector.[66] In the metal industry, recalculated BTR1 figures show that emissions from iron and steel manufacturing increased from 304.14 kt CO_2-eq (≈304 Gg) in 2000 to 943.20 kt CO_2-eq (≈943 Gg) in 2022, reflecting gradual growth in scrap-based electric arc furnace production and renewed sectoral investment.[67]

The % share of emissions from the emitting categories is provided in Figure 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.[68]

[66] Ibid.
[67] Ibid
[68] Ibid

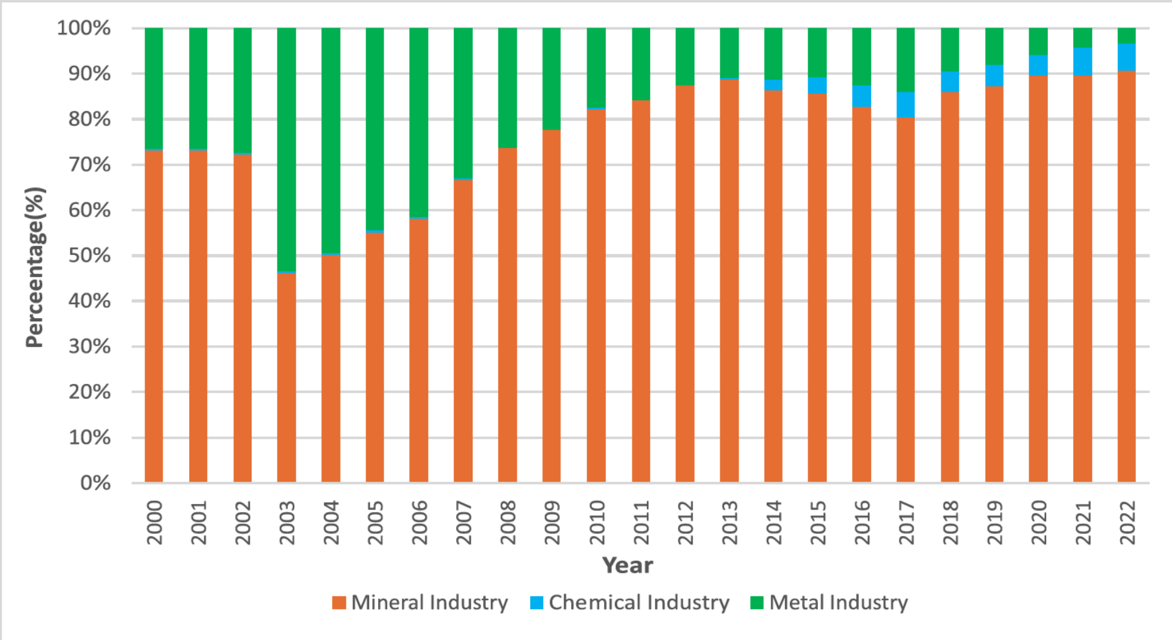

Table 2: Share (%) of emissions by IPPU subsectors (2000-2022)

Emissions from ammonia and nitric acid production remain smaller in absolute volume compared to cement but are significant due to the high global warming potential of nitrous oxide (N_2O) released from nitric acid plants. While ammonia production primarily emits CO_2 through natural gas reforming, nitric acid production contributes N_2O emissions that have a disproportionately high climate impact. BTR1 indicates fluctuations across the time series, with potential upward pressure expected as domestic fertilizer production capacity expands.[69]

Across the sector, carbon dioxide (CO_2) remains the dominant gas, primarily from cement and ammonia production. However, N_2O from nitric acid production and HFCs from product use (IPPU categories 2.F and 2.G) are increasingly important contributors. The rapid growth in refrigeration and air conditioning demand suggests that fluorinated gases will constitute a growing share of future IPPU emissions if mitigation measures are not strengthened.

Taking into consideration Nigeria's greenhouse gas emissions from the IPPU sector in both gross and per capita terms, the country remains a relatively low emitter compared to more industrialized developing economies, despite the rapid growth recorded over the past two decades. Nigeria's First Biennial Transparency Report (BTR1) confirms that gross IPPU emissions increased by 947% between 2000 and 2022, rising from 2,511 Gg CO_2-eq in 2000 to approximately 26 Mt CO_2-eq in 2022 (Federal Republic of Nigeria, 2024, BTR1). While this growth rate is the highest among all sectors over the time series, Nigeria's per capita IPPU emissions remain low at well below 0.15 t CO_2-eq per person due to its large population and comparatively modest industrial base. By contrast, emerging economies such as China, India, Brazil, Indonesia, and South Africa report significantly higher absolute and per capita IPPU emissions, reflecting larger-scale cement, steel, petrochemical, and fluorinated gas industries. Nigeria's current emissions profile therefore reflects a country in an accelerated industrialization phase: although its absolute emissions remain moderate relative to major emerging economies, the steep upward trajectory underscores the urgency of embedding low-carbon technologies and stronger MRV systems within its expanding industrial sector.

2.2 Environmental Impacts and Emission Profile

In accordance with the IPCC 2006 Guidelines (2019 Refinement) and Nigeria's First Biennial Transparency Report (BTR1), emissions from the Industrial Processes and Product Use (IPPU) sector are reported under **IPCC Category 2**

[69] Ibid

(IPPU) and disaggregated into sub-categories 2A–2G under the Common Reporting Tables (CRT). The discussion below focuses strictly on **process-related emissions**, excluding energy combustion emissions (reported under Energy Sector, Category 1A2).

2A.1 – Cement Production (CRT 2A1: Mineral Industry)[70]

Cement production is the largest source of IPPU emissions in Nigeria and is reported under CRT Category 2.A.1 (Cement Production) in the national inventory. Emissions arise primarily from the calcination of limestone, where calcium carbonate ($CaCO_3$) is thermally decomposed into lime (CaO) and carbon dioxide (CO_2):

$CaCO_3 = CaO + CO_2$

These emissions are classified strictly as process emissions under the IPPU sector and are independent of fuel combustion in kilns, which is reported separately under Energy Sector CRT 1.A.2 (Manufacturing Industries and Construction) to avoid double counting.

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 2. 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.

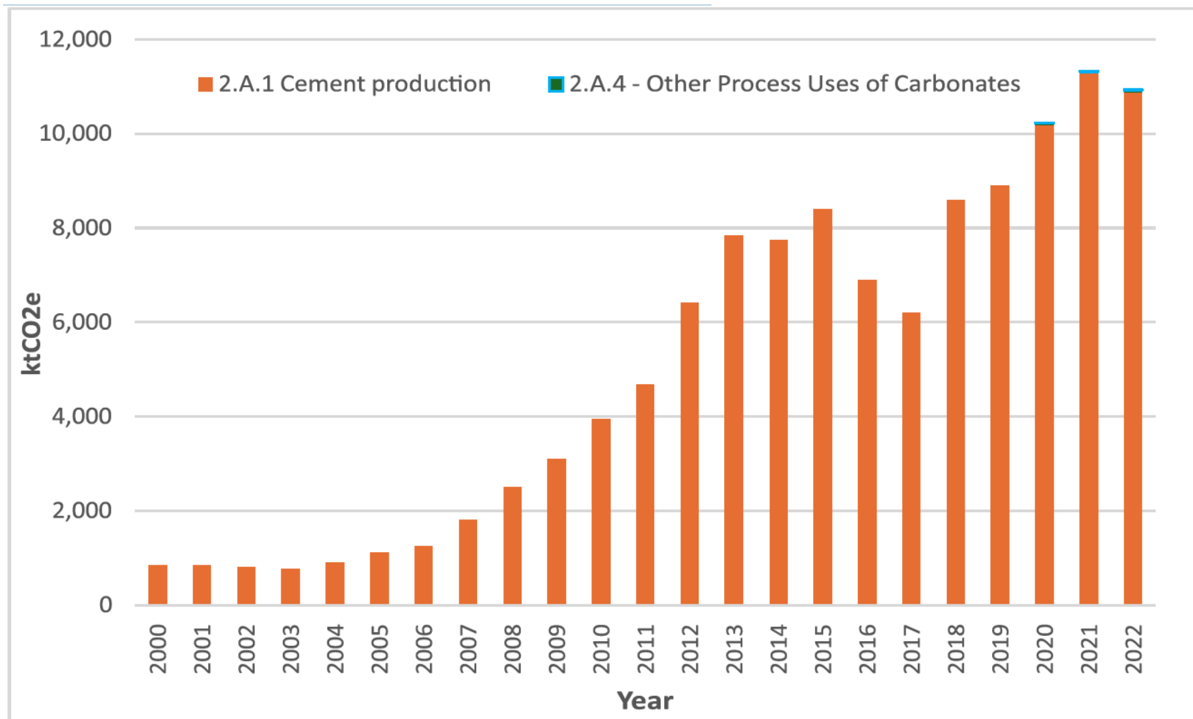

Figure 2: Emissions (kt CO2 e) from Mineral Industry (2000-2022)

[70] Federal Republic of Nigeria (2024). *First Biennial Transparency Report (BTR1) and National Inventory Document (NID)*, Chapter 4, Table 4.4 (CRT 2.A.1 – Cement Production), p. 129-132.

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 1). Except for 2017 and 2020 when there was a drop, emissions increased steadily during the period under review (Figure 1).

Table 3: 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%

The steady rise in cement-related process emissions reflects expanded clinker production capacity and sustained infrastructure demand across Nigeria and the West African sub-region. While fuel switching, biomass co-processing, and energy efficiency improvements may reduce combustion emissions under the Energy sector, process-related CO_2 emissions remain chemically inherent to clinker production.
Environmental impacts associated with cement production extend beyond greenhouse gases and include:

- Release of process CO_2 from calcination
- Quarry-related land degradation
- Dust and particulate matter from clinker grinding and raw material handling (non-GHG pollutants, though relevant for environmental management)

Mitigation opportunities within **process emissions (2A1)** include:

- Increased use of **blended cements** (reducing clinker-to-cement ratio through substitution with slag, fly ash, or calcined clays)
- Development of **low-clinker formulations**
- Deployment of **Carbon Capture and Storage (CCS)** technologies targeting calcination emissions

While energy efficiency measures and alternative fuels (e.g., biomass substitution, waste heat recovery) are important, these fall primarily under **Energy Sector mitigation** and are therefore not addressed within the IPPU process accounting framework.

2A – Other Mineral Industry (Lime Production, if applicable)
Where lime production occurs, emissions arise similarly from calcination reactions and are reported under **CRT 2A2 (Lime Production)**. These emissions follow the same chemical principle as cement calcination and are treated as process emissions under IPPU.

2B – Chemical Industry (CRT 2B1 & 2B2)
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 3. 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%.

Emissions from chemical production are reported under:

- **2B1 – Ammonia Production (CO_2 process emissions)**
- **2B2 – Nitric Acid Production (N_2O process emissions)**

Ammonia production releases CO_2 as part of feedstock transformation during natural gas reforming, classified under IPPU when associated with chemical conversion rather than fuel combustion. Nitric acid production emits nitrous oxide (N_2O), a greenhouse gas with a high global warming potential. Though smaller in absolute tonnage compared to cement, nitric acid emissions are significant due to their high climate impact.

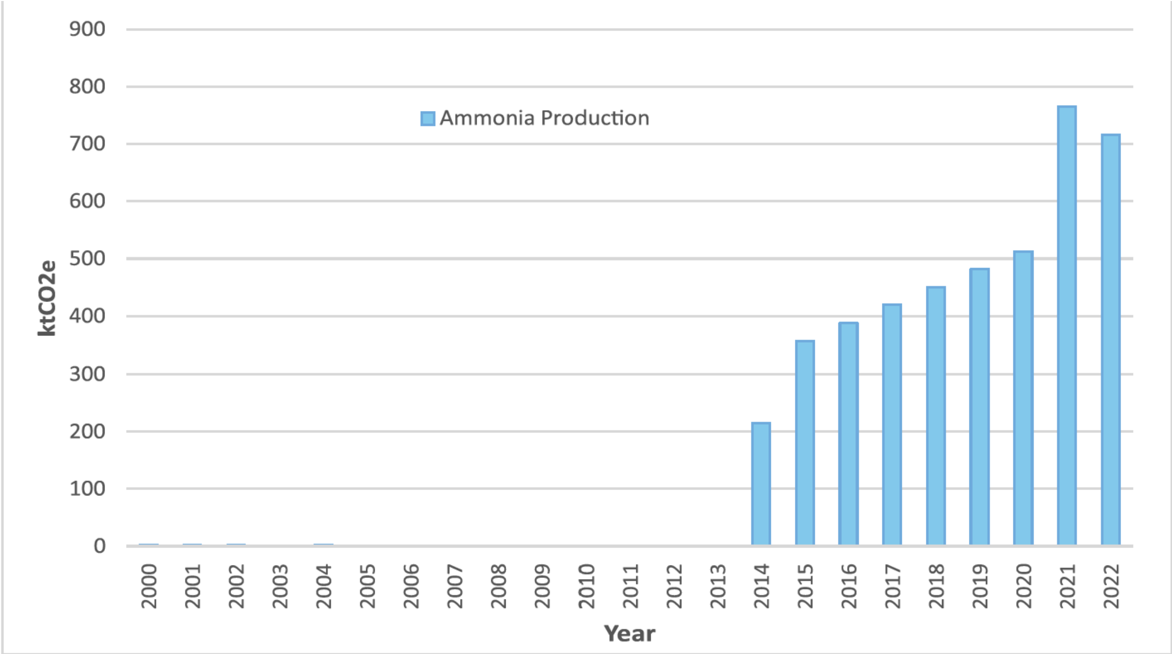

Figure 3: Emissions (kt CO2 e) from Chemical Industry (2000-2022)

2C – Metal Industry (CRT 2C1: Iron and Steel Production)

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 for the full time series and in Table 4 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: Emissions (kt CO2 e) from Metal Industry (2000-2022)

Table 4: 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%

2F & 2G – Product Use (Fluorinated Gases)

Process-related product use emissions are reported under:

- **2F – Product Uses as Substitutes for Ozone-Depleting Substances (e.g., HFCs in RAC systems)**
- **2G – Other Product Manufacture and Use (e.g., SF_6 in electrical equipment)**

These emissions arise from leakage, servicing, and end-of-life release of high global warming potential gases. While currently smaller than cement emissions in absolute terms, they represent one of the fastest-growing IPPU categories.

*Table 5**Summary of Emission Profile***

IPCC Category	Sector	Dominant Gas	Trend (2000–2022)
2A1	Cement Production	CO_2	Strong increase; largest IPPU source
2B1	Ammonia	CO_2	Moderate increase
2B2	Nitric Acid	N_2O	High GWP; fluctuating
2C1	Iron & Steel	CO_2	Gradual increase
2F	HFC Product Use	HFCs	Rapid growth

2G	Electrical Equipment (SF_6)	SF_6	Data gaps; improvement planned

2.3 Future Dynamics of the IPPU Sector: BAU Projections, Demand–Supply Balance and Mitigation Pathways

While the preceding sections examined the historical evolution of emissions in Nigeria's Industrial Processes and Product Use (IPPU) sector, policy design requires a forward-looking understanding of how the sector is likely to evolve over the next decade. Nigeria is simultaneously pursuing industrialization, infrastructure expansion, food security, regional export competitiveness, and energy transition objectives. These structural drivers will shape the future trajectory of cement, ammonia, steel, and product-use emissions (particularly hydrofluorocarbons), which already account for a rapidly growing share of national greenhouse gas emissions.

*Table 6: **BAU Demand-Side Outlook by IPPU Sub-sector (Drivers, Activity Proxies, and Emissions Implications)***

CRT / IPCC Category (Order)	**Sub-sector product/service**	**BAU demand drivers (Nigeria-specific)**	**Demand-side proxy indicators to project (practical)**	**Expected BAU direction to 2030**	**Emissions implication under BAU (process/product-use)**	**Key uncertainty that can swing BAU**
2.A.1	**Cement (clinker & cement)**	Housing deficit, roads/rail/ports, power infrastructure, urbanisation, public capital spending cycle, ECOWAS export demand	Cement dispatch volumes; clinker production; clinker-to-cement ratio; import/export volumes; construction GDP; public capex	**High growth** (strongest among IPPU subsectors)	Process CO_2 rises approximately in proportion to **clinker output** unless clinker ratio declines materially	Real estate/infrastructure cycles; FX & import substitution; clinker ratio policy; availability of SCMs (slag/calcined clay)
2.A.2	Lime (where applicable)	Construction materials, steel, water treatment	Lime production; limestone input	Low–moderate	Process CO_2 increases with production; often small vs cement	Lack of consistent industrial statistics
2.B.1	Ammonia (fertilizer feedstock)	Fertilizer demand, agro-policy, domestic blending capacity, export competitiveness, gas availability	Ammonia production volumes; urea output; fertilizer consumption; gas supply reliability	Moderate	CO_2 process emissions rise with ammonia output; potential structural shift if blue/green ammonia emerges	Gas availability/pricing; export market; plant utilisation rates
2.B.2	Nitric acid (if operating/expanding)	Fertilizer chain, explosives/mining, industrial chemicals	Nitric acid output; abatement installation status	Uncertain / episodic	N_2O can be high climate-impact even at low volumes; abatement makes a	Whether plants operate continuously; whether N_2O abatement is installed/maintain

					step-change	ed
2.C.1	Iron & steel (scrap/EAF dominant; integrated routes potential)	Infrastructure demand, manufacturing base, import substitution policy, energy reliability, scrap availability	Steel output; scrap flows; billet imports; EAF capacity utilisation	Moderate	Process CO_2 depends on route; BAU likely gradual increase if EAF grows; big jump only if integrated route scales	Grid reliability; scrap system maturity; policy/finance for large integrated facilities
2.D	Non-energy use of fuels & solvents (lubricants, waxes, solvents)	Industrialisation, transport fleet size, manufacturing, consumer products	Apparent consumption (imports + production − exports); industrial surveys	Low–moderate	Potentially non-trivial but often diffuse; in Nigeria currently **NE/IE** due to data gaps	Administrative data quality; product coding; survey coverage
2.F	HFCs (RAC, foams, aerosols)	Heat stress, urbanisation, appliance penetration, cold chain growth, servicing market expansion	Refrigerant import volumes by type; equipment stock; servicing intensity; recovery/destruction rates	**High growth** (fastest-growing *product-use* driver)	High GWP means small mass leakage can become major CO_2-eq; BAU worsens if informal servicing dominates	Kigali phase-down pace; enforcement; shift to low-GWP refrigerants; technician capacity
2.G	SF_6 (electrical equipment) and other product uses	Grid expansion, substations, industrial power demand	Installed switchgear base; SF_6 purchases; maintenance logs	Moderate	CO_2-eq can be large if leakage rates are high; currently **NE/IE** due to data limits	Utility reporting discipline; procurement transparency; maintenance practices

*Table 7: **BAU Supply-Side Capacity Assessment (Can Nigeria Supply BAU Demand?)***

CRT Category	**Current supply-side position (Nigeria)**	**BAU supply-side constraint risk**	**Likely outcome by 2030 under BAU**	**What "demand-supply mismatch" would look like**	**Emissions consequence of mismatch**
2.A.1 Cement	Installed capacity is already high; strong domestic producers; export orientation	Moderate: energy/logistics costs, FX, input disruptions	**Supply can meet demand** in most BAU cases	Short-term regional shortages or price spikes if logistics/FX shocks occur	Emissions keep rising with clinker output; price spikes do not reduce process emissions unless production falls
2.B.1	Large-scale capacity exists; utilisation depends on gas	High: gas reliability, input	Supply likely adequate;	Imports rise if utilisation dips; or	Emissions track utilisation: higher

Ammonia	& export market	pricing, export competition	expansion depends on economics	exports rise if competitiveness improves	utilisation → higher process CO_2 unless low-carbon route adopted
2.B.2 Nitric acid	Capacity/operations uncertain; often underreported	High: operational intermittency, maintenance	Output may be intermittent	Demand met via imports or intermittent domestic supply	If domestic production ramps without abatement, N_2O can spike sharply
2.C.1 Iron & steel	Domestic output constrained; EAF mini-mills common; imports significant	High: power supply, scrap logistics, investment	Partial supply; continued imports likely	Persistent import dependence; constrained local production growth	If supply gap met by imports, domestic IPPU emissions grow slower; if large integrated plants start, domestic emissions rise
2.F HFCs (RAC)	Mostly imported refrigerants/equipment; servicing market fragmented	Moderate–high: enforcement and customs data quality	Demand largely met via imports; informal channels may grow	Rising informal refrigerant trade; weak reporting	Emissions increase sharply (high GWP leakage) and MRV becomes harder
2.G SF_6	Utilities/procurement systems exist; reporting not systematic	High: reporting discipline and inventory management	Equipment stock grows with grid expansion	"Hidden" SF_6 bank grows without leakage control	Potentially high CO_2-eq leakage; large uncertainty in inventory

*Table 8: **Demand–Supply Intercomparison Under BAU (What It Means for Nigeria's IPPU Trajectory)***

CRT Category	**BAU demand vs supply balance**	**"So what?" (industrial/economic implication)**	**"So what?" (inventory/MRV implication)**	**Priority risk if nothing changes**
2.A.1	Supply likely ≥ demand	Cement remains growth engine; exports possible	Cement will dominate IPPU totals; requires robust clinker data and clinker ratio tracking	High emissions lock-in if clinker ratio stays high
2.B.1	Supply depends on gas/utilisation	Fertilizer value chain strengthens; export potential	Must separate process CO_2 vs energy emissions and track utilisation rates	Under/over-estimation if plant activity data inconsistent
2.C.1	Supply < demand (imports fill gap)	Steel import dependence persists; investment incentives grow	Domestic inventory may not reflect "consumption-based" steel footprint	Emissions could jump if integrated routes suddenly scale
2.F	Imports meet demand; informal trade grows	Cooling becomes major development need	Product-use MRV becomes essential: imports, servicing, leakage	HFC emissions become major future IPPU driver if Kigali is weak

2.G	Equipment base grows with grid	Reliability investments increase	Need utility MRV protocol for SF_6 bank and leakage	Large hidden emissions + high uncertainty

Table 9: ***Mitigation Scenarios Matrix (Options to Bend BAU While Maintaining Productivity)***

Scenario	Focus categories (CRT)	Core intervention logic	What changes vs BAU (activity/emissions driver)	Emissions impact potential (direction + where it comes from)	Productivity / competitiveness effect	MRV & data requirements (what must be measured)	Readiness in Nigeria (today)	Key barriers / risks	Implementation pathway (sequencing)
S1: Clinker Ratio Reduction & Blended Cement Scale-up	**2.A.1**	Reduce process CO_2 by lowering clinker content per tonne cement	Lower clinker-to-cement ratio; expand SCM use (slag, fly ash where available, calcined clays/LC3); update standards and market acceptance	**High** (process CO_2 reduction is direct and structural)	Often **positive**: lower energy use per tonne, potential cost savings if SCM supply is stable	Clinker production; clinker ratio; SCM volumes; cement dispatch; plant-level carbonate content; QA/QC on materials	Medium (some blending exists, needs scale and standards enforcement)	SCM supply constraints; standards compliance; market perception; logistics	(1) Standards & specs update → (2) SCM supply mapping → (3) producer reporting templates → (4) compliance monitoring
S2: Process Optimisation for Calcination (Best Available Techniques)	**2.A.1**	Reduce emissions intensity and improve process control (still limited vs clinker ratio)	Better kiln control, raw meal optimisation, reduced waste, improved maintenance	**Low–moderate** for process CO_2 (bigger impact on energy), but some process reductions possible via reduced clinker losses and improved	Positive (higher yield, lower rejects)	Plant process parameters; clinker composition; carbonate inputs; mass balance; QA/	Medium–high (many plants already modern; needs systematic reporting)	Data confidentiality; inconsistent reporting	(1) Standardised plant reporting → (2) benchmarking → (3) targeted upgrades

				chemistry control)					
S3: CCUS for Cement Calcination CO_2 (Deep Decarbonisation)	**2.A.1**	Capture unavoidable process CO_2 from calcination	Adds capture unit, compression, transport, storage/utilisation chain	**Very high** (only option to near-eliminate process CO_2 at scale)	Mixed: raises costs, but can future-proof exports/carbon border risks	Continuous emissions monitoring; capture rate; energy penalty accounting; storage verification; MRV chain-of-custody	Low–medium (no scale deployment yet; needs enabling framework)	High capex; storage sites; regulatory framework; power reliability	(1) Pre-feasibility & site screening → (2) pilot → (3) cluster approach → (4) scale
S4: Blue/Green Ammonia Transition	**2.B.1**	Decouple ammonia from fossil reforming emissions	Blue: CCS on reforming CO_2; Green: hydrogen via renewables	**Moderate–high** (depends on fraction of output shifted)	Potential export premium, but high investment; may reduce gas exposure (green)	Production volumes by route; capture rates; electricity source; H_2 carbon intensity	Blue: low–medium; Green: low (depends on renewables scale)	Cost of H_2, infrastructure, policy incentives	(1) MRV-ready baseline → (2) blue pilots → (3) green scale with renewables
S5: N_2O Abatement in Nitric Acid	**2.B.2**	Install/ensure operation of N_2O abatement catalysts	Step-change reduction in N_2O independent of output	**High per unit** (N_2O has high GWP; abatement can cut most emissions)	Generally neutral/positive (compliance, potential carbon value)	Plant operating hours; abatement installation status; monitoring of N_2O emissions or proxy control	Unknown/variable (depends on plant existence/operation)	Plant intermittency; maintenance; enforcement	(1) Identify operating plants → (2) mandate abatement → (3) monitor performance
S6: Circular Steel & EAF Efficiency + Scrap System Strengthening	**2.C.1**	Keep growth in steel demand from driving high process emissions	Expand scrap recovery, improve EAF efficiency, avoid high-emission integrated routes	**Moderate** (prevents jump rather than deep cuts)	Positive (lower import dependence; job creation in recycling)	Steel output by route; scrap flows; EAF capacity utilisation; route-specific EFs	Medium (EAF already present; scrap system needs strengthening)	Power reliability; scrap quality/availability	(1) Map scrap flows → (2) incentives for recycling → (3) route-based reporting

			where possible						
S7: Kigali-aligned HFC Phase-down + Servicing MRV System	**2.F**	Reduce high-GWP refrigerants and leakage rates	Shift to low-GWP refrigerants; technician certification; recovery/recycling; tighten import controls	**High future avoidance** (prevents product-use becoming dominant)	Positive (better servicing industry, lower leakage costs); transition costs manageable	Refrigerant import by type; equipment stock; leakage rates; recovery/destruction; servicing sector registry	Medium (policy basis exists; MRV weak)	Informal markets; enforcement; skills gap	(1) Customs coding & reporting ⟶ (2) technician certification ⟶ (3) recovery infrastructure ⟶ (4) leakage reduction targets
S8: SF_6 Inventory Management & Leakage Control in Power Sector	**2.G**	Prevent high-GWP leakage from expanding switchgear base	Utility SF_6 "bank" accounting; leak detection; replacement with alternatives	**Moderate–high** (depends on scale of grid expansion and leakage control)	Positive (asset reliability; reduced losses)	SF_6 purchase records; installed base; leak rates; maintenance logs; disposal protocols	Low–medium (utilities can do it; needs mandate and template)	Data gaps; procurement opacity	(1) Utility reporting template ⟶ (2) mandatory annual reporting ⟶ (3) leakage KPIs

3.0 Policy and Regulatory Frameworks

National Climate Change Policies and their Implications for the IPPU Sector

Nigeria's commitment to addressing climate change is encapsulated in its National Climate Change Policy (NCCP) 2021–2030,[71] which outlines strategies for reducing greenhouse gas (GHG) emissions across various sectors, including industrial processes. The policy aims to foster a low-carbon, climate-resilient economy by integrating climate considerations into national development plans. It emphasizes the need for sustainable industrialization, promoting energy efficiency, and adopting cleaner technologies in industrial operations.

Complementing the NCCP, the Climate Change Act of 2021[72] provides a legal framework for climate action in Nigeria. The Act establishes the National Council on Climate Change (NCCC), tasked with coordinating climate change activities and implementing policies to achieve Nigeria's climate goals. The Act mandates the development of carbon budgets and sectoral emissions reduction targets, directly impacting the IPPU sector by requiring industries to monitor and report their emissions and adopt mitigation measures.

3.1 Sector-Specific Regulations

The Nigerian government has instituted a suite of sector regulations and cross-cutting permitting instruments to control industrial pollution and improve environmental performance across IPPU-relevant industries. NESREA's regulatory framework includes the National Environmental (Air Quality Control) Regulations (2014) and the amended Air Quality Control Regulations (2021), which set national requirements for air pollution management, including emissions control, monitoring and compliance obligations for industrial facilities.[73 74] In addition, NESREA issues sector-specific regulations that are directly relevant to IPPU subsectors, particularly the Non-Metallic Minerals Manufacturing Industries Regulations (S.I. No. 21, 2011) for cement and clinker operations, the Base Metals, Iron and Steel Manufacturing/Recycling Industries Regulations (S.I. No. 14, 2011) for metallurgical operations, and the Chemicals, Pharmaceuticals, Soap and Detergent Manufacturing Industries Regulations (2009) for chemical production facilities.[75 76 77 78] These instruments require facilities to adopt pollution abatement measures, keep records, and undertake monitoring/reporting activities that can be leveraged to strengthen IPPU MRV protocols and facility-level data flows.

Product-use emissions control is supported through NESREA's Ozone Layer Protection Regulations (2009) and the updated Ozone Layer Protection Regulations (S.I. No. 65, 2022), which establish prohibitions on release, permit systems and controls for refrigerant handling and related activities in the RAC sector an essential foundation for improving inventory completeness for fluorinated gases as Nigeria implements Kigali phase-down measures.[79 80] Cross-cutting instruments such as the Permitting and Licensing System Regulations (S.I. No. 29, 2009) and the Quarrying and Blasting Operations Regulations (S.I. No. 33, 2013) provide important enabling mechanisms for facility enumeration, licensing registers and upstream activity verification (e.g., limestone extraction), which can directly strengthen IPPU activity data quality and inventory QA/QC.[81 82 83] Finally, legacy FEPA interim guidelines on industrial effluents, gaseous emissions and hazardous wastes remain useful reference benchmarks for industrial compliance and environmental management, particularly where sectoral regulations are incomplete or where

[71] Federal Ministry of Environment (2021). *National Climate Change Policy for Nigeria (2021-2030)*.
[72] Federal Republic of Nigeria (2021). *Climate Change Act, 2021 (Act No. 17 of 2021)*
[73] National Environmental (Air Quality Control) Regulations, 2014 (NESREA PDF).
[74] NESREA Laws & Regulations listing for National Environmental (Air Quality Control) Regulations, S.I. No 88, 2021 (Amended)
[75] National Environmental (Non-Metallic Minerals Manufacturing Industries Sector) Regulations, 2011 (NESREA PDF).
[76] National Environmental (Base Metals, Iron and Steel Manufacturing/Recycling Industries Sector) Regulations, 2011
[77] National Environmental (Chemical, Pharmaceuticals, Soap and Detergent Manufacturing Industries) Regulations, 2009 (NESREA PDF).
[78] National Environmental (Domestic and Industrial Plastic, Rubber and Foam Sector) Regulations, 2011 (NESREA PDF)
[79] National Environmental (Ozone Layer Protection) Regulations, 2009 (Official Gazette PDF on NESREA).
[80] NESREA Laws & Regulations listing for National Environmental (Ozone Layer Protection) Regulations, S.I. No. 65, 2022.
[81] NESREA Laws & Regulations listing for National Environmental (Permitting and Licensing System) Regulations, S.I. No. 29, 2009.
[82] NESREA Laws & Regulations listing for National Environmental (Quarrying and Blasting Operations) Regulations, S.I. No. 33, 2013.
[83] NESREA Laws & Regulations listing for National Environmental (Mining and Processing of Coal, Ores and Industrial Minerals) Regulations, S.I. No. 31, 2009

historic data series require contextual interpretation.[84] [85]

3.2 Incentives and Barriers to GHG Mitigation in Industry

Nigeria's framework for incentivizing industrial emissions reduction is embedded within broader fiscal, investment and industrial policy instruments rather than in a dedicated carbon pricing or industrial decarbonization tax credit scheme. One of the most prominent incentives available to manufacturing firms, including those operating in IPPU-relevant sectors such as cement, steel and chemicals, is the Pioneer Status Incentive (PSI) established under the *Industrial Development (Income Tax Relief) Act*.[86] The scheme grants qualifying companies an initial three-year corporate income tax holiday, extendable by an additional two years, for activities designated as beneficial to national development. The Nigerian Investment Promotion Commission (NIPC) administers this regime. While renewable energy generation and certain manufacturing categories have been included among eligible activities, the incentive is not explicitly tied to greenhouse gas (GHG) performance metrics, and publicly available documentation does not demonstrate measurable GHG mitigation outcomes attributable specifically to this scheme.

In addition, the *Companies Income Tax Act (CITA)* provides capital allowance provisions that enable firms to deduct investments in plant and machinery, including energy-efficient equipment.[87] These fiscal measures, administered by the Federal Inland Revenue Service (FIRS), indirectly reduce the cost of industrial modernization and may support process optimization in IPPU facilities. However, they are not climate-targeted instruments and do not require reporting of emissions reductions as a condition for benefit. Similarly, periodic customs duty waivers approved by the Federal Government for renewable energy equipment reduce the cost of captive solar installations and related technologies.[88] While such measures can lower industrial energy intensity under the Energy sector (CRT 1A2), they do not directly address process emissions reported under IPPU (CRT 2A-2G).

Nigeria's sovereign green bond programme, coordinated by the Debt Management Office (DMO), represents another potential financing avenue for climate-related investments.[89] Although past issuances have primarily financed renewable energy, afforestation and transport projects, the framework allows for industrial energy efficiency projects to qualify if appropriately structured. To date, however, there is limited evidence of significant uptake of green bond financing within heavy industrial IPPU subsectors.

Notwithstanding these instruments, Nigeria currently does not operate a dedicated industrial carbon tax, emissions trading system, or sector-specific GHG mitigation tax credit applicable to cement, steel or chemical production. This institutional gap is particularly relevant given the rapid growth of IPPU emissions documented in the First Biennial Transparency Report (BTR1).[90] Although the *Climate Change Act, 2021* provides for the development of carbon budgets and sectoral targets under the oversight of the National Council on Climate Change (NCCC), operationalization of binding industrial carbon limits remains at an early stage. The absence of a clear carbon pricing signal reduces the economic incentive for firms to invest in capital-intensive mitigation technologies such as carbon capture, utilization and storage (CCUS) in cement production or low-carbon hydrogen pathways in ammonia manufacturing.

Beyond fiscal limitations, structural barriers constrain industrial decarbonization. High domestic interest rates and limited access to long-term concessional finance increase the cost of clean technology deployment. Infrastructure deficits including unreliable electricity supply, gas supply volatility, and the absence of CO_2 transport and storage infrastructure further undermine feasibility of deep decarbonization pathways. In addition, while NESREA's sectoral regulations require pollution control and environmental monitoring for industrial facilities, these

[84] National Interim Guidelines and Standards for Industrial Effluents, Gaseous Emissions and Hazardous Wastes Management in Nigeria (1991)
[85] NESREA Laws & Regulations listing for National Environmental (Energy Sector) Regulations, S.I. No. 63, 2014.
[86] Industrial Development (Income Tax Relief) Act, Cap I7, Laws of the Federation of Nigeria; administered by the Nigerian Investment Promotion Commission (NIPC)
[87] Companies Income Tax Act (CITA), Cap C21, Laws of the Federation of Nigeria; administered by the Federal Inland Revenue Service (FIRS).
[88] Federal Ministry of Finance, Budget and National Planning; Nigeria Customs Service tariff schedules and renewable energy duty waiver provisions
[89] Debt Management Office (DMO), Federal Government of Nigeria, *Sovereign Green Bond Programme Framework* (2017; subsequent issuances 2025)
[90] BTR, 2024

compliance systems are not yet fully integrated with Nigeria's national GHG inventory architecture under the Enhanced Transparency Framework. This weak linkage between facility-level environmental reporting and national inventory compilation constrains the quality and timeliness of IPPU emissions data.

In the product-use domain (CRT 2F and 2G), Nigeria has ratified the Kigali Amendment and updated its Ozone Layer Protection Regulations in 2022, providing a regulatory basis for phasing down high-GWP refrigerants.[91] However, enforcement challenges, limited technician certification coverage, and gaps in refrigerant recovery systems continue to limit mitigation effectiveness in the refrigeration and air-conditioning sector.

Nigeria's incentive landscape supports industrial development broadly but provides limited targeted mechanisms specifically designed to drive GHG mitigation within IPPU subsectors.

3.3 International Commitments Affecting IPPU

Paris Agreement and ETF reporting implications for IPPU

Under the Paris Agreement's Enhanced Transparency Framework, Parties are required to submit Biennial Transparency Reports (BTRs) and associated inventory information in accordance with agreed modalities and guidelines.[92] Nigeria submitted its first BTR (BTR1) by the end-2024 deadline, reinforcing that national reporting must be based on transparent, consistent time series across sectors, including IPPU. For IPPU, this increases the importance of facility enumeration (cement, ammonia, iron/steel), activity data systems, archiving, and recalculation protocols that can withstand expert review under the ETF.

Kigali Amendment implications for IPPU product-use emissions

Nigeria's acceptance of the Kigali Amendment commits the country to a phasedown of hydrofluorocarbons (HFCs), a major driver of future IPPU emissions under product-use categories. Nigeria deposited its instrument of ratification/acceptance in **December 2018**, placing it within the Kigali compliance regime.[93] In practical terms, this commitment requires Nigeria to strengthen refrigerant import licensing, servicing-sector governance, recovery/recycling infrastructure, and data systems that can quantify and reduce HFC leakage. These measures are directly relevant to improving completeness and accuracy for IPPU Category 2F and related product-use reporting.

CBAM and the competitiveness case for IPPU MRV

The EU's Carbon Border Adjustment Mechanism (CBAM) is a major emerging international driver for industrial MRV because it targets carbon-intensive imports and initially covers products that overlap with Nigeria's IPPU subsectors most notably cement, iron and steel, and fertilizers. The European Commission confirms that CBAM has a transitional period (2023-2025) and moves into its definitive regime from 2026, aligned with the EU ETS architecture.[6] Independent policy analysis also confirms the initial product coverage list and explains that the mechanism can generate wider trade implications for exporting countries.[7] For Nigeria, CBAM's relevance is not only potential cost exposure for EU-bound exports, but also the incentive it creates to establish credible embedded-emissions calculations and verification systems for industrial goods meaning IPPU MRV improvements can become a competitiveness strategy, not only a reporting obligation.[94]

[91] National Environmental (Ozone Layer Protection) Regulations, S.I. No. 65, 2022, issued by the National Environmental Standards and Regulations Enforcement Agency (NESREA).
[92] UNFCCC, "First Biennial Transparency Reports (BTRs)" (reporting requirements under Article 13 / MPGs)
[93] United Nations Treaty Collection, Kigali Amendment to the Montreal Protocol
[94] European Commission, "Carbon Border Adjustment Mechanism (CBAM)" (scope, transition period 2023–2025 and definitive regime from 2026).

4.0 Institutional Framework

An effective institutional framework is vital for the robust and transparent preparation of greenhouse gas (GHG) inventories, particularly for complex sectors such as Industrial Processes and Product Use (IPPU). In Nigeria, multiple government agencies, regulatory bodies, and sectoral institutions play complementary roles in the governance of IPPU-related data, policy development, emissions estimation, and reporting. The effectiveness of their collaboration directly influences the quality and reliability of the national GHG inventory, as well as Nigeria's compliance with its international climate obligations.

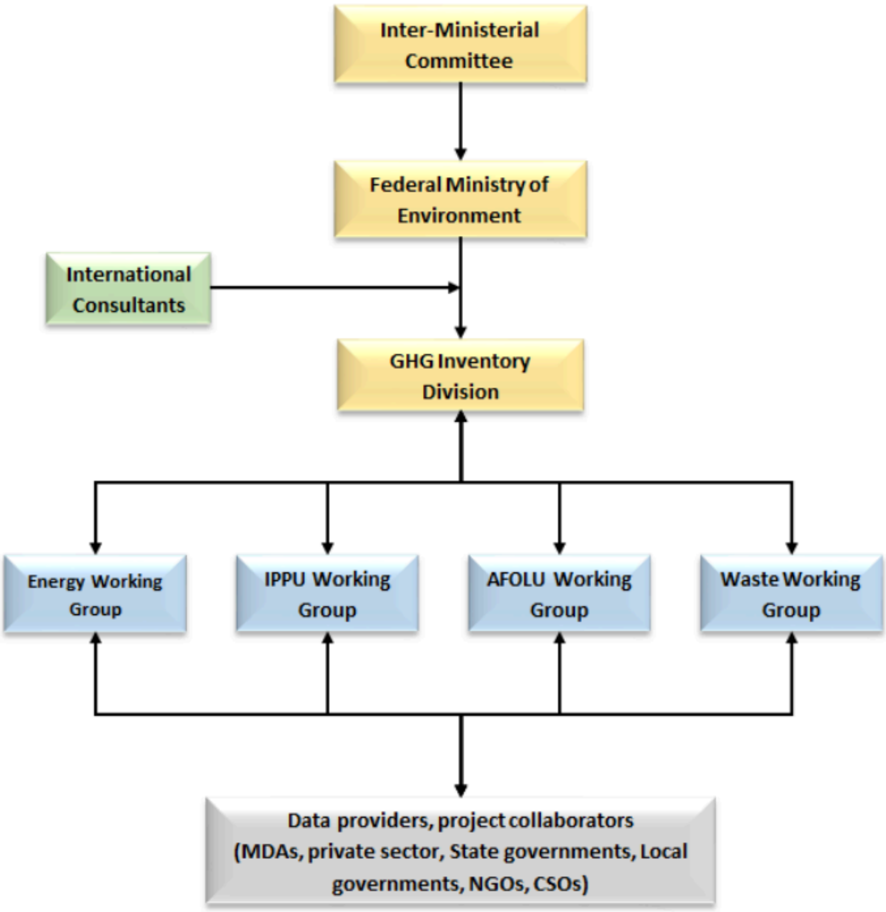

Fig 1: Formal institutional Arrangement for the MRV covering the IPPU Sector

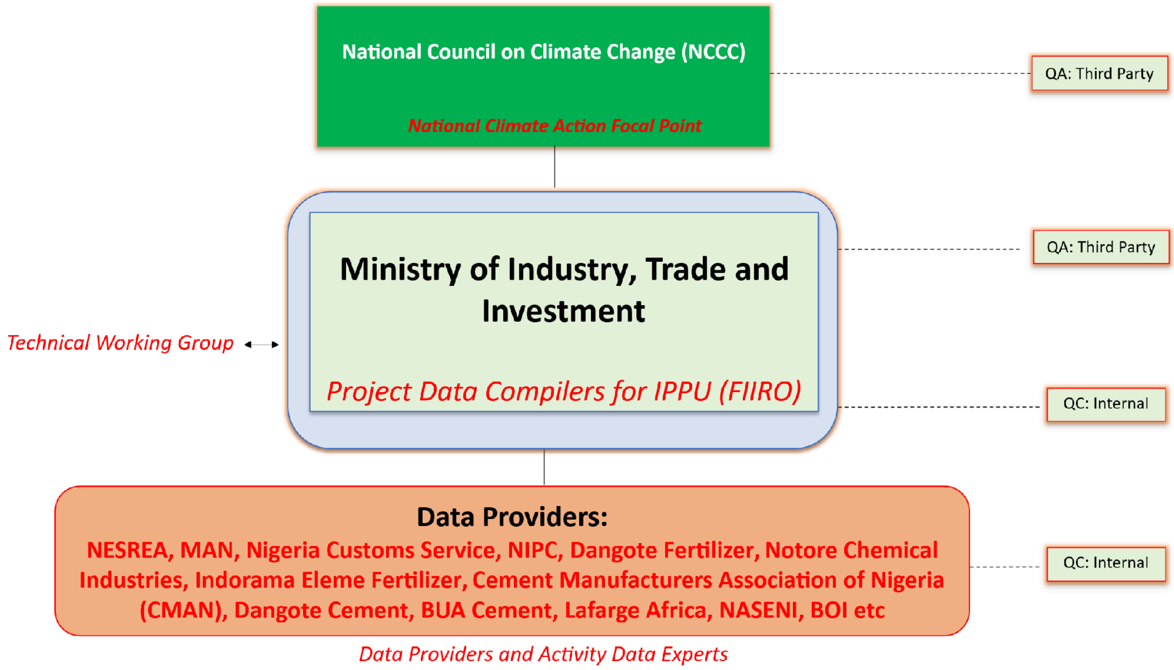

Fig 2: Proposed Institutional Arrangement IPPU Sector

4.1 Key Institutions Involved in IPPU Governance

Nigeria's climate governance framework was fundamentally restructured by the *Climate Change Act, 2021 (Act No. 17 of 2021)*, which established the National Council on Climate Change (NCCC) as the apex body responsible for coordinating national climate action, including greenhouse gas (GHG) inventory management, carbon budgeting, and international climate reporting under the UNFCCC and the Paris Agreement. The NCCC's mandate provides the overarching institutional basis for economy-wide coordination of emissions reduction efforts and the development of sectoral pathways, including for industrial process emissions and product-use emissions reported under the IPPU sector.

Within this architecture, the Federal Ministry of Environment (FMEnv), through its Department of Climate Change (DCC), retains a central technical role in inventory compilation and sectoral coordination, working under the policy direction and coordinating authority of the NCCC. The FMEnv/DCC contributes to methodological development, inventory QA/QC processes, stakeholder engagement, and coordination of technical inputs required for reporting under the Enhanced Transparency Framework. The Ministry also provides institutional linkages to environmental compliance systems and to sectoral regulators whose administrative data and monitoring records are critical for improving the completeness and accuracy of IPPU reporting.

Environmental regulation and industrial compliance oversight are led by the National Environmental Standards and Regulations Enforcement Agency (NESREA), which issues and enforces sector-specific environmental regulations relevant to IPPU subsectors such as cement and clinker production, iron and steel manufacturing and recycling, chemical manufacturing, plastics/rubber/foam production, quarrying and industrial minerals processing, and ozone layer protection. NESREA's permitting, inspection and monitoring functions are not designed for GHG inventory compilation; however, its compliance records, facility registers, and monitoring reports provide an important institutional entry point for strengthening facility-level data flows, improving the identification of emitting installations, and supporting verification of industrial activity data used in IPPU emissions estimation.

The National Bureau of Statistics (NBS) serves as the official custodian of national statistical data and is a key provider of activity data for IPPU estimation, including industrial production statistics, manufacturing indices, and trade-related datasets. For IPPU categories, NBS data on cement output, fertilizer and chemical production, steel production, and industrial growth indicators provide the core statistical basis for national activity data series. Strengthening interoperability between NBS production statistics and inventory data requirements remains critical for improving time-series consistency and reducing reliance on ad-hoc or project-based datasets.

Industrial development policy and private sector engagement are primarily led by the Federal Ministry of Industry, Trade and Investment (FMITI), which interfaces with strategic manufacturing sectors and helps shape industrial growth pathways that drive future IPPU emissions trajectories. The Standards Organization of Nigeria (SON) complements this role by setting product and process standards that directly influence emissions intensity, including cement standards affecting clinker substitution and blended cement uptake, industrial product specifications, and conformity assessment systems that shape technology choices in manufacturing.

Fiscal and investment institutions also play a decisive role in enabling or constraining industrial mitigation. The Federal Ministry of Finance, Budget and National Planning (FMFBNP) shapes fiscal policy, public investment priorities, and climate finance mobilization pathways that can support industrial decarbonization, including concessional financing approaches for low-carbon manufacturing. The Federal Inland Revenue Service (FIRS), as the national tax authority responsible for administering corporate income tax provisions, is a key institutional actor for any fiscal instruments that may influence mitigation investment decisions in industry, including the operationalization of tax-based incentives or any future carbon-related fiscal measures.

Investment promotion and industrial incentives are administered by the Nigerian Investment Promotion Commission (NIPC), which manages the Pioneer Status Incentive regime under the *Industrial Development (Income Tax Relief) Act*. While this is not a climate-specific incentive, its implementation influences industrial investment decisions and can indirectly affect the pace of technology upgrades in IPPU-relevant industries.

Trade and customs agencies are increasingly important for IPPU governance and MRV, particularly in the context of product-use emissions and potential trade-related climate measures such as the EU Carbon Border Adjustment Mechanism (CBAM). The Nigeria Customs Service (NCS) holds critical administrative data on imports and exports of cement and clinker inputs, steel products, fertilizer and chemical products, and refrigerants used in refrigeration and air-conditioning systems. Customs data are therefore essential both for demand–supply assessments and for strengthening inventory completeness for IPPU product-use categories, especially fluorinated gases under IPCC 2F.

For product-use emissions linked to refrigeration and air-conditioning (2F) and for SF_6 management in electrical equipment (2G), additional institutional actors become critical. The electricity utilities and system operators, including the Transmission Company of Nigeria (TCN) and Distribution Companies (DisCos), are key data holders for SF_6-containing switchgear and maintenance systems, and their asset inventories and procurement/maintenance records are necessary for quantifying and managing emissions from electrical equipment. Similarly, agencies involved in refrigerant regulation and ozone layer protection implementation, working alongside NESREA's ozone regulations, provide institutional entry points for building registries, technician certification coverage, and refrigerant tracking systems that are necessary for robust HFC phase-down implementation.

Sector-specific regulators in the energy and hydrocarbons space also indirectly influence IPPU emissions, particularly for ammonia production where natural gas availability, pricing and supply reliability are fundamental. The Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) therefore has an important enabling role, even though its mandate is not climate-focused, because gas market governance affects the operational stability and emissions trajectory of large chemical manufacturing facilities.

Finally, effective IPPU governance requires structured engagement with private sector operators and industry associations that are primary sources of facility-level activity data and technology information. Major producers in cement, fertilizer and steel industries, as well as umbrella bodies such as the Manufacturers Association of Nigeria (MAN) and relevant subsector associations, are essential partners for institutionalizing consistent data reporting protocols and improving the credibility of both inventory estimates and mitigation monitoring.

4.2 Roles and Responsibilities in GHG Inventory Preparation

Under the *Climate Change Act, 2021*, the National Council on Climate Change (NCCC) serves as the apex national climate authority and the central coordinating institution for carbon budgeting, sectoral emissions oversight, and international reporting under the UNFCCC and the Paris Agreement.[1] In this context, the NCCC provides strategic oversight for the preparation and submission of national greenhouse gas (GHG) inventories, including emissions from the Industrial Processes and Product Use (IPPU) sector. The NCCC functions as the National Climate Action Focal Point and ensures that sectoral inventory processes align with national carbon budget frameworks and Enhanced Transparency Framework (ETF) requirements.

In line with the governance architecture illustrated above, the Federal Ministry of Industry, Trade and Investment (FMITI) serves as the sectoral coordinating institution and lead data compiler for the IPPU sector. Through its designated inventory focal unit (currently operating under the project framework), FMITI coordinates activity data collection, engages industrial stakeholders, and consolidates facility-level production data. This institutional positioning reflects the fact that IPPU emissions are intrinsically linked to industrial production systems and that the Ministry has direct policy and engagement leverage over major emitting facilities.

Data provision for IPPU must move progressively toward a facility-based reporting system, particularly for major emitting subsectors such as cement (CRT 2A.1), ammonia (CRT 2B.1), nitric acid (CRT 2B.2), iron and steel (CRT 2C.1), and fluorinated gases (CRT 2F and 2G). Unlike diffuse agricultural emissions, IPPU emissions are concentrated in identifiable industrial installations. International best practice, such as the EU Emissions Trading System (EU-ETS), demonstrates that facility-level mandatory annual reporting significantly improves data accuracy, time-series consistency, and transparency.

Currently, Nigeria relies on a combination of:

- National Bureau of Statistics (NBS) industrial surveys,
- Administrative records,
- Industry association data (e.g., Cement Manufacturers Association of Nigeria - CMAN; Manufacturers Association of Nigeria - MAN),
- Direct engagement with major operators (e.g., Dangote Cement, BUA Cement, Lafarge Africa, Dangote Fertilizer, Notore Chemical Industries, Indorama Eleme Fertilizer),
- Trade statistics from the Nigeria Customs Service (for refrigerants, clinker inputs, fertilizers and steel products).

However, there is no dedicated regulation mandating annual GHG emissions reporting at the facility level for IPPU installations. Establishing such a regulatory requirement potentially under NESREA regulations or pursuant to carbon budgeting provisions of the Climate Change Act would significantly enhance inventory quality and align Nigeria's IPPU system with international best practice.

The role of NESREA remains critical for compliance monitoring and environmental regulation enforcement across cement, steel, chemical manufacturing and ozone-related sectors. While NESREA does not compile the GHG inventory, its permitting records, inspection reports, and facility registries provide essential institutional entry points for establishing a mandatory emissions reporting framework.

The National Bureau of Statistics provides national production and industrial output data, which remain important for cross-checking and validation, particularly where facility-level data are incomplete. Nigeria Customs Service contributes import-export data critical for tracking refrigerants (HFCs), clinker imports, steel trade flows, and fertilizer products, all of which influence IPPU activity data and embedded emissions calculations especially in light of potential Carbon Border Adjustment Mechanism (CBAM) exposure for exports to the European Union.

Quality Control (QC) and Quality Assurance (QA) responsibilities are structured at two levels, consistent with the diagram. Internal QC is conducted at the sectoral compilation level within FMITI's IPPU technical unit and the sectoral Technical Working Group. External QA is undertaken through third-party review, including academic experts, independent consultants, and international technical review processes under the UNFCCC ETF framework. The NCCC provides high-level validation before submission.

4.3 Coordination Mechanisms and Inter-Agency Collaboration

Nigeria's IPPU inventory governance operates within a multi-tier coordination framework. At the apex, the NCCC ensures policy alignment, carbon budget consistency, and cross-sector harmonization. Beneath this level, the sectoral coordination responsibility for IPPU rests with FMITI, supported by a Technical Working Group (TWG) comprising representatives from relevant MDAs, regulatory agencies, statistical institutions, academia, and industry stakeholders.

The IPPU Technical Working Group plays a central operational role in:

- Identifying data sources,
- Validating production statistics,
- Recommending methodological improvements (e.g., transition from Tier 1 to Tier 2 approaches),
- Addressing recalculation needs,
- Documenting uncertainty assessments,
- Supporting archiving and transparency documentation for BTR reporting.

Data providers including NESREA, NBS, Nigeria Customs Service, NIPC, major cement and fertilizer producers, CMAN, MAN, NASENI, and financial institutions such as the Bank of Industry (BOI) form the foundational layer of the system. These entities act as Activity Data Experts and primary data holders.

Despite improvements observed during preparation of Nigeria's First Biennial Transparency Report (BTR1), coordination challenges persist. These include delays in data submission, limited digital automation of reporting systems, absence of formal data-sharing agreements in some cases, and institutional turnover that affects technical continuity. Furthermore, the absence of a legally binding facility-level GHG reporting requirement remains a structural limitation in achieving EU-ETS-level inventory robustness.

To address these challenges, strengthening formal data-sharing protocols, digitalizing inventory management systems, institutionalizing annual facility reporting requirements, and integrating regulatory compliance data into the national inventory architecture will be essential. Doing so would move Nigeria's IPPU inventory system from a largely project-supported model toward a sustainable, legally anchored, and ETF-compliant institutional framework.

4.4 Institutional Strengths, Gaps, and Capacity Needs

Nigeria's institutional framework for IPPU governance and greenhouse gas inventory preparation has matured significantly in recent years, particularly following enactment of the *Climate Change Act, 2021* and submission of the First Biennial Transparency Report (BTR1). The establishment of the National Council on Climate Change (NCCC) as a statutory apex authority has provided a durable governance foundation for carbon budgeting, sectoral coordination, and international reporting. Unlike earlier arrangements that were largely project-driven, the current framework embeds climate oversight within national law, thereby enhancing institutional legitimacy and long-term continuity.

Another important structural strength lies in the concentrated nature of Nigeria's IPPU emissions profile. Major emissions originate from a limited number of identifiable facilities in cement, ammonia, nitric acid, iron and steel, and fluorinated gas-intensive product-use sectors. This concentration creates a strategic opportunity: with appropriate regulatory instruments, Nigeria can significantly improve inventory accuracy and mitigation monitoring through facility-level reporting. The growing willingness of major industrial actors particularly in cement and fertilizer production to engage in reporting processes demonstrates increasing private-sector recognition of climate governance expectations. The National Bureau of Statistics provides a reliable statistical foundation for cross-checking production volumes and industrial growth trends, while administrative data from regulators and customs authorities offer complementary validation channels.

However, despite these strengths, the institutional framework remains transitional and exhibits several structural gaps that constrain robustness, transparency, and sustainability.

The most critical gap is the absence of a legally operationalised facility-level greenhouse gas reporting requirement for major industrial emitters. While the Climate Change Act provides for carbon budgeting and sectoral emission oversight, it has not yet translated into binding annual emissions reporting obligations for IPPU installations. As a result, inventory compilation still relies heavily on cooperative data provision rather than enforceable disclosure. International experience such as the EU Emissions Trading System demonstrates that mandatory, standardised, plant-level reporting dramatically improves transparency, time-series consistency, and verification quality. Without a similar regulatory mechanism, Nigeria's IPPU inventory remains vulnerable to data gaps, reporting delays, and inconsistencies arising from institutional turnover.

Closely related is the incomplete operationalisation of carbon budgets for the industrial sector. Although the Climate Change Act provides a framework for national carbon budgets, sector-specific allocations and compliance pathways for IPPU industries are not yet clearly defined. In the absence of defined emission ceilings or mitigation benchmarks for high-emitting subsectors, inventory preparation risks becoming descriptive rather than policy-linked. The integration of sectoral carbon budgets into industrial planning, licensing, and compliance systems remains a critical next step in strengthening governance coherence.

A further gap concerns verification architecture. Current quality control (QC) processes operate internally within sectoral compilation teams and Technical Working Groups, with external quality assurance largely dependent on international expert review under the Enhanced Transparency Framework. However, there is no institutionalised domestic third-party verification mechanism for facility-level emissions data. Establishing nationally accredited verification procedures would enhance credibility, particularly if Nigeria seeks to align with international trade-related climate measures or develop carbon market instruments.

Financial sustainability represents another structural vulnerability. Much of the technical progress achieved in IPPU inventory development has been supported by donor-funded or project-based initiatives. While these have strengthened capacity, reliance on external support risks discontinuity between reporting cycles. A fully institutionalised system requires predictable annual budget allocations, dedicated staff positions, and long-term digital infrastructure investment anchored in national planning and finance frameworks.

Data governance also requires strengthening. Currently, there are no nationally standardised digital templates or automated submission platforms for industrial emissions data. Data collection is often conducted through correspondence and manual consolidation. This limits auditability, increases administrative burden, and constrains archiving quality. The absence of a centralised emissions data management platform restricts Nigeria's ability to maintain transparent recalculation records, document methodological changes systematically, and ensure version control across inventory cycles core requirements under the Enhanced Transparency Framework.

In addition, confidentiality safeguards for commercially sensitive industrial data have not yet been formally codified within the inventory architecture. As Nigeria moves toward facility-level reporting and potentially toward embedded emissions accounting for export competitiveness, clear legal and procedural assurances regarding data confidentiality and aggregation will be essential to sustain private-sector cooperation.

Subnational institutional alignment remains uneven. While federal-level agencies involved in BTR preparation have strengthened technical capacity, state environmental agencies and industrial regulators often lack training in IPCC methodologies, uncertainty analysis, and MRV system design. Given that industrial facilities operate within state jurisdictions, strengthening vertical coordination between federal climate institutions and state-level regulators will be critical for sustained compliance and data reliability.

Methodological limitations persist as well. Reliance on Tier 1 emission factors for several IPPU subcategories reduces precision and limits analytical capacity for mitigation scenario modelling. The development of country-specific emission factors particularly for clinker composition, lime production processes, nitric acid abatement performance, and fluorinated gas leakage rates requires sustained technical collaboration with industry and potentially plant-level measurement studies.

Trade-related readiness is an emerging institutional challenge. With mechanisms such as the EU Carbon Border Adjustment Mechanism placing increasing emphasis on embedded emissions in exported goods, Nigeria currently lacks a nationally standardised product carbon footprint methodology or accredited domestic verification framework capable of certifying embedded emissions in cement, steel, or fertilizer exports. This represents both a governance gap and a competitiveness risk.

Despite these challenges, the trajectory of reform is positive. Nigeria's IPPU governance system has evolved from a fragmented, project-supported model toward a legally anchored structure under the Climate Change Act. The next phase of institutional strengthening must focus on institutionalisation: establishing mandatory facility-level reporting regulations; operationalising sectoral carbon budgets; developing accredited verification systems; formalising data-sharing agreements; investing in digital emissions registries; ensuring sustainable public financing; and embedding confidentiality safeguards. Achieving these reforms would significantly enhance transparency, accuracy, completeness, consistency, and comparability of Nigeria's IPPU inventory while positioning the country to manage industrial decarbonisation strategically within its broader economic transformation agenda.

5.0 Data Collection and Management

A reliable and transparent data collection and management system is fundamental to the accurate estimation and reporting of greenhouse gas emissions, particularly in data-intensive sectors such as Industrial Processes and Product Use (IPPU). Nigeria's approach to IPPU data collection has evolved over the years, with significant strides made in recent submissions under the Enhanced Transparency Framework (ETF) as reflected in the First Biennial Transparency Report (BTR1). However, systemic gaps, data access constraints, and coordination challenges still persist, limiting the robustness of emission estimates.[95]

[95] BTR, 20204

5.1 Sources of Activity Data

Activity data for the IPPU sector in Nigeria are derived from a combination of industrial production records, structured government statistical surveys, regulatory administrative data, and trade documentation. Because IPPU emissions originate from identifiable industrial processes, the reliability of the inventory depends heavily on accurate production statistics and facility-level operational information.

Major industry stakeholders serve as primary data providers for high-emitting subcategories. The Cement Manufacturers Association of Nigeria (CMAN) and individual producers such as Dangote Cement, BUA Cement, and Lafarge Africa provide production volumes, clinker ratios, and plant-level operational information relevant to Category 2A.1 (Cement Production). In the chemical sector, companies such as Dangote Fertilizer, Indorama Eleme Fertilizer, and Notore Chemical Industries provide output data for ammonia (2B.1) and nitric acid (2B.2), while the Fertilizer Producers and Suppliers Association of Nigeria (FEPSAN) contributes aggregated industry statistics. In iron and steel (2C.1), production data are sourced from facility operators and relevant industrial associations.

The National Bureau of Statistics (NBS) plays a central coordinating role by compiling and publishing industrial production statistics through instruments such as the Annual Abstract of Statistics, the Industrial Sector Performance Reports, and manufacturing surveys. These datasets provide annual production volumes, sector growth indicators, and structural economic data that support IPPU activity data estimation. NBS data are particularly important for time-series consistency and for validating industry-reported figures.

Administrative records from sectoral ministries including the Federal Ministry of Industry, Trade and Investment and the Federal Ministry of Environment provide complementary information on installed production capacity, new plant commissioning, and industrial expansion trends. The Nigeria Customs Service supplies import and export data that are especially relevant for fluorinated gases (CRT 2F) and other product-use categories. Refrigerant import volumes, for example, form the basis for estimating consumption and stock changes in refrigeration and air-conditioning systems.

In addition to these sources, Nigeria's national energy balance constitutes an important cross-sectoral validation tool. Although fuel combustion emissions are reported under the Energy sector (CRT 1A2 – Manufacturing Industries and Construction), energy balance statistics compiled by national energy authorities provide valuable consistency checks for IPPU activity data. For example, fuel consumption in cement kilns can be used to cross-validate reported clinker production trends; natural gas consumption data can support plausibility checks for ammonia production volumes; and electricity consumption patterns in steel plants can help distinguish between primary and secondary production routes. While energy data are not used directly to estimate IPPU process emissions, they are critical for preventing double counting, identifying data anomalies, and ensuring coherence between the Energy and IPPU sectors within the national inventory.

The integration of industrial production statistics, trade records, regulatory information, and energy balance data strengthens completeness and internal consistency across the national GHG inventory. However, the current system remains partly dependent on voluntary data provision and aggregated statistics. Strengthening facility-level reporting and improving interoperability between statistical, regulatory, and energy datasets will further enhance transparency, comparability, and methodological robustness in future inventory cycles.

5.2 Current Data Collection Processes and Tools

The data collection process for the IPPU inventory is coordinated by the Department of Climate Change (DCC) under the Federal Ministry of Environment, with technical support from the National Council on Climate Change Secretariat (NCCCS). Data are gathered through formal requests to MDAs and industry stakeholders using predesigned templates aligned with IPCC 2006 Guidelines and its 2019 Refinement. The process is supported by sector-specific Technical Working Groups (TWGs), which review submitted data, verify activity levels, and determine the appropriateness of emission factors.

To facilitate this, Nigeria has increasingly adopted digital tools such as Excel-based reporting templates, IPCC's

Inventory Software, and in some cases the Low Emissions Analysis Platform (LEAP)[96] for scenario modelling. However, the majority of data exchange and validation is still conducted manually or via email correspondence, resulting in inefficiencies and potential for human error. Only a few sectors primarily cement and fertilizer have begun implementing enterprise-level data tracking that is regularly synchronized with inventory processes.

5.3 Data Quality, Consistency, and Completeness

Data quality in the IPPU sector varies widely across subsectors. Cement production data, for instance, tends to be more complete and consistent, given the dominance of a few large producers who maintain good internal reporting systems. The use of Tier 2 methodologies and site-specific emission factors in this subsector is increasingly being explored. In contrast, data for smaller industries and less organized subsectors (e.g., informal metallurgy, smaller chemical producers, HFC servicing) are often incomplete, estimated with default IPCC factors, and based on extrapolated trends from outdated surveys.

The 2024 BTR highlights the improvements made in disaggregating emissions at subcategory levels and recalculating historical estimates for consistency across the 2000–2022 time series. However, persistent issues include inconsistent data formats across sources, duplication of figures, time lags in submissions, and varying levels of technical competence among data providers. There is limited application of systematic quality assurance and control (QA/QC) protocols, and data archiving systems remain fragmented and underdeveloped.

5.4 Confidentiality and Access Issues

A significant constraint in IPPU data collection is the reluctance of some private sector actors to disclose production and emissions data due to confidentiality concerns. Companies view such data as commercially sensitive, especially in competitive sub-sectors like cement and chemicals. This limits the granularity and transparency of data that can be accessed by inventory compilers.

Moreover, there are no legal requirements mandating industries to submit emissions data or activity statistics for inventory purposes, except through voluntary cooperation or soft regulations via sectoral guidelines. The absence of a central data-sharing platform with built-in confidentiality protections further hampers data access and verification.

To address this, Nigeria has initiated dialogue on data governance standards under the Climate Change Act of 2021. However, operational frameworks such as non-disclosure agreements (NDAs), third-party data auditing, and anonymized reporting protocols are still in the early stages of development.

5.5 Identified Gaps and Recommendations for Improvement

Several gaps have been identified in the current data collection and management system for the IPPU sector:

1. Lack of institutionalized data-sharing mandates: Many MDAs and industry groups lack binding obligations to provide regular, standardized data for GHG inventories.

2. Limited sub-sectoral coverage: Informal and small-scale industrial activities are largely unrepresented in current data systems, despite their cumulative emissions significance.

3. Non-existence of local emission factors: Most IPPU subsectors rely on default IPCC emission factors, which may not reflect local production processes or material characteristics.

4. Low technical capacity for emissions estimation: Many institutions do not have dedicated personnel trained in GHG inventory methodologies or IPPU sector emissions accounting.

5. Fragmented data storage and archiving: There is no unified digital platform or database for storing, updating, and sharing inventory data among stakeholders.

[96] Developed by Stockholm Environment Institute (SEI)

To improve the system, the following actions are recommended:

- Establish legal mandates for industrial data reporting under the Climate Change Act and embed them into sectoral regulatory frameworks.
- Develop sector-specific emission factor studies to localize inventory parameters, beginning with the cement and fertilizer industries.
- Build a centralized, web-based GHG data portal managed by the NCCCS, with tiered access, secure data storage, and built-in QA/QC tools.
- Conduct regular training programs and capacity-building workshops for data providers and inventory compilers across MDAs and the private sector.
- Introduce incentives (e.g., tax rebates, compliance credits) for companies that voluntarily provide verified emissions data.
- Strengthen coordination between the NBS, NESREA, FMEnv, and key industrial associations to institutionalize periodic data collection schedules.

7.0 Challenges and Opportunities

The Industrial Processes and Product Use (IPPU) sector in Nigeria plays an increasingly significant role in the country's greenhouse gas (GHG) profile. As industrialization expands especially in the cement, chemicals, metallurgy, and refrigeration sub-sectors so too does the urgency to improve the accuracy, transparency, and consistency of data used for inventory development. While progress has been made, the process is still hampered by several persistent challenges. Conversely, there are substantial opportunities for improvement that could enhance national reporting and support low-carbon industrial development.

7.1 Data Availability and Institutional Coordination

One of the most persistent challenges facing Nigeria's IPPU GHG inventory system is the limited availability of high-quality, timely, and disaggregated data. The current data ecosystem is characterized by fragmentation across multiple institutions, reliance on outdated surveys, and inconsistencies in reporting standards. Much of the available data especially from private industrial operators is not shared regularly, and when it is, it often lacks sufficient granularity or metadata for proper validation and use in IPCC-compliant inventory formats.

Institutional coordination mechanisms, while formalized through steering committees and technical working groups, remain largely reactive and project-driven. Inter-agency cooperation is often constrained by unclear mandates, overlapping roles, and data ownership concerns. While the Department of Climate Change (DCC) under the Federal Ministry of Environment plays a coordinating role, it lacks the enforcement authority to compel data provision from other ministries, departments, and agencies (MDAs) or the private sector.

Despite these coordination platforms, such as the National Inventory System Steering Committee and sectoral Technical Working Groups, the frequency and effectiveness of inter-agency collaboration remain suboptimal. This is especially true outside of periods tied to external funding or reporting deadlines.

7.2 Technical Capacity Constraints

Another critical bottleneck is the limited technical capacity available for emissions estimation, quality assurance, and long-term data management. Many personnel within key MDAs and private sector institutions lack training in the application of IPCC guidelines, use of inventory software tools, and the interpretation of emission factors or uncertainty analysis. Even among trained staff, institutional turnover and limited budgetary support for continuous learning lead to knowledge attrition.

Furthermore, the application of advanced inventory methodologies (e.g., Tier 2 or Tier 3 approaches) remains limited in most IPPU categories due to the absence of robust local data and trained modelers. This is especially problematic for subsectors like chemical production and metal smelting, where process-specific emissions require higher-tier methods for accuracy.

The limited deployment of digital infrastructure compounds this challenge. Data collection and verification systems remain heavily reliant on manual spreadsheets, emailed templates, and static databases. There is also a lack of investment in automation, industrial sensors, or integrated monitoring-reporting-verification (MRV) platforms that could support real-time or near-real-time inventory development.

7.3 Industry Engagement and Transparency

Engaging industry actors particularly large cement producers, fertilizer manufacturers, and refrigerant importers is essential for IPPU inventory development. While some companies (e.g., Dangote, BUA, Notore) have begun to collaborate more openly with the government on climate data, broader industry engagement remains sporadic and driven by personal relationships or corporate goodwill rather than regulatory obligations.

There is a widespread perception within the private sector that emissions reporting is either a compliance burden or a reputational risk, rather than an opportunity for efficiency gains or market advantage. This leads to reluctance in sharing sensitive production or process data, especially in sectors with oligopolistic market structures. The absence of data confidentiality protocols and enforceable data-sharing regulations contributes to this mistrust.

Moreover, while many companies collect internal environmental data such as fuel consumption, clinker-to-cement ratios, or refrigerant usage this information is rarely formatted or reported in a manner suitable for national inventories. As a result, the potential for industry-generated data to strengthen the inventory remains underutilized.

7.4 Opportunities for Mitigation, Data System Strengthening, and MRV Integration

Despite these challenges, there are several promising opportunities for improving the integrity of Nigeria's IPPU sector inventory and aligning it with mitigation goals.
First, the expansion of industrial efficiency and cleaner production programs presents a pathway for simultaneous emissions reduction and data enhancement. For instance, the cement sector could reduce emissions through the use of blended cement, increased clinker substitution, and waste heat recovery systems. If embedded into corporate sustainability reporting, these changes would also generate more accurate, facility-level data for inventory use.

Second, the Climate Change Act of 2021 and the operationalization of the National Council on Climate Change (NCCC) offer a regulatory platform for institutionalizing GHG reporting requirements across sectors. By mandating emissions disclosures and integrating climate data requirements into environmental permitting, Nigeria can enhance compliance and transparency in the IPPU sector.

Third, donor-supported programs and international partnerships offer opportunities to build capacity and digitize data flows. For example, projects under the UNFCCC Capacity-building Initiative for Transparency (CBIT), the NDC Partnership, and bilateral cooperation with countries like Germany and the UK could support the deployment of sector-specific MRV systems and the training of inventory compilers and industry personnel.

Fourth, the development of a centralized, secure, and user-friendly emissions data portal could significantly streamline data collection and access. If coupled with tiered data access and anonymized reporting protocols, such a platform could overcome industry confidentiality concerns and foster greater stakeholder trust.

Lastly, engaging industry associations such as CMAN, FEPSAN, and refrigeration servicing coalitions as partners in data collection and verification can build collective accountability and reduce the burden on individual companies. These associations can serve as aggregators and validators of sectoral data, making it easier for government to access comprehensive, quality-controlled inputs for inventory compilation.

8. Recommendations

The effective and sustainable management of GHG emissions from Nigeria's IPPU sector depends on a combination of regulatory reform, institutional coordination, capacity development, methodological rigor, and stakeholder collaboration. Drawing on the findings from this assessment including challenges in data collection, technical expertise, and transparency this section outlines a series of targeted recommendations to strengthen the country's IPPU inventory system and support broader national climate goals.

8.1 Policy and Institutional Reforms

Strengthening Nigeria's IPPU greenhouse gas inventory requires clear legal anchoring and institutional alignment rather than continued reliance on ad hoc coordination mechanisms. The primary reform priority is the formal recognition of industrial greenhouse gas reporting as a statutory obligation under the Climate Change Act, 2021. While the Act establishes the National Council on Climate Change (NCCC) as the apex coordinating body for climate governance and carbon budgeting, sector-specific reporting obligations for industrial installations are not yet fully operationalized. A policy directive or subsidiary regulation issued pursuant to the Act should formally designate IPPU-related data reporting as a mandatory component of national climate governance.

Such a policy instrument should clarify the institutional hierarchy for IPPU inventory governance. The NCCC should provide overarching authority and ensure alignment with national carbon budgets and international reporting obligations. The Federal Ministry of Environment (FMEnv), including its Department of Pollution Control, should serve as the primary technical counterpart for environmental compliance integration. NESREA, as the enforcement agency, should incorporate greenhouse gas reporting obligations into its existing industrial permitting and compliance frameworks. This would ensure that greenhouse gas reporting becomes embedded within routine environmental oversight rather than remaining a parallel process.

Institutional mandates must also be clarified to avoid duplication and ambiguity. The respective responsibilities of NCCC, FMEnv, NESREA, FMITI, and NBS in relation to industrial emissions reporting should be formally codified through an inter-agency framework or memorandum of understanding endorsed at ministerial level. This would establish predictable lines of accountability for data submission, regulatory oversight, and sectoral coordination.

A further policy reform concerns enforcement credibility. Existing environmental regulations provide emission standards, but enforcement capacity and independent monitoring remain limited. Strengthening enforcement authority and ensuring that greenhouse gas reporting obligations are backed by compliance mechanisms—including penalties for non-reporting—will be essential for institutionalizing inventory reliability. Without enforceable reporting requirements, inventory preparation will continue to depend largely on voluntary cooperation.

Finally, policy coherence must ensure that greenhouse gas inventory obligations are explicitly linked to Nigeria's carbon budgeting framework under the Climate Change Act. Industrial reporting should not operate in isolation but should feed into national carbon accounting and sectoral emissions oversight processes. Formalizing this linkage at policy level will ensure that IPPU inventory improvements contribute directly to the implementation of national climate commitments and enhance Nigeria's transparency under the Enhanced Transparency Framework.

8.2 Data Systems

Strengthening Nigeria's IPPU inventory requires a structured, predictable, and auditable data management architecture capable of delivering transparent, accurate, complete, consistent, and comparable time series in accordance with IPCC and Enhanced Transparency Framework (ETF) requirements. While institutional coordination has improved, the current system remains partially manual, project-supported, and reliant on informal data exchange.

The first priority is the establishment of a structured annual data collection cycle aligned with the national inventory calendar. IPPU activity data particularly for cement (CRT 2A.1), lime (2A.2), ammonia (2B.1), nitric acid (2B.2), iron and steel (2C.1), and fluorinated gases (2F/2G) should be collected through a standardized, recurring reporting cycle with predefined submission deadlines. This will reduce uncertainty, improve predictability, and strengthen time-series continuity.

Second, Nigeria should transition from predominantly aggregated data sources toward structured facility-level activity datasets for major emitting installations. For cement, this includes plant-level clinker production and clinker ratio data; for ammonia and nitric acid, plant-level output and abatement technology status; for iron and steel, differentiation between primary and secondary production routes; and for fluorinated gases, importer-level refrigerant volumes and stock tracking. Concentration of emissions in relatively few installations makes facility-level reporting both feasible and impactful.

Third, interoperability between administrative datasets must be strengthened. Industrial production statistics from NBS, compliance records from NESREA, trade data from Nigeria Customs Service, and sectoral data from FMITI should not exist in silos. A structured data-sharing protocol should ensure cross-validation between:

- Production statistics and facility submissions
- Import/export data and domestic production data
- Industrial capacity expansions and emissions trend shifts

This triangulation improves completeness and supports detection of anomalies.

Fourth, data archiving and version control must be institutionalized. Every submission, recalculation, methodological adjustment, and emission factor update should be documented and stored in a centralized archive system. This is essential to meet ETF transparency requirements and to ensure recalculation traceability across reporting cycles. Without a structured archive, institutional memory is vulnerable to staff turnover.

Fifth, uncertainty management must be integrated into data systems. Data collection formats should enable capture of parameters necessary for uncertainty assessment, including:

- Measurement precision levels
- Assumptions used in calculation
- Default vs. plant-specific data use
- Estimated completeness of coverage

Embedding uncertainty considerations at the data-collection stage significantly improves methodological robustness downstream.

Sixth, fluorinated gas (2F/2G) data systems require particular strengthening. Import licensing data should be reconciled annually with domestic consumption and servicing data to prevent underestimation of stock-based emissions. Establishing a structured refrigerant tracking mechanism is critical to avoid future inventory gaps as HFC usage evolves.

Finally, digitalization of data flows is necessary to reduce manual consolidation errors, improve timeliness, and enhance transparency. While detailed portal design is outside the scope of this subsection, a structured digital submission and storage platform would substantially improve auditability, consistency, and long-term sustainability of IPPU inventory data.

In summary, strengthening data systems requires predictable annual reporting cycles, facility-level disaggregation, administrative data integration, archiving protocols, uncertainty capture, and digital infrastructure support.

8.3 Methodological Improvements

While Nigeria has successfully applied IPCC 2006 Guidelines and 2019 Refinement methodologies in its IPPU reporting, methodological improvements are necessary to enhance accuracy and reduce uncertainty, particularly as emissions continue to grow in cement, chemical production, and fluorinated gas use.

The most immediate methodological priority is transitioning from exclusive reliance on Tier 1 default emission factors toward selective application of Tier 2 approaches in key subcategories where national circumstances significantly influence emission intensity.

For cement production (CRT 2A.1), Tier 2 implementation would involve using country-specific clinker ratios and plant-level clinker production data rather than relying solely on aggregated cement production and default ratios. Given that clinker production drives process emissions, improving clinker ratio accuracy can substantially reduce uncertainty in total IPPU emissions.

For nitric acid production (CRT 2B.2), Tier 2 methods should incorporate plant-specific abatement technology status and operational performance, especially where secondary or tertiary N_2O abatement systems are installed. This avoids overestimation when default emission factors are applied without accounting for mitigation technologies.

For ammonia production (CRT 2B.1), methodological refinement may include differentiation between production technologies (e.g., conventional steam methane reforming vs. more efficient processes), where data availability allows.

In iron and steel (CRT 2C.1), improving differentiation between primary steel production (blast furnace route) and secondary steel production (electric arc furnace route using scrap) would improve emission accuracy and better reflect Nigeria's production structure.

For fluorinated gases (CRT 2F/2G), methodological strengthening requires improved stock-change modelling. Transitioning from simplified consumption-based estimates toward stock-based emission modelling where feasible would better reflect leakage patterns over equipment lifetimes.

Another priority area is recalculation management. As better activity data or emission factors become available, recalculations must be systematically documented and consistently applied across the full time series. Institutionalizing recalculation protocols enhances time-series consistency and comparability under ETF review.

Uncertainty analysis should also be expanded and formalized. Applying quantitative uncertainty estimation methods particularly for high-contribution categories such as cement would strengthen transparency and allow prioritization of improvement efforts based on uncertainty contribution analysis.

Furthermore, Nigeria should progressively develop country-specific emission factors where feasible. This may involve collaboration with industry for:

- Chemical composition analysis of clinker
- Process-based emission measurements
- Performance data from abatement systems

Country-specific factors improve accuracy and enhance national ownership of inventory methodologies.

Finally, methodological improvements must be aligned with projection modelling needs. As Nigeria operationalises carbon budgets under the Climate Change Act, IPPU methodologies must support forward-looking scenario analysis. Ensuring that methodological structures are compatible with emissions projection frameworks will improve integration between inventory reporting and mitigation planning.

8.4 Capacity-Building Priorities

A structured, multi-year capacity-building plan should be developed and funded either via domestic budgetary allocations or international support under the Enhanced Transparency Framework (ETF) and Capacity Building Initiative for Transparency (CBIT). The plan should focus on:

- Training government and private sector stakeholders in IPCC guidelines, inventory software (e.g., IPCC Inventory Software, LEAP), and GHG estimation methods for key IPPU subcategories.
- Building institutional memory by training multiple officers per institution and developing training manuals, job aids, and e-learning platforms for continuous knowledge transfer.
- Deploying training-of-trainers (ToT) programs for industry associations and subnational regulators to ensure cascading capacity development.

Capacity efforts must also include improvements in statistical literacy, database management, QA/QC implementation, and the use of digital tools to support data archiving and traceability.

Improvements in Data Systems and Methodological Choices

A top priority should be the design and implementation of a centralized digital GHG inventory data portal, hosted by FMEnv or the NCCC and accessible to all key stakeholders. This portal should support secure data uploads, automatic quality checks, historical data visualization, and integration with national and subnational MRV systems.

In parallel, Nigeria must invest in developing country-specific emission factors for high-impact subcategories, especially cement manufacturing, nitric acid production, and HFC use. This will require collaboration with academic institutions, research centers, and leading companies to conduct emission testing, process modelling, and material characterization studies.

To enhance methodological accuracy, Nigeria should gradually transition from Tier 1 to Tier 2 methodologies where feasible, particularly for sectors with large and stable production bases like cement and steel. Emission estimation protocols should be documented and updated regularly, with uncertainty assessments applied systematically.

8.5 Stakeholder Engagement Strategies

Engaging the private sector, industrial associations, and technical experts is essential for inventory accuracy, sector buy-in, and transparency. A Public-Private Data Partnership Framework (PPDPF) should be established to promote structured, recurring collaboration between the government and industry actors.
Key elements of this framework should include:

- Data-sharing agreements that protect commercially sensitive information while ensuring compliance with climate reporting needs.
- Incentive mechanisms, such as tax deductions, regulatory fast-tracking, or public recognition for companies that voluntarily share validated data or adopt mitigation measures.
- Annual stakeholder forums or knowledge exchanges that bring together government, academia, and business to review emission trends, methodological updates, and inventory findings.
- Technical Working Groups (TWGs) for each major IPPU subsector (e.g., cement, fertilizer, HFCs), with clearly defined TORs and meeting schedules.

Civil society, academia, and the media should also be included as observers or communicators to promote transparency and build public understanding of industrial emissions and mitigation strategies.

8.6 Roadmap for Strengthening the IPPU Sector’s Inventory Reporting

To institutionalize these improvements, a five-year roadmap (2025–2030) should be developed, aligned with Nigeria’s Nationally Determined Contributions (NDCs), Long-Term Low Emission Development Strategy (LT-LEDS), and Climate Change Act. The roadmap should include the following milestones:

1. 2025 – Formalize IPPU inventory coordination structure and initiate policy amendments to enforce emissions reporting; begin scoping study for a national GHG data portal.
2. 2026 – Pilot GHG data collection in cement and fertilizer industries; develop draft emission factors for key IPPU categories; begin staff training and build IPPU MRV toolkit.
3. 2027 – Launch operational GHG inventory portal with automated reporting templates; publish Nigeria’s first fully digitalized IPPU emissions dataset for public and donor access.
4. 2028 – Institutionalize regular (annual or biennial) IPPU inventory updates; expand coverage to informal industry clusters and refrigeration servicing sectors.
5. 2029–2030 – Evaluate performance, update methodologies, and transition at least two subsectors (e.g., cement, nitric acid) to Tier 2 estimation with country-specific emission factors.

This roadmap should be accompanied by an investment plan and monitored through a Results-Based Management (RBM) framework to ensure accountability and track progress.