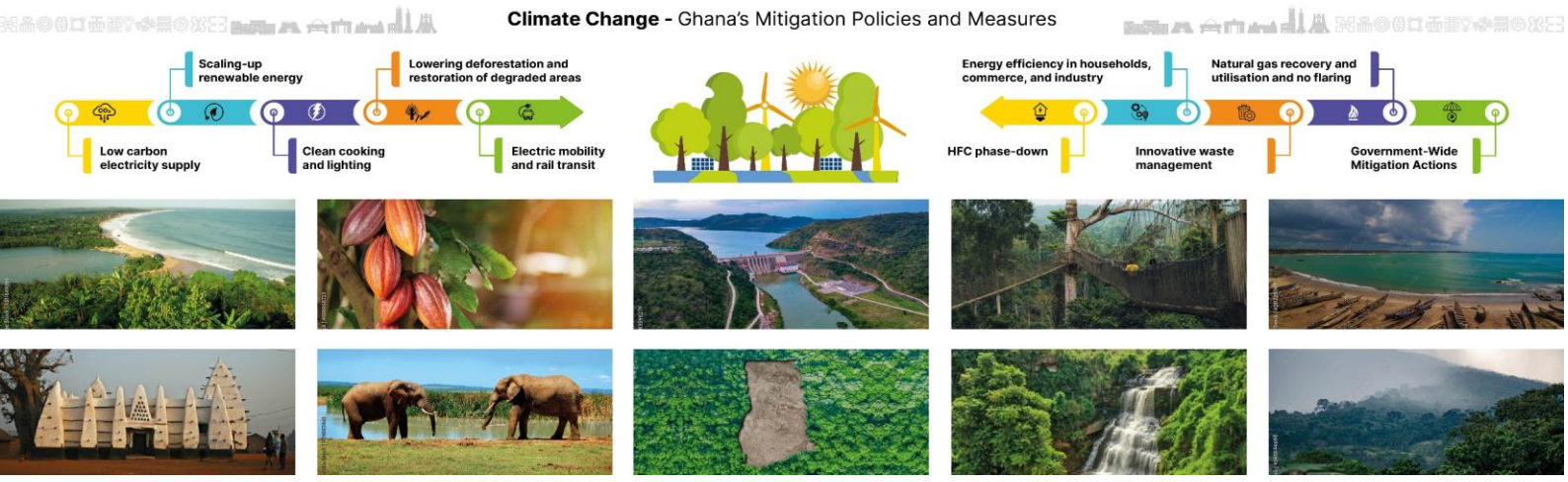
Ghana's Fourth Biennial Update Report to the United Nations Framework Convention on Climate Change



Ghana's final BUR to the UNFCCC

March 2024

Environmental Protection Agency (EPA)

With kind support from

Ghana's Fourth Biennial Update Report to the United Nations Framework Convention on Climate Change

The report is available for download on the EPA website address www.epa.gov.gh.

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Foreword

On behalf of the Republic of Ghana, I am honoured to submit Ghana's Fourth Biennial Update Report (BUR4) to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) in fulfilment of its reporting obligation under decision 2/CP/17 paragraph 41(f). The report is Ghana's final BUR to the UNFCCC before submitting its first Biennial Transparency Report (BTR) by December 2024. In this BUR4, Ghana has thoroughly documented the latest information on its national-level efforts on climate actions and its contributions to sustainable development.

The BUR4 publishes the key findings of two years of data gathering and analysis on a wide range of topics covering greenhouse gas emissions trends; mitigation measures efforts, and inflows of climate support. As the Government assiduously works to reset the national economy to its pre-pandemic status, climate action forms an integral part of the Government's recovery agenda. Some of Ghana's recent leading climate policies are climate prosperity plans, a national energy transition and investment plan, an electric vehicle policy and a roadmap on sustainable GHG reduction from the chemicals industry. The policies seek to operationalise the goals stated in the update nationally determined contributions.

As a result, we continue to implement mitigation programmes in renewable energy, clean cooking, electric vehicles, forest restoration, alternative waste management, etc. These measures are yielding impressive results on all counts. Access to clean energy have increased, forest restoration through REDD+ and plantation development is growing, household cooking is improving, and the momentum around electric mobility is thriving. Our policies are not only positively impacting lives, but they are ambitiously contributing to reducing global greenhouse gas emission. My hope is that the academia, researchers, civil society organisations, and industry players will find the BUR4 report a relevant reference document for your use. Kindly reach out to my team for further information or clarification via email info@epa.gov.gh.

Hon. Dr. Henry Kwabena Kokofu, *Esq*
Executive Director, Environmental Protection Agency

Acknowledgement

The BUR4 contains updated information on Ghana's climate actions and support from 1990 to the year 2021. The Climate Change Unit of EPA coordinated the compilation of the BUR4. In this round of BUR, we have provided updates on how Ghana is addressing comments and capacity-building needs identified in the technical assessment of the BUR3. We have also incorporated new datasets and approaches to improve the overall quality of the BUR4.

The EPA wishes to express our gratitude to all who contributed to the preparation of this report. We are grateful to GEF for providing funding support for the preparation of the BUR4. We also appreciate the UN Environment team for providing technical insights and guidance in the preparation, compilation, and submission of the BUR4. We also thank NDC-SP and ICAT projects for the complementary technical assistance.

Our sincere gratitude goes to all the international partners who provided technical support during the preparation and review of the BUR4; we say thank you for your continued partnership. Furthermore, we thank various working group members, consultants, and other state institutions engaged in BUR4 preparation. Our sincere thanks go to MESTI for their insightful advice and support.

As we get ready to prepare our first BRT for submission in December 2024, we will seek to deepen and broaden our collaborations with relevant national and international organisations, forge new partnerships and explore innovative ways of working to become more effective. We will prioritise our efforts toward improving the technical areas of the BTR where we have identified capacity gaps.

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Abbreviations

ACE	-	Action for Climate Empowerment
AD	-	Activity data
ADCOM	-	Adaptation Communication
AFOLU	-	Agriculture, Forestry and Other Land Uses
AR4	-	Fourth Assessment Report
BC	-	Black Carbon
BRT	-	Bus Rapid Transit
BUR	-	Biennial Update Report
CAP	-	Coronavirus Alleviation Plan
CARES	-	COVID-19 Alleviation and Revitalisation of Enterprises Support
CBAM	-	Carbon Border Adjustment Mechanism
CBIT	-	Capacity Building Initiative on Transparency
CCOs	-	Climb Operation/Approach
CCU	-	Climate Change Unit
CDM	-	Clean Development Mechanism
CH_4	-	Methane
CLIMFINTRACK	-	Climate Change Finance Tracking tool
CO_2	-	Carbon Dioxide
CRM	-	Cylinder Recirculation Model
CTCN	-	Climate Technology Centre and Network
DVLA	-	Driver and Vehicle and Licensing Authority
EB	-	Executive Board
EC	-	Energy Commission
EEAs	-	Energy Efficiency Advisors
EF	-	Emission Factor
EPA	-	Environmental Protection Agency
ERCST	-	European Roundtable Climate Change and Sustainable Transition
ERPA	-	Emission Reductions Payment Agreement
EU-AITF	-	European Union Africa Infrastructure Trust Fund
FCPF	-	Forest Carbon Partnership Facility
FOLU	-	Forestry Other Land Uses
FPDS	-	Forest Plantation Development Strategy
FREL	-	Forest Reference Emission Levels
FREL	-	National Forest Reference Level
GACMO	-	Greenhouse Gas Abatement Cost Model
GAPTE	-	Greater Accra Passenger Transport Executive
GCARP	-	Climate Ambitious Reporting Program
GCF	-	Green Climate Fund
GDP	-	Gross Domestic Product
GEF	-	Global Environment Facility
GHG	-	Greenhouse Gas
GJAM	-	Green Jobs Assessment Model
GMP	-	National Gas Master Plan
GNGC	-	Ghana National Gas Company

GST	-	Global Stocktake
GWh	-	Gigawatt Hour
HDI	-	Human Development Index
HFCs	-	Hydrofluorocarbon
HFO	-	Heavy Fuel Oil
HPMP	-	HFC Phase-out Management Plan
ICA	-	International Consultation and Analysis
ICA	-	International Consultation and Analysis
ILO	-	International Labour Organisation
IMO	-	International Maritime Organisation
IPCC	-	Inter-governmental panel on Climate Change
IPCC	-	Intergovernmental Panel on Climate Change's
IPPU	-	Industrial Products and Product Use
ITMOs	-	Internationally Transferred Mitigation Outcomes
KCA	-	Key Category Analysis
LCO	-	Light Crude Oil
LEAP	-	Low Emission Analysis Platform
LED	-	Light Emitting Diode
LPG	-	Liquefied Petroleum Gas
LULUCF	-	Land Use Land Use Change and Forestry
MEA	-	Multilateral Environmental Agreement
MESTI	-	Ministry of Environment, Science, Technology, and Innovation
MiDA	-	Millennium Development Authority
MPG	-	Modalities Procedures and Guidlines
MRV	-	Monitoring Reporting and Verification
MSW	-	Municipal Solid Waste
$MtCO_2e$	-	Million Tonne Carbon Dioxide Equivalent
MCER	-	Megatonnes Certified Emission Reduction
MWh	-	Megawatt Hour
N_2O	-	Nitrous oxide
NAG	-	Non-Associated Gas
NAP	-	National Adaptation Plan
NC4	-	National Communication
NCCC	-	National Climate Change Committee
NCEP	-	National Clean Energy Access Programme
NDA	-	National Designated Authority
NDC	-	Nationally Determined Contribution
NFP	-	National Focal Point
NIR	-	National Inventory Report
NMTDP	-	National Medium- Term Development Plan
PFCs	-	Perfluorocarbons
POA	-	Programme of Activity
PV	-	Photo Voltaic
PVTS	-	Private Vehicle Test Stations
QA/QC	-	Quality Assurance/Quality Control
RA	-	Reference Approach

REDD+	-	Reducing Emissions Deforestation and Forest Degradation
RTEMS	-	Real-Time Energy Monitoring System
SA	-	Sectoral Approach
SARPs	-	Standard and Recommended Practices
SDGs	-	Sustainable Development Goals
SLCPs	-	Short-Lived Climate Pollutants
SOPs	-	Standard operating procedures
SUNREF	-	Sustainable Use of Natural Resources and Energy Finance
T2	-	Takoradi Thermal 2
TA	-	Technical Assessment
TT1PS	-	Tema Thermal 1 Power Station
TTE	-	Technical Team of Expert
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environment Programme
UNFCCC	-	United Nations Framework Convention on Climate Change
VALCO	-	Volta Aluminium Company
VCS	-	Verified Carbon Standard

Executive Summary

ES. Executive Summary

ES 1. Biennial Update Reports Mandate

All developing countries, including Ghana, were mandated by paragraph 41 (a) of decision 2/CP.17 to submit their first BUR by December 2014 and every two years afterwards, according to paragraph 41 (f). In 2016, Ghana prepared its first BUR in July 2017 and successfully underwent the mandatory International Consultation and Analysis (ICA). Ghana submitted its BUR2 in 2018, covering information on national greenhouse gas emissions from 1990 to 2016 and other relevant information on climate change actions. The 2021 BUR3 updated information to 2019. The BUR4 cover information up to 2021. It is also the reporting under the MRV arrangements under the Convention and provides the direction for the transition to the enhanced transparency framework under the Paris Agreement (PA) pursuant to Article 13 of the PA and decision 18/CMA1.

ES.2 National Circumstances and Institutional arrangement

Ghana is a lower-middle-income West African nation that contributes 0.1% to global greenhouse gas emissions and falls in the top climate-vulnerable countries in Africa. Ghana also prioritises climate change issues despite the many pressing development imperatives such as poverty eradication, provision of adequate, affordable health services, clean water, and access to clean and affordable energy. It is for this reason that Ghana's national development and the COVID-19 recovery programmes outline measures to mitigate climate change as well as addressing its adverse impacts thereof. Table ES 1 presents an overview of the state of Ghana.

Table ES 1: State of Ghana's national circumstances

Parameters	Details
Territory of Ghana	• Land area of 238,539 km^2 and coastline of 560km^2 • Divided into 16 administrative regions and further into 260 districts.
Demography	• Estimated 33.4 million people, with a 2% annual growth rate and a 59% urban population in 2022. • Global climate risk index score of 53.33, ranking 42 out of 130 in 2019. • Multidimensional poverty index (on a scale of 0-1) of 0.247. • Over 12 million inhabitants in savanna drylands and coastal belts are the most vulnerable to climate change.
Agroecological zones	• Wet Evergreen • Rain Forest • Deciduous Forest • Transitional, Coastal savanna • Guinea savanna • Sudan savanna
Water Resources	• Freshwater covers nearly 5% of the total land area. (11,800km^2). • The volta, southwestern and coastal river systems have a total annual run-off of 54 billion m^3.
Energy Resources	Final energy consumption by fuel type in 2022 (EC, 2023) • Petroleum - 4, 318 ktoe (49.3%) • Biomass - 2, 940 ktoe (33.5%)

	• Electricity - 1,509 ktoe (17.2%) Total installed grid electricity generation capacity in 2022 • Hydro (1584 MW), • Thermal (3758 MW) • Renewable (112 MW) Installed renewable generation capacity (162.3 MW in 2022) • On-grid - -distributed solar PV (42.8 MW), utility solar (112 MW), W2E (0.1 MW), mini-hydro (0.045 MW). • Mini-grid - solar (0.314 MW), wind (0.011 MW) • Off-grid - solar (7.4 MW), wind (0.02 MW)
Land Resources	Agricultural lands (1,000ha, 2021 estimates) • Cropland - 5,291.9 Forest land (1,000ha, 2021 estimates) • Total forest land - 6,395.7 ▪ of which area is close forest - 1,167.4 ▪ of which area is open forest - 5,228.2
Low-carbon development measures	Greenhouse emissions trends • Total 2021 greenhouse emissions - 51.8 $MtCO_2e$ (recalculated) • Total 2030 emissions without measures – 100 $MtCO_2e$ • Total 2030 emissions with measures – 75.1 $MtCO_2e$ • Total 2030 emissions with additional measures – 36.2 $MtCO_2e$
	Low carbon development measures since the submission of BUR • National climate prosperity plan. • Sustainable financing framework. • National energy transition and investment plan, 2023. • Ghana's electric vehicle policy, 2023. • Updated nationally determined contribution. • Ghana's automotive development policy. • Renewable Energy (Amendment) Act, 2020 (Act 1045). • National programme to introduce an alternative technology to HFC. • National Gas Master Plan (GMP) to facilitate gas commercialisation and gas infrastructure development. • LPG for Development for increasing the use of LPG to 50% by 2030. • Forest Plantation Development Strategy and REDD+ strategy. • Circular economy through integrated recycling and composting. • Energy efficiency standard and labelling for regulated appliances. • Development of Ghana's methane mitigation road map.
Climate adaptation, vulnerability reduction and resilience-building measures	Adaptation programmes in Ghana • Ghana National Climate Change Adaptation Strategy (2012). • National Adaptation Plan Framework in 2018. • Ghana's plan of action for disaster risk reduction and climate change adaptation (2012). • National Climate-Smart Agriculture and Food Security Action Plan (2016-2020). • National Adaptation Planning (ongoing).

	• Ghana National Framework for Climate Services, 2021.Ghana's First • Adaptation Communication to UNFCCC.
Impacts of implementation of response measures	Measures that support efforts to address the impacts of response measures. • National green jobs strategy (2021 - 2025). • Study on Energy transition and critical minerals in Ghana. • Ghana Case Study conducted by the European Roundtable Climate Change and Sustainable Transition (ERCST) in collaboration with Ghana EPA. • Training on the social and employment implications of climate policies and NDC. • Green Jobs Assessment Model for Ghana conducted by the International Labour Organisation (ILO) and the EPA.

The Ministry of Environment, Science, Technology, and Innovation (MESTI) formulate climate policies and supervises the implementation of the multilateral environmental agreements (MEA). MESTI also hosts the National Climate Change Committee (NCCC). As the technical arm of the MESTI, the EPA is responsible for the technical coordination of the implementation of climate programmes and climate reporting under the Convention and the Paris Agreement. The EPA thus manages the compilation of national communications, biennial update reports and the greenhouse gas inventory. Within the EPA, the Climate Change Unit (CCU) coordinated the BUR4 based on the EPA Act 490. The CCU worked closely with more than 25 national organisations to compile the current BUR. These organisations were grouped under three thematic working groups.

ES 3. National Greenhouse Gas Inventory

Ghana has prepared the GHG inventory for the BUR4 with the latest national data. The national greenhouse gas inventory covers the period from 1990-2021 to meet the N-2-year reporting requirement as per the enhanced transparency framework. Where N is the year of reporting. Recalculations was performed on GHG emission estimates from 1990-2019 for selected categories as new datasets became available as well as changes to the methodological approaches. The national GHG inventory was conducted using the methodological guidance in the 2006 IPCC Guidelines for National GHG Inventories. The GHG inventory incorporates anthropogenic emissions by sources and removals by sinks of Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), SF_6 and Fluorocarbons (F-gases) in the Energy, Industrial Process and Product Use (IPPU), Agriculture, Forestry and Other Land Uses (AFOLU) and Waste sectors. Ghana has voluntarily calculated SLCP emissions using the EMEP/CORINAIR Emission Inventory Guidebook.

ES 3.1 Greenhouse gas emission inventory results

Ghana's total greenhouse gas emissions is estimated 51.78 $MtCO_2e$ (million tonnes carbon dioxide equivalent) in 2021 representing 12% higher than the 2019 levels. Since 2010, energy has remained Ghana's largest greenhouse gas emissions sources averagely contributed 41% to the total national emissions. In 2021, the sector breakdown of the total emissions was 51.2% from the energy sector, followed by Agriculture (23%), LULUCF (15.3%), Waste (7.3%) and IPPU (3.2%).

When the net emissions from LULUCF are excluded from the national totals, the overall emissions amounted to 43.87 $MtCO_2e$ in 2021. The total national emission levels steadily rose over three decades (1990-2021). Ghana's total greenhouse gas emissions have increased by 372.3% from 10.36 $MtCO_2e$ in 1990 to 51.78 $MtCO_2e$ in 2021 at an annual growth rate of 5.1% (Table ES 2).

Table ES 2: Trends of greenhouse gas emission by sectors

Emissions by sources/Removals by sinks	Total emissions ($MtCO_2e$)							Percentage Change
	1990	2000	2010	2012	2016	2019	2021	[2019-2021]
National Emissions with LULUCF	10.96	20.68	30.62	35.09	33.68	46.42	51.78	16%
National Emissions without LULUCF	8.74	111.93	22.42	26.12	28.82	36.12	42.21	19%
Energy	2.86	4.07	10.82	13.64	14.06	19.36	26.52	22%
Industrial Processes and Product Use	1.96	0.90	0.94	2.02	1.69	1.82	1.66	3%
Agriculture, Forestry, and Other Land Use	5.11	14.23	15.85	16.21	13.68	20.37	19.83	11%
Waste	1.02	1.48	3.01	3.23	4.25	4.87	3.77	13%

Carbon dioxide is Ghana's dominant direct greenhouse gas, followed by CH_4, N_2O, HFCs, PFCs and SF_6 in 2021. At 33.7 Mt, CO_2 accounted for 63.3% of the total national emissions in 2021. The rest of the emissions were CH_4 (17.9%), N_2O (15.9%), HFC (1.1%), PFC (0.95%) and SF_6 (0.86%) in the same year. Most CO_2 emissions (including those from LULUCF) were mainly from the energy sector. The sector accounted for 74.8% of the total CO_2 emissions in 2021. Transport (61.5%) and electricity generation (27.1%) are the two largest contributors to CO_2 emissions in the energy sector.

The observed trends of GHG emissions are attributed to the impacts of recalculations and the effect of carbon-intensive economic policies. Despite the reductions in GHG emissions due to the impacts of recalculations, the emission levels showed rising trends due to economic, policy and demographic factors. Agriculture commodity production, processing utilisation and rising urban population significantly influence Ghana's GHG emissions.

ES 4. Mitigation actions and their effects

ES.4.1 Emission projections & assessment of mitigation actions

Using the GACMO and LEAP models, GHG emission in the country is projected to almost double to 100 $MtCO_2e$ by 2030 based on its development prospects. The expected rise in emissions is likely to be driven by expanding fossil-fuel intensive manufacturing and electricity generation, rising motorisation, gas flaring, and solid waste disposal. Thirty-four mitigation actions with the potential to reduce 68.2 $MtCO_2e$ by 2030 of GHG emissions

have been identified within the Energy, Transport, Industry, Oil and gas, IPPU, LULUCF and Waste sectors.

In this BUR4, Ghana has presented 17 mitigation actions to reduce current emissions across energy, forestry, waste, transport, and Refrigeration and Air-condition (RAC). It covers technology, fiscal and regulatory instruments, capacity development and awareness measures. Of the 17 mitigation actions, 13 are being implemented, with the remaining 4 soon to be implemented.

Ghana has reported actual emission reductions for 13 actions within the reporting period. The implementation of the 13 measures has led to 29.3 $MtCO_2e$/year GHG mitigation outcomes representing a 43.3% reduction compared to the 2021 GHG emissions (Table ES 3). When the emission reductions from LULUCF and large hydro dams are excluded, the total mitigation outcomes stood at 26 $MtCO_2e$/year and 25.9 $MtCO_2e$/year, respectively. Implementing the 13 mitigation measures have delivered sustainable development co-benefits such as jobs, investment, increase renewable energy, energy savings, restoration of forest and cost-savings.

Table ES 3: Breakdown of the mitigation effect and co-benefits

Mitigation action variables	Value	Unit
Total mitigation measures being reported	17	No
of which being implemented	13	No
of which are planned	4	No
GHG savings	29.3	$MtCO_2e$/year
GHG savings without large hydro-dam	25.9	$MtCO_2e$/year
GHG savings without LULUCF	26	$MtCO_2e$/year
GHG emissions reduction potential 4 planned measures	4.1	$MtCO_2e$/year
Fuel cost saving	94-109	US$ million
Investments	1,317.26	US$ million
Jobs created	588,906	No of people
Renewable energy produced	238.7	GWh/per year

ES.4.2 Information on international market mechanisms

Ghana has onboarded 8 CDM projects in the UNFCCC pipeline covering crop cultivation, gas recovery, energy efficiency in thermal power, landfill gas management, and composting. Of the 8 projects, the validation of 4 of them was terminated and did not proceed to the registration stage. The four remaining CDM projects are expected to generate 3.0 $MtCO_2e$ per year in the first crediting period. None of the registered projects have issued credits.

Ghana is involved in 35 Components of Project Activities (CPAs) as a host country into four POAs covering clean cooking, waste management, renewable energy, and water purification. The 4 POAs are expected to generate a total of 1.82 $MtCO_2e$ per year in the first crediting period. A total of 0.41 MtCERs have been issued to the 4 POAs, of which 0.051 MtCERs have been voluntarily cancelled.

In the voluntary carbon market, 29 mitigation projects have been onboarded on Gold Standard and VCS-Verra carbon standards. Of the 29 projects, 16 were onboarded on

Gold Standard, and the remaining 13 are on VCS-Verra. For those on Gold Standard, between 2007 and 2021, 8.7 Mt offset credits (each representing one metric tonne of CO_2-equivalent reduced or removed from the atmosphere) were issued to the 10 certified projects. On the VCS-Verra, from 2012 to 2021 vintage years, a total of 1.2 Mt offset credits were issued from which 0.24 1.2 Mt offset credits were retired over the same period. The issuances of the 2021 vintage were the highest, with 0.41 Mt offset credits.

ES 4. Domestic MRV system

Below are the highlights of the key achievements in the operationalisation of Ghana's Climate Ambitious Reporting Programme (GCARP) as its domestic reporting and monitoring system since 2019:

- Through Ghana's CBIT initiative, the National Development Planning Commission (NDPC) and the Environmental Protection Agency (EPA) have created a set of indicators to monitor the advancement of Ghana's Nationally Determined Contributions (NDC) at both national and sectoral levels.

- The EPA has developed an NDC accounting tool for anthropogenic GHG emission consistent with the Guidance for accounting for Parties' nationally determined contributions, referred to in decision 1/CP.21, paragraph 31. The tool will enable Ghana to regularly prepare, communicate and account for its nationally determined contributions under the Paris Agreement.

- The Ministry of Finance has developed a climate finance tracking tool to track climate-relevant expenditures using the national budget codes to isolate climate-relevant public expenditure on climate change and international inflows.

- The second tool (MRV of finance guidance manual) was also developed to track Ghana's climate finance, verify the completeness of data, and help demonstrate transparency of support and climate action.

- Climate Change Finance Tracking tool (CLIMFINTRACK) updates the existing tracking tools to reflect the new policy, programme areas and budget codes. The CLIMFINTRACK is to help capture relevant end-of-year outturn climate-relevant expenditures. The manual is firmly based on Ghana's existing policy planning and public financial management system.

- Forestry Commission has developed a Foundational Platform for REDD+ FREL – To support the regular preparation of the REDD+ FREL, the Forestry Commission has developed a Foundational Platform.

- The Forestry Commission is establishing a forest monitoring system to improve forest monitoring capacities.

- EPA has incorporated GHG inventory data requirements into the Annual Environmental Report Template for the industry sectors.

ES.5 Climate support needed and received.

Ghana would require $9.3 billion to invest in 47 adaptation and mitigation actions in 11 sectors by 2030. Ghana has reported updates on funding and monetised inflows for 2002 to 2021, covering international and national climate flows. Financial inflows are reported in Ghana Cedi (Gh₵) and US Dollar (US) dominations. Non-US dollar-denominated flows have been converted to US$ using the December exchange rate for each year. Projects that started in 2011 and are still active have been included in the analysis.

The OECD/DAC and the EPA annual survey captured information on climate financial commitments for 963 projects valued at US$ 18.4 billion between 2012 and 2021. When Ghana National Gas Company's (GNGC), TEN and ENI/Vitol's debt financial investments (estimated at $14.2 billion) in the natural gas field development were excluded from the analysis, the total financial commitments for the period amounted to US$4.2 billion over the same period. investments contribute to decarbonising the oil/gas and electricity sectors in the NDC.

The financial commitment to mitigation projects amounts to $16.7 billion, whereas adaptation projects are valued at $1.6 billion, and projects that target adaptation and mitigation are valued at $0.34 billion. Of the 963 projects, 342 fall under the "*principal climate objective*" category per the OECD/DAC Rio markers classification and 621 are in the "*significant climate objective*" group. The financial commitments comprised grants, debt instruments, equity and a mix of loans, co-financing and grants or equity. Grants and debt instruments are the dominant financial tools financial providers use. Grants comprise 96% (925) with a total financial commitment value of $2.1 billion. Debt comprises 3% (27) of total financial commitment valued at $15.6 billion. The remaining 11 projects of value of $0.7 billion were mixed instruments by the financial providers. Below are some of the main additional technical assistance Ghana received in preparing the BUR4:

- UNEP-DTU ICAT Project uses the GACMO tool to assess mitigation action and effect and uses an in-built MRV template to systematically track and monitor climate measures.

- UNDP NDC Support programme on developing the Ghana NDC tracking tool and energy sector MRV system. Ghana's NDC tracking tool is Excel-based and will be used for NDC accounting established in Article 4.13 of the Paris Agreement.

- CfRN and FAO Training: Quality Control for Collect Earth Database to prepare a land-cover map for Ghana.

- Remote Training on the Building of Sustainable National Greenhouse Gas Inventory Management Systems-Ghana organised by the UNFCCC in collaboration with the US Environmental Protection Agency.

- FAO's Knowledge Transfer/ Capacity Building Programme on Forest Reference Levels for Ghana.

ES. 6 Constraints and gaps

Ghana has identified the following as the key financial and capacity constraints encountered in the preparation of the BURs:

- Funding for climate change activities, including BUR preparation, is mostly donor-driven and project-based. There are no clear sustainable funding sources for BUR preparation at the national level. Ghana's contribution to the BUR preparation is mainly through in-kind support. The current funding gap for the BURs is a challenge for the continuous preparation of the report and the subsequent consideration stage.

- The cost of continuously decentralising data gathering and climate reporting to the facility level can be high for the companies. Even though the approach to involve companies more in the reporting was welcomed by the respondents, it was recommended that the involvement of the companies must overburden them.

- Lack of transparency on reporting non-financial support for training and technical assistance makes monitoring and reporting of non-monetary support difficult.

- Limited access to funding for continuous data generation, collection, analysis archiving, and distribution. Data generation and sharing costs can be prohibitive if no support system is available.

General Introduction

1. Introduction

1.1 Background to BUR

Per Decision 1/CP.24, paragraph 38, final biennial update reports shall be submitted to the UNFCCC secretariat by 31st December 2024. The Fourth Biennial Update report (BUR4) is Ghana's final BUR to the UNFCCC. The BUR4 is the latest update of the most recent Fourth National Communication (NC4)[1] published in 2020 and the Fifth National Greenhouse Gas Inventory Report (NIR5)[2] of 2022.

Ghana, as a non-annexe 1 Party to the UNFCCC, has the obligation under decision 2/CP.17, paragraph 41 (a) to submit its first BUR by December 2014 and every two years afterwards, according to paragraph 41 (f). To the extent its national circumstances can permit, and the support it received for reporting under decision 2/CP.17, Ghana has successfully prepared and published three BURs, followed by the mandatory two-stage international consultation and analysis (ICA), which typically takes up to 17 months.

The first round of BUR submissions commenced in July 2015[3]. After the submission, the report was considered until August 2016. Ghana submitted the second BUR[4] in October 2018, which fell within the expected two years from the previous submission. The ICA of the BUR2 concluded in March 2020. After completing the second cycle of the BUR in 2020, it took Ghana eleven months to plan, prepare, and make a third submission to the UNFCCC in August 2021[5].

Similarly, the ICA process took 21 months to conclude in May 2023. The Environmental Protection Agency (EPA) coordinated the preparation of Ghana's BUR4. The compilation process spanned April 2022 to February 2024. Ghana has prepared the BUR4 as a stand-alone report per the guidelines of decision 2/CP.17 for Parties not included in Annex 1 to the Convention.

The BUR4 captures the latest updated information since the submission of the previous report. The new updates include changes or revisions of the information reported in the BUR3 and NC4. Ghana also reported in the BUR4 policy and regulations reforms that support climate actions in the country. The BUR4 aims to publish the findings of almost two years of information gathering and analysis on national greenhouse gas emissions trends and projections, assessment of mitigation actions and their effects in the context of sustainable development and tracking of climate support.

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[1] https://unfccc.int/sites/default/files/resource/Gh_NC4.pdf
[2] https://unfccc.int/sites/default/files/resource/gh_nir5_15052022_final.pdf
[3] https://unfccc.int/sites/default/files/resource/GHNBUR1.pdf
[4] https://unfccc.int/sites/default/files/resource/gh_bur2_rev-2.pdf
[5] https://unfccc.int/sites/default/files/resource/gh_BUR3_1282021_submission.pdf

Over 50 experts from over 25 public and private organisations, CSOs and academia were involved in the BUR4 preparation.

The BUR 4 follows the outline below:

a. Introduction – sets the background and mandate of the BUR4.
b. National circumstances – presents the snapshot of the current state of Ghana, the prospects, and its implications for climate change. It also captures the updates of institutional arrangements.
c. National greenhouse gas inventory – captures the national GHG inventory processes for 1990-2021.
d. GHG mitigation actions and their effects – gives the results of the assessment effect of mitigation actions.
e. Domestic MRV system – updates the information on Ghana's domestic MRV.
f. Constraints, gaps, related financial, technical, and capacity needs and support received.
g. Annexes – contain a summary of the data and information that provide additional details to the issue addressed in the respective sections.

Updates of national circumstances

2. National Circumstances

2.1 Country profile

Ghana is a lower-middle-income developing country in West Africa with a stable democratic government and an estimated 33.4 million population as of 2022. The economy is structurally dominated by industry and services, but it relies on natural resource extraction and is traditionally agrarian (World Bank, 2022).

Statistically, the economy has expanded 13 times, leading to halving poverty to 23% and a total natural resource rent of 13% of GDP in 2021 (forest - 3.8% of GDP, oil - 4.1%, natural gas rent - 0.4% of GDP and mineral rent - 5.2% of GDP). With a total international export value of US$ 14.1 billion in 2021, Gold was 38%, then crude petroleum (25%), cocoa beans (11%) and other merchantable (26%).

Despite the positive contribution of natural resource extraction to the economy, the cost of environmental degradation was estimated at ~9% of GDP in 2017. The COVID-19 ravaging effects slowed economic growth to 3.1%, although showing signs of recovery to the pre-pandemic growth rate of 6.5%. The country's major development challenges are the high cost of living due to rising fuel and food prices, high public debt, urbanisation, and illegal mining.

Deforestation is high and spatially concentrated in areas of high poverty, with land use change from forest to agriculture causing about 92% of deforestation (World Bank, 2022). Climate change is already showing its effects and compounding the challenge. The negative impacts of climate change include risks for the health and agriculture sectors, primarily due to altered rainfall patterns and coastal area flooding.

Despite the economic challenges, climate change remains a priority in Ghana. That is why its recent national development policy outlines climate change as a priority area for action. The ambitious climate actions in the updates nationally determined contribution have shown the commitment to tackling climate on all fronts. Table 1 presents an update on the state of Ghana.

Table 1: Updates on Ghana

Parameters	Details
Territory of Ghana	• Land area of 238,539 km^2 and coastline of 560km^2 • Divided into 16 administrative regions and further into 260 districts.
Demography	• Estimated 33.4 million people, with a 2% annual growth rate and a 59% urban population in 2022. • Global climate risk index score of 53.33, ranking 42 out of 130 in 2019. • Multidimensional poverty index (on a scale of 0-1) of 0.247. • Over 12 million inhabitants in savanna drylands and coastal belts are the most vulnerable to climate change.
Agroecological zones	• Wet Evergreen • Rain Forest • Deciduous Forest • Transitional, Coastal savanna

	• Guinea savanna • Sudan savanna
Water Resources	• Freshwater covers nearly 5% of the total land area. (11,800km^2). • The volta, southwestern and coastal river systems have a total annual run-off of 54 billion m^3.
Energy Resources	Final energy consumption by fuel type in 2022 (EC, 2023) • Petroleum - 4, 318 ktoe (49.3%) • Biomass - 2, 940 ktoe (33.5%) • Electricity - 1,509 ktoe (17.2%) Total installed grid electricity generation capacity in 2022 • Hydro (1584 MW), • Thermal (3758 MW) • Renewable (112 MW) Installed renewable generation capacity (162.3 MW in 2022) • On-grid - -distributed solar PV (42.8 MW), utility solar (112 MW), W2E (0.1 MW), mini-hydro (0.045 MW). • Mini-grid - solar (0.314 MW), wind (0.011 MW) • Off-grid - solar (7.4 MW), wind (0.02 MW)
Land Resources	Agricultural lands (1,000ha, 2021 estimates) • Cropland - 5,291.9 Forest land (1,000ha, 2021 estimates) • Total forest land - 6,395.7 ▪ of which area is close forest - 1,167.4 ▪ of which area is open forest - 5,228.2
Low-carbon development measures	Greenhouse emissions trends • Total 2021 greenhouse emissions - 51.8 $MtCO_2e$ (recalculated) • Total 2030 emissions without measures – 100 $MtCO_2e$ • Total 2030 emissions with measures – 75.1 $MtCO_2e$ • Total 2030 emissions with additional measures – 36.2 $MtCO_2e$
	Low carbon development measures since the submission of BUR • National climate prosperity plan. • Sustainable financing framework. • National energy transition and investment plan, 2023. • Ghana's electric vehicle policy, 2023. • Updated nationally determined contribution. • Ghana's automotive development policy. • Renewable Energy (Amendment) Act, 2020 (Act 1045). • National programme to introduce an alternative technology to HFC. • National Gas Master Plan (GMP) to facilitate gas commercialisation and gas infrastructure development. • LPG for Development for increasing the use of LPG to 50% by 2030. • Forest Plantation Development Strategy and REDD+ strategy. • Circular economy through integrated recycling and composting. • Energy efficiency standard and labelling for regulated appliances. • Development of Ghana's methane mitigation road map.
Climate adaptation,	Adaptation programmes in Ghana

vulnerability reduction and resilience-building measures	• Ghana National Climate Change Adaptation Strategy (2012). • National Adaptation Plan Framework in 2018. • Ghana's plan of action for disaster risk reduction and climate change adaptation (2012). • National Climate-Smart Agriculture and Food Security Action Plan (2016-2020). • National Adaptation Planning (ongoing). • Ghana National Framework for Climate Services, 2021.Ghana's First • Adaptation Communication to UNFCCC.
Impacts of implementation of response measures	Measures that support efforts to address the impacts of response measures. • National green jobs strategy (2021 - 2025). • Study on Energy transition and critical minerals in Ghana. • Ghana Case Study conducted by the European Roundtable Climate Change and Sustainable Transition (ERCST) in collaboration with Ghana EPA. • Training on the social and employment implications of climate policies and NDC. • Green Jobs Assessment Model for Ghana conducted by the International Labour Organisation (ILO) and the EPA.

2.2 Ghana's policies relevant to climate actions

Climate change continues to be a top development priority for Ghana. Thus, climate change issues are not treated in isolation but mainstreamed into development planning. Despite the country's economic challenges, climate change features prominently in the latest national development policies. Since the submission of BUR3, the following policies have been adopted to support the implementation of Ghana's nationally determined contribution:

- Ghana has initiated processes to develop climate change legislation. The new Environmental Protection Bill has a dedicated component (part 5) for climate change. The bill was laid in Parliament and referred to the Committee on Environment, Science and Technology (CEST) for consideration.

- The National Energy Transition and Investment Plan was adopted in September 2023. The plan is to guide the orderly transition of the energy system to a net zero by 2060.

- The Ministry of Transport announced the National electric vehicle policy in December 2023. As a result of the policy, the Government abolished the import tax on electric vehicles for public transport and the import of semi-knocked and whole-knocked down vehicle parts for local assembly for eight years.

- Under Article 4.19 of the Paris Agreement, Ghana began preparing a long-term low-emission development strategy with support from Pathway 2050.

- The amended Renewable Energy Act (Act 1045), 2020, introduced a net metering policy to promote the integration of renewable energy into the national grid. As a result, the Public Utilities Regulatory Commission (PURC) adopted the “Rate Setting Guidelines for Net Metering of Renewable Energy Generation Systems Connected to Distribution Networks in Ghana”.

- Ghana adopted a national framework on the international carbon market and non-market approaches to guide the implementation of Article 6 voluntary cooperation of the Paris Agreement to support the NDC.

The following are the key policies and measures that directly or indirectly support Ghana's climate-resilient and low-carbon development outcomes:

National and cross-cutting policy measures

- Ghana Beyond Aid Charter envisions transforming Ghana into a green manufacturing and high-value services economy.
- Ghana at 100 Framework is the country’s long-term development framework to position Ghana on a sustainable pathway by 2057 and deliver the vision of Ghana beyond the aid charter.
- Coordinated Programme of Economic and Social Development Policies 2017-2024 and its associated National Medium-Term Development Plan to domesticate the SDGs and the Paris Agreement.
- National Climate Change Policy aims to ensure a climate-compatible economy for achieving sustainable development (2013-2020).
- Ghana’s Updated Nationally Determined Contribution (NDC) to UNFCCC contains medium-term property climate action toward building resilience and low carbon future (2020-2030).
- National Green Jobs Strategy (2021 - 2025) aims to promote just climate transition and minimise the negative impact on the workforce.
- Climate Prosperity Plan (CPP, 2023) to advance climate prosperity and security while creating new economic opportunities in Ghana.

Energy sector measures

- The revised 2021 National Energy Policy set the broad vision for transforming Ghana’s energy sector into a sustainable, climate-resilient, low-carbon energy economy that orderly energy transition.
- The following policy documents outline concrete strategies for achieving the policy intentions in the revised national energy policy:

    - National energy transition and investment plan (2023).
    - Amended Renewable Energy Act (Act 1045), 2020.
    - Renewable Energy Master Plan (2019).
    - Integrated Power Sector Master Plan for Ghana (volume 3, 2023).
    - Renewable Energy Master Plan (2019).
    - National Gas Master Plan (2016).
    - Sustainable Energy for All Country Action Plan (2012).

- Mini-grid Electrification Policy (2015, revised in 2017).
- National LPG Promotion Policy (2017).
- Ghana Nuclear Power Programme (NPP) (2019).
- Energy Efficiency Guidelines for Manufacturers, Importers and Retailers of regulated electrical appliances, 2023.

Transport sector measures.

- The transport sector mitigation strategy aims to promote low-carbon mass transport mobility in the long term. This strategy is anchored on the national transport policy emphasising electric mobility (e-mobility), fleet renewal, efficient vehicle inspections, green shipping, and rail-based transits.
- Some of the key policy measures are contained in the following:
    - Adoption of the Ghana National e-vehicle policy, 2023.
    - Restriction of importation of salvaged and 10-years overaged vehicles as part of the amended Act 891 to incentives to automobile manufacturers and assemblers registered under the Ghana Automotive Manufacturing Development Programme.
    - Development of policy options for fuel economy, soot-free buses, and electric mobility.
    - Adoption of Ghana Standard for Environment and Health Protection – Requirements for Motor Vehicle Emissions to minimise vehicular emissions' impact on public health and the environment.

Land and forestry sector measures.

- The 2012 National Forest and Wildlife policy is the foundation of the mitigation strategy for the forest sector. The policy is operationalised using the Forestry Development Master Plan, Forest Plantation Development Strategy, and the REDD+ strategy.
- The Forest Plantation Strategy aims to increase forest cover and restore degraded lands, whereas the REDD+ strategy addresses the key drivers of deforestation and forest degradation in the cocoa, shea, and sub-national mangrove landscapes.
- There are five major collaborative initiatives underway in the high forest ecological zone that anchor the REDD+ strategy, namely: the Ghana Cocoa Forest REDD+ Programme (GCFRP), Ghana Forest Investment Programme (GFIP), Dedicated Grant Mechanism (DGM) and the Cocoa Forest Initiative (CFI).
- The Green Climate Fund approved the Shea landscape emission reduction programme. The project aims to generate 6 million tonnes of carbon emissions reductions over 7 years.

2.3 National institutional arrangements

2.3.1 Climate change institutional structure

The Ministry of Environment, Science, Technology, and Innovation (MESTI) coordinate all environment and climate change issues for the Government. As part of their functions, MESTI formulate climate policies and supervise the implementation of the Multilateral Environmental Agreements (MEA). MESTI is also the host of the National Climate Change Committee (NCCC), a multi-sectoral task force on climate change. Since 2015, MESTI has facilitated the implementation of Ghana's NDC and reported progress to the cabinet.

The EPA is an implementation Agency under MESTI. Through its Climate Change Unit (CCU), the EPA provides technical coordination for implementing national climate programmes and domesticating the UNFCCC. The EPA also sees to the implementation of Ghana's obligation to the UNFCCC, the Kyoto Protocol and its Doha Amendment, and the Paris Agreement as a Party. Since the submission of the BUR3, MESTI has led the introduction of legislation to codify the MESTI and EPA roles in implementing the UNFCCC in the new Environmental Protection Bill. The bill is at the consideration stage in Parliament. The following are the specific roles of MESTI and EPA that are included in the Environmental Protection Bill:

- Climate reporting under the convention and the Paris Agreement.
- Preparation of NDC and long-term low-emission development plans.
- Climate vulnerability impacts and risk.
- Mainstreaming adaptation and responses to loss and damage.
- Implement of Article 6 of the Paris Agreement.
- Support national efforts on the development and transfer of climate technology.
- Coordinate capacity building, climate change awareness and public participation.

Therefore, when the Government adopted Ghana's framework on the international carbon market and non-approaches, the EPA set up the carbon market office (CMO) to administer Article 6 technical and administrative functions. The CMO is also responsible for authorising Internationally Transferred Mitigation Outcomes (ITMOs) involving Article 6 voluntary cooperation, manages Ghana's carbon registry, and is responsible for NDC accounting and Article 6 mandatory reporting. The summary of the roles of organisations involved in the UNFCCC and the Paris Agreement is below:

- EPA serves as the UNFCCC Focal Point (NFP).
- EPA is also the designated body for Climate Technology Centre and Network CTCN) and Action for Climate Empowerment (ACE).
- MESTI serves as the national focal point for the Adaptation Fund
- MESTI/EPA DNA for Article 6.4 Mechanism of the Paris Agreement.
- The Ministry of Finance is the National Designated Authority for the GCF.
- The Forestry Commission is the National REDD+ secretariat.
- Ecobank is the GCF-accredited National Implementing Entity.

Figure 1 shows the institutions contributing to implementing Ghana's obligations under the UNFCCC and the Paris Agreement.

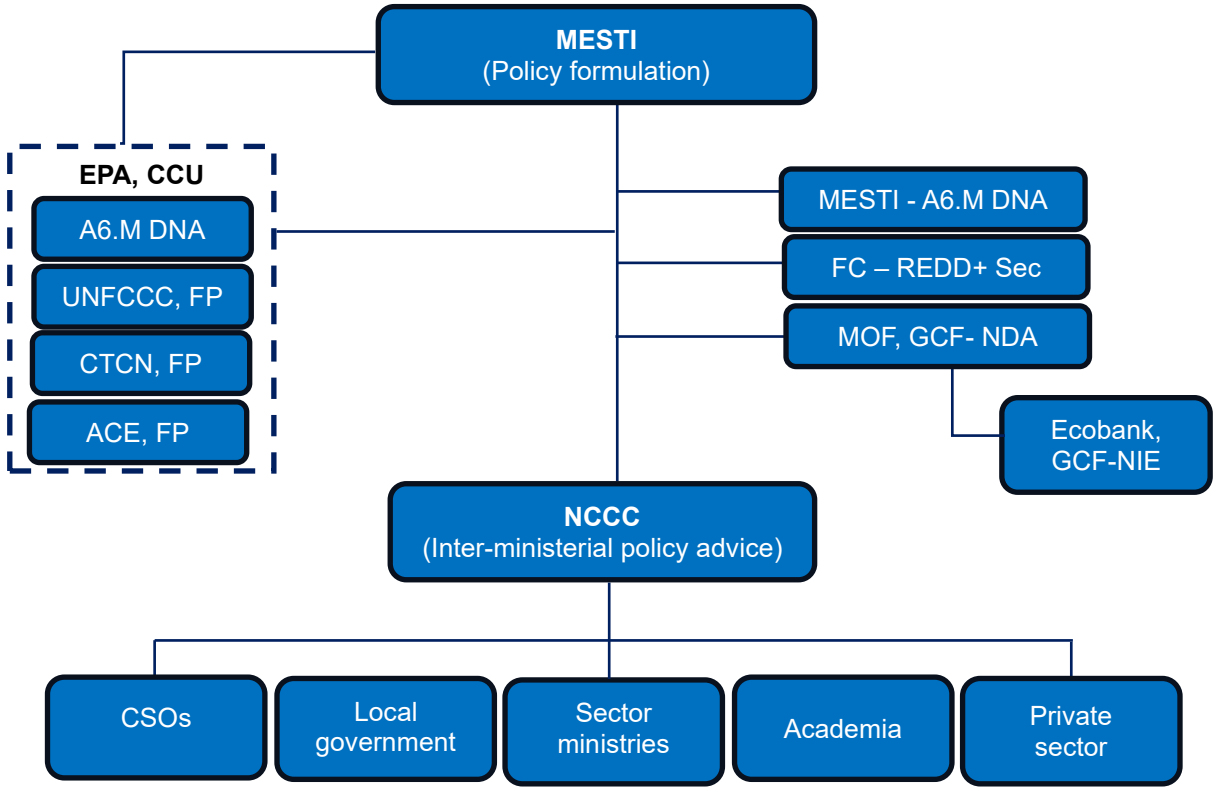


Figure 1: Institutions involved in the implementation of the UNFCCC in Ghana

2.3.2 Institutional arrangements for BUR4 Preparation

The EPA leads the planning, preparation, and submission of climate reports to the UNFCCC. As a party to the UNFCCC, Ghana established the Ghana Climate Ambitious Reporting Programme (GCARP) as its domestic MRV system. With the GCARP in place, Ghana has been able to submit 4 National Communications (NCs), 5 National Greenhouse gas Inventory Reports (NIRs), 1 Adaptation Communication (ADCOM) and 3 Biennial Update Reports (BUR3). The Forestry Commission has also led the submission of two REDD+ FRL/FREL.

The EPA led the preparation of the BUR4, the final BUR submission before the first publication of the Biennial Transparency Report (BTR) scheduled for December 2024 under Article 13 of the Paris Agreement. The CCU within the EPA coordinated the preparation of the BUR4 based on the mandate derived from the EPA Act 490, 1994. The CCU worked closely with more than 25 public and private organisations to compile the current BUR, which constituted three thematic working groups. Each working group plans and executes its assigned tasks. The tasks include data sourcing and analysis, quality control, drafting chapter reports and archiving. The CCU combines the individual chapter reports into the draft BUR4 for informal third-party review before submission to the UNFCCC. MESTI is also responsible for the official approval and endorsement of BUR and onward submission to UNFCCC.

After submission to the UNFCCC, the CCU uploads all files and documents onto the climate data hub for digital copy, retrieval, and public access. The CCU also facilitates

Ghana's involvement in the ICA process. During technical analysis, the Unit communicates with the Technical Team of Experts (TTE). The CCU works with the TTE to identify and prioritise capacity needs. During the facilitative sharing of views workshops, the CCU makes the country presentations and responds to questions from parties.

Through the UN Environment, the Global Environment Facility (GEF) provided financial support and operational guidance to Ghana in preparing and submitting the BUR4. UNDP's NDC support programme and the UNEP's CBIT project provided additional technical support to the BUR4 preparation through workshops and institutional engagement. The institutional arrangements for the preparation of BUR4 are presented in Figure 2

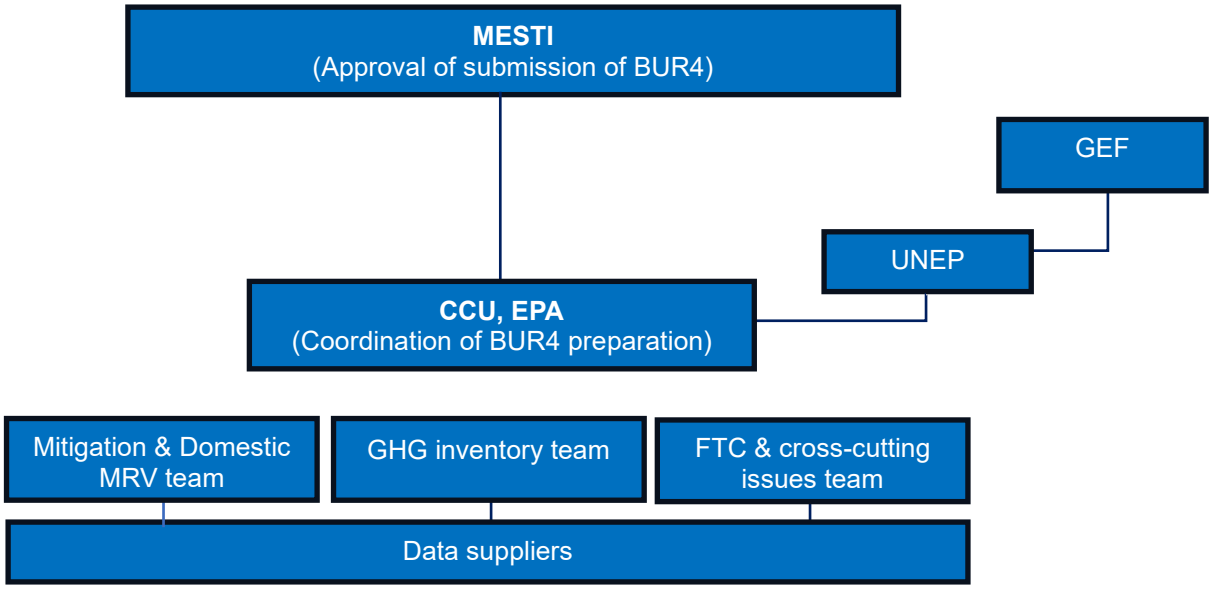


Figure 2: Institutional arrangement for BUR4 preparation.

Since the BUR3 submission to the UNFCCC:

- EPA's CCU has established a carbon market office to work on all Article 6 transaction reporting on voluntary cooperation established under the Paris Agreement.
- VALCO and Volta River Authority have started reporting annual facility-level GHG inventory results to the CCU.
- Completed an institutional capacity assessment for BUR, NC and BTR preparation. The revised capacity needs were built on the identified capacity priorities from the technical analysis of the BUR3. Reviewed the institutional roles that served as the basis for preparing the first BTR. The revised institutional arrangement supports the continuous preparation of NCs, BUR, NIR, AdCOM and BTRs.
- The Environmental Protection bill includes the legal mandate backing the institutional arrangement for continuous climate reporting to ensure its durability.
- Inclusion of the National Development Planning Commission (NDPC) in the institutional arrangement for climate reporting. NDPC tracks the progress and achievements of climate policies and measures.

National Greenhouse Gas Inventory

3. Ghana's Greenhouse Gas Inventory

3.1 Overview of the national GHG inventory

The BUR4 presents the latest updates of Ghana's national greenhouse gas inventory result in the NIR5. In this BUR4, the GHG inventory information is reported according to the requirements in decision 2/CP and the annexe to decision 17/CP.8.

Ghana intends to voluntarily publish a stand-alone 6th National Inventory Report (NIR6) to provide elaborate information on the NIR preparation steps, methodologies, results, capacity needs, improvements list and plans to address them. The NIR6 will provide Ghana with concrete steps to strengthen its national arrangement for regularly preparing BTRs. The BUR4's GHG inventory covers the time series from 1990 to 2021 with the following breakdown:

- Inventory base year: 1990.
- Inventory latest year: 2021.
- GHG inventory time-series in BUR3: 1990-2019
- Time series of new GHG in BUR4: 2020-2021
- Recalculation time series of selected IPCC sectors: 1990-2019

Recalculations have been conducted on GHG emission estimates for 1990 - 2019 for the Energy, IPPU, LULUCF and Waste sectors due to the availability of new datasets and methodological changes. The IPCC Fourth Assessment Report (AR4) 100-year time horizon GWPs were used to report the CO_2 equivalent of the emissions.

Ghana prepared the updated national GHG inventory using the methodological guidance in the 2006 IPCC guidelines for national GHG Inventories and 2019 refinement to the 2006 IPCC guidelines for national GHG Inventories where applicable.

This latest GHG inventory has estimated and reported anthropogenic emissions by sources and removals by sinks of Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Fluorocarbons (F-gases) and Sulphur Hexafluoride (SF_6) from applicable activities in the energy, industrial process and product use, agriculture, forestry and other land uses and waste sectors. Emissions from harvested wood products and SF_6 sources have been reported for the first time across the time series.

The EPA coordinated the planning and preparation of the national GHG inventory as a "single national entity". As the coordinating body in the GHG inventory, the Agency collaborates with many stakeholders to compile the national GHG estimates. Within the EPA, the Climate Change Unit (CCU) is the national inventory entity directly responsible for managing the entire inventory process.

The CCU ensured that the delivery of the inventory is timely, of good quality, and meets international standards. The EPA also serves as the generalist to the entire process by performing recalculations, key category analysis, management of QA/QC practices and improvement plans. Four national working groups were responsible for completing the energy, IPPU, AFOLU and waste sectors.

The inventory commenced with the review of the status to address the capacity needs and improvement list identified in the BUR 3 cycle. The recommendations from the ICA process were also addressed as much as Ghana's national circumstances may allow.

3.1.1 Description of the national GHG inventory steps

Preparing the GHG inventory component of the BUR4 involved a series of iterative steps, which were captured in the inventory timetable. The inventory's planning, preparation, and management spanned over fourteen months from 2022. It started with a kick-off meeting of the four inventory teams to discuss how Ghana addresses recommendations and capacity needs from the ICA3 and improvement list. After the review, the team decided which recommendations and improvement lists Ghana would address in the BUR4 based on the available resources. Below is a summary of the steps Ghana followed to prepare the inventory:

- Review of ICA3 recommendations, capacity building needs and improvement list.
- Determine which recommendations and improvement list will be addressed in the BUR4 and communicate the same to the team members.
- Undertake a literature review to identify new methodologies, data and approaches relevant to updating the inventory for the BUR4.
- Identifying key data sources, Activity Data (AD) collection and processing.
- Selection of applicable IPCC estimation tier and choice of Emission Factor (EF).
- Estimation and recalculation of direct GHG emissions, including CO_2, CH_4, N_2O, SF_6, F-gases and local air pollutants.
- Compilation of individual sector emissions into total GHG emissions by sectors and gases, followed by key category analysis by level and trends.
- Follow agreed QA/QC and uncertainty management practices.
- Improved documentation and uploaded all datasets to an online database.
- Prepare inventory summary report for BUR4.
- Publish BUR4 with GHG inventory component.

The steps described above have been presented in Figure 3.

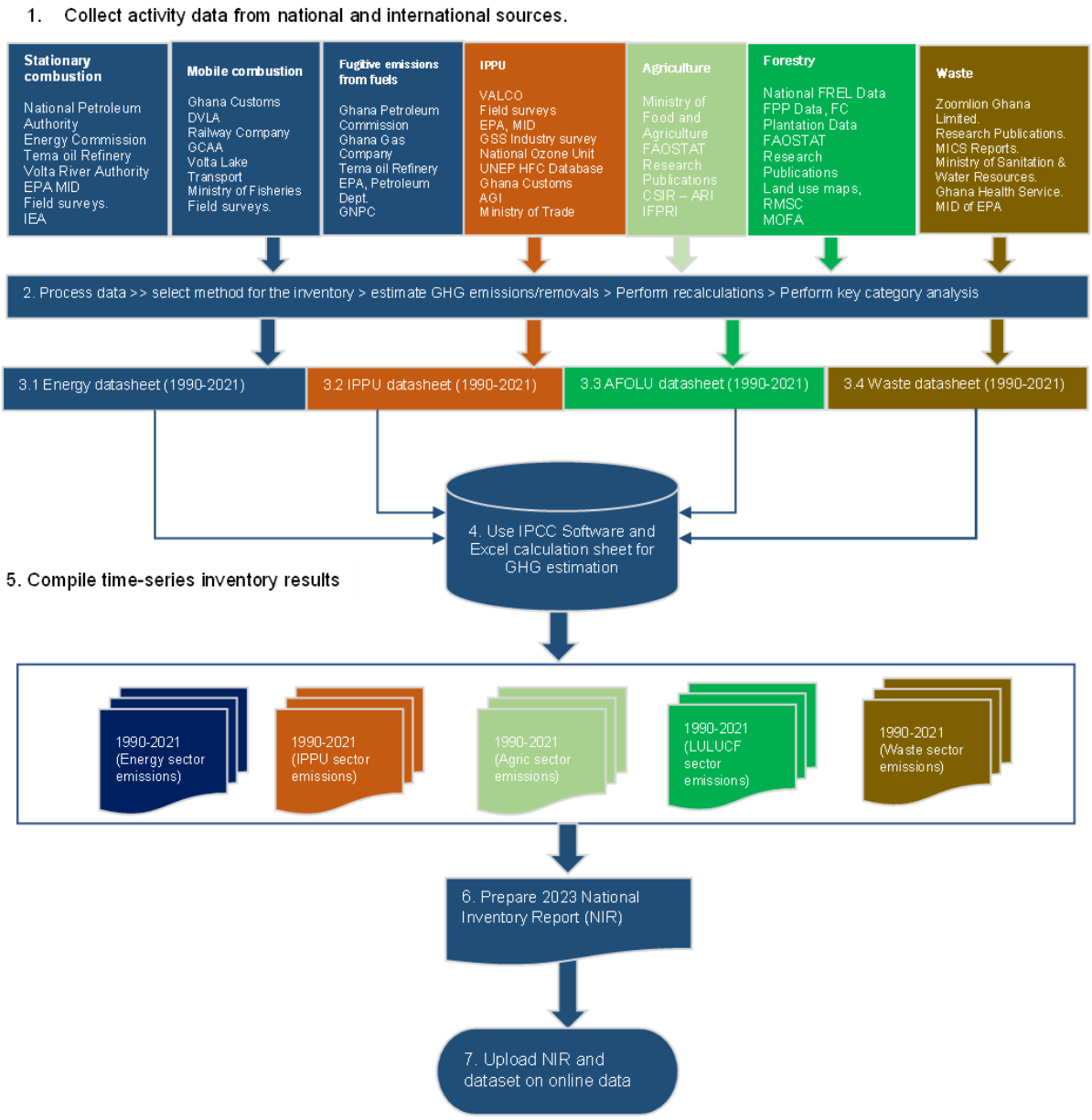


Figure 3: GHG inventory preparation steps for BUR4.

3.1.2 Description of methodological choices

The methodology and dataset used in the BUR4 improve on the previous inventories. Ghana has incorporated new country-specific activity data and emissions, mostly for the new inventory years, and period recalculations were performed. The methods described in the 2006 IPCC were used to compute emissions/removals for each category.

Generally, tier 1 and tier 2 have been used in the GHG emission and removal estimation that captures new country-specific activity data. As it waits for the IPCC to complete the methodology work on short-lived climate pollutants (SLCPs), Ghana has voluntarily calculated SLCP emissions using the EMEP/CORINAIR Emission Inventory Guidebook.

The availability of facility-level data from Volta Aluminium Company (VALCO) and Land-use changes enabled tier 2 methodology and country-specific emission factors to estimate emissions from Aluminium production and the Land categories.

The decision tree in Figure 4 guided the selection of the methods. Generally, tier 1 IPCC methodology was applied to most sectors, except in cases where available national data allowed us to adopt a higher tier.

For example, the availability of facility-level data from Volta Aluminium Company (VALCO) enabled tier 2 methodology to estimate emissions from aluminium production and solid waste disposal. The tier 3 method was to estimate net emission from the LULUCF sub-sector because of the disaggregated and modelled data from country-specific REDD+ studies.

As much as practical, the methodological difference between the latest REDD+ FRL and the LULUCF has been addressed. Notwithstanding the similarities in data sources for the FRL and the LULUCF, there were differences regarding the completeness level of the activity and the emission factors. The areas of difference are presented in Table 2.

Table 2: Methodological differences between REDD FRL and LULUCF

Parameters	REDD+ FRL	LULUCF
Land activities	Forest land transitions only.	Forestland, cropland, grassland, settlement, wetland, and other lands transitions
Land representation approach	Sampling	Wall-to-wall
Annual increment in biomass	Annual biomass increment excluded for natural forest	Annual biomass increment for natural and planted forests included for completeness

It is good practice to systematically follow the IPCC decision tree in selecting a appropriate methodological tier for the GHG inventory. The decision tree allowed Ghana to select the appropriate methodological tier for the GHG inventory based on activity occurrence, activity data availability and disaggregation levels in the inventory period and emission factors.

During the BUR4, Ghana followed the modified IPCC decision tree Figure 4 to select the methodological tiers for calculating the net emissions. Based on the activity data and emission factors available in the country, a higher tiers method was applied to estimate net GHG emissions in the LULUCF, waste and metal industries.

Since the submission of BUR3, Ghana has collected new data on harvested wood products and SF_6 use in electricity and medical facilities. With this new data, Ghana has reported net emissions from harvested wood products and SF_6 use under the IPPU and AFOLU sectors.

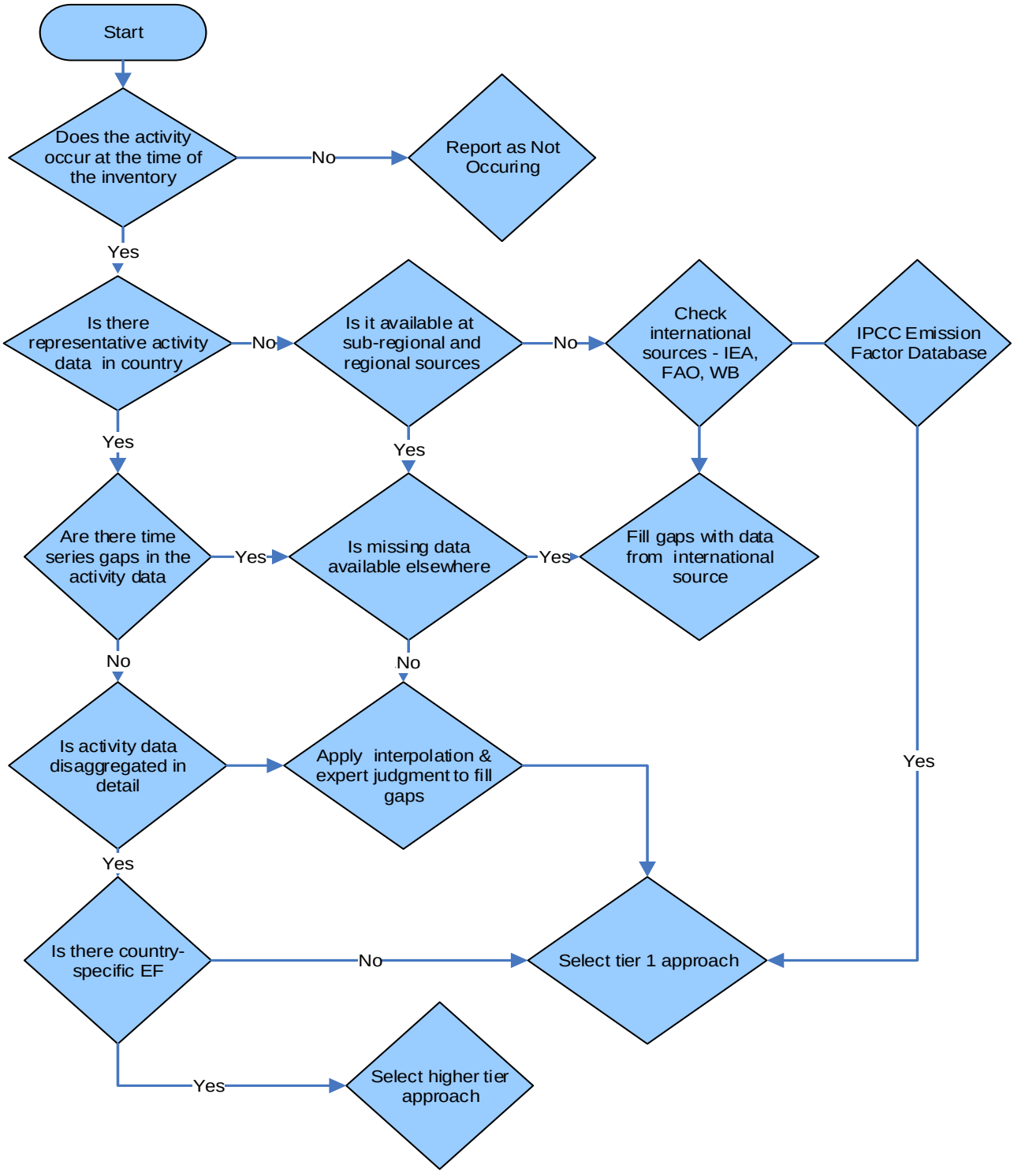


Figure 4: Modified IPCC decision tree for making methodological choices.

According to the IPCC methodological and the UNFCCC reporting guidelines, it is also good practice to report the methods and emission factors used for each gas and its corresponding activity. Reporting on the methods, EF and AD will contribute to increasing the transparency of the BUR. In this regard, Ghana has reported in Table 3 the methodological tiers and emissions factors for each greenhouse gas in the inventory.

Table 3: Methodological tiers and emission factors for emission/removal categories

IPCC Code	Emission sources/removal categories	CO_2		CH_4		N_2O		PFCs		HFCs		SF_6	
		M	EF	Meth	EF	Meth	EF	Meth	EF	Meth	EF	Meth	EF
1.A	Fuel Combustion	T1, T2	D, CS	T1, T2	D, CS	T1, T2	D, CS						
1.A1	Energy Industries	T1	D	T1	D	T1	D						
1.A2	Manufacturing Industries and Const.	T1	D	T1	D	T1	D						
1.A3	Transport	T1, T2	D, CS	T1, T2	D, CS	T1, T2	D, CS						
1.A4	Other Sectors	T1	D	T1	D	T1	D						
1.B	Fugitive Emissions			T1	D								
1.B1	Solid Fuels			NO	NO								
1.B2	Oil and Natural Gas			T1	D								
1.B3	Other Emissions from Energy Production			NO	NO								
2.A	Mineral Products	D	D	NE	NE	NE	NE						
2.B	Chemical Industry	NO	NO	NO	NO	NO	NO						
2.C	Metal Production	T2	PS	NE	NE	NE	NE	T2	PS				
2.D	Non-Energy Products from Fuels and Solvents Use	T1	D										
2E	Electronics Industry	NO	NO	NO	NO	NO	NO						
2.F	Product Uses as Substitutes for Ozone Depleting Substances									T1	D		
2.G	Other Product Manufacture and Use											T1	D
3.A	Livestock			T1	D		D						
3.B	Land	T2	CS	T1	D								
3C	Aggregate sources and non-CO_2 emissions sources on land	T1	D										
3D	Harvested Wood Products	T1	D										
4.A	Solid waste disposal	T1	D	T1	D	T1	D						
4.B	Biological Treatment of Solid Waste			D	D	D	D						
4.C	Incineration and Open Burning of Waste			TI	D	T1	D						
4.D	Wastewater Treatment and Discharge	T1	D	TI	D	T1	D						

CS= Country-Specific, PS= Plant-Specific, NE = Not Estimated, NO=Not Occurring, D = Default IPCC methodology and emission factor, EF = Emission Factor, Meth=Methods, T1, T2 - Levels of Tiers

3.1.3 Activity data sources

Activity data is collected from several national and international institutions and scientific literature. Much of the AD was obtained from existing data platforms managed by government institutions such as Energy Statistics[6] (Energy Commission), Agriculture Facts and Figures (Ministry of Food and Agriculture), National Forest Management System (Forestry Commission), Vehicle Statistics (Driver Vehicle and Licensing Authority - DVLA), Industry environmental statistics (EPA). The Energy Commission relies on data supplied by the oil refinery, electricity-producing companies, the National Petroleum Authority (NPA), the Petroleum Commission and the Ghana National Gas Company (GNGC). The Energy Commission also collects data from the Ghana Statistical Service (GSS) and uses survey data. The energy statistics data was the primary source of the AD for 1A1, 1A2, 1A3 and 1B. Data on vehicle population and circulation patterns were from the Ministry of Transport and DVLA.

The AD sources for the IPPU sector were sourced from the facility statistics collected through official requests. Others are obtained from the Environmental Management Plans (EMPs), Annual Environmental Reports and Quarterly Report companies submitted to the Environmental Protection Agency as per the Environmental Permit Conditions and Regulations 24 and 25 of LI 1652. The activity data were also retrieved from the Environmental Performance Rating and Public Disclosure Database hosted by the EPA and the Industry Survey published by the GSS and the EPA.

EPA also collected data on HFC consumption in refrigeration air-conditioners from the national survey on HFC. The Ministry of Food and Agriculture's Statistics Research and Information Directorate (SRID) publishes the Agric Facts and Figures. The current online version of the Facts and Figures was published, covering data from 1999 to 2009. The SRID made the latest version of the facts and figures to the inventory team covering 2021, though they are not published online. The Facts and Figures is the primary activity data source for the 3A and selected categories under 3C.

The primary source of the AD for Land category (3B) is the National Forest Management System (NFMS), hosted by the REDD+ Secretariat of the Forestry Commission. Most of the requisite data have been pulled together at a central point at the Forest Commission during the REDD+ National Forest Reference Level (FREL) preparation of UNFCCC. Having the dataset at the Forest Commission made access to the land representations dataset far more accessible. The AD for the Waste sector was mostly dispersed among several district assemblies. So, the waste inventory team consulted various data sources, including government reports, scientific literature, data from environmental sanitation service companies, and the GSS, to assemble all the necessary data. Alternative reliable data from international organisations such as FAO, IEA, and the World Bank without national data were used. Table 4 presents the data used in the inventory.

[6] http://www.energycom.gov.gh/planning/data-center/energy-statistics.

Table 4: Sources of activity data, format, and the principal data providers

Sector		Data Type	Data Sources	Principal Data Providers	Remarks
1. Energy Sector					
1.A1	Energy Industry	Fuel types, supply, and consumption: • Crude oil production, imports, exports and use for electricity generation and as refinery inputs. • Natural gas production is processed, imported, and used as fuel for electricity generation. • Production, imports, export, and petroleum products production. • Auto production of selected petroleum products in the refinery, the gas processing plants, and the oil fields.	National Energy Statistics. Tema oil refinery material balance. National Energy Plan. International Energy Agency Database. Oil and Gas Production Figures. Ghana National Gas Company Data.	Energy Commission. National Petroleum Authority. Tema Oil Refinery. Thermal Electricity Generation Utility Companies (VRA, Sunon Asogli, Takoradi International Company TICO and other independent power producers. Ghana National Gas Company Limited. National Petroleum Commission. International Energy Agency.	National Energy Statistics is published online in April every year. TOR material balance is updated every year but not published. TOR data is administrative data requests through the Energy Commission. Oil and Gas Production figures are published every month by the Petroleum Commission.
1.A2	Manufacturing Industry and Construction	Industrial sectors and their fuel consumption: fuel types and consumption, the quantity of fuel used as feedstock, and the quantity of fuels used for non-energy use.	National Energy Statistics, 2018. Industry survey data, 2013. National Industry Census, 2003 IEA	Energy Commission. Manufacturing Industry Department of the Environmental Protection Agency. Ghana Statistical Service.	The fuel allocation per industry sector share is based on the fuel shares in the Energy Commission's SNEP dataset. To improve the existing data, surveys are planned.
1.A3	Transport	Fuel, vehicle and traffic information.	Vehicle registration database. Transport sector study reports.	Energy Commission. Environmental Protection Agency. Driver Vehicle Licensing Authority	Yearly vehicle population figures are sourced from the yearly release of administrative data on

		Fuel types and consumption by vehicles of different years of manufacture and technology class. International and domestic Aviation Rail and Navigation, Number of Registered Vehicles, Vehicle Types	Petroleum product sales data. Railway fuel consumption data. Water transport fuel consumption. Premix fuel consumption data.	Oil Marketing Companies (particularly Shell Ghana Limited and Total Ghana Limited). Ministry of Transport, Ghana Railway Company. Volta Lake Transport Company. Ghana Bunkering Services. Premix Committee at the Ministry of Fisheries and Aquaculture Development	vehicle registration, roadworthy certification figures from DVLA and Vehicle import figures from the GcNET under Ghana Customs. There are plans to liaise with the newly established garages regarding vehicle inspections to collect additional vehicle odometer readings and measured emission figures.
1.A4	Other Sectors	Quantities of solid and liquid fuel consumption per category.	National Energy Statistics, National Energy Plan, National Census Report, Ghana Living Standard Survey Report	Energy Commission Ghana Statistical Service	The fuel allocation per industry sector is based on the fuel shares in the Energy Commission's SNEP dataset. There are plans to survey to improve the existing data.
1. B	Fugitive emissions from fuels	Quantities of wet production, quantities of reinjected, quantities of gas flared, and gas consumed on site. Quantities of gas exported to Ghana National Gas Company.	Oil Exploration and Production. Gas transmission lines. Oil refinery data in the energy statistics.	Ghana National Petroleum Corporation. Petroleum Commission. Oil Production Companies. Environmental Protection Agency. Tema Oil Refinery.	Oil and Gas Production figures are published every month by the Petroleum Commission.
2. Industrial Process and Product Use Sector					
2. A	Mineral Industry	Industrial production and Plant-specific emission factors	Environmental Reports. Environmental Performance Rating and Public Disclosure Database. Industry Survey. Industrial data from companies.	Volta Aluminum Company Limited Tema steelworks Aluworks Limited Environmental Protection Agency	No industry-specific data is published. Data are officially requested from the industry and the Environmental Impact Statements.
2.C	Metal Industry				
2.D	Non-Energy Products from Fuels and Solvents Use	Amount of non-energy use of diesel and kerosene			

2F	Product Uses as Substitutes for Ozone Depleting Substances	Quantities of different types of refrigerant imports and volumes sold per year to the refrigeration and air-conditioner.	National survey on HFC consumption	National Ozone Office, Environmental Protection Agency	One-time national survey on HFCs by the Ghana EPA
3. Agriculture, Forestry and Other Land use					
3.A1 and 3.A2	Enteric Fermentation & Manure Management	Animal population, Animal attribute (age, sex and weight classes). Fractions of manure management practices.	Agriculture Facts and Figures. FAOSTAT. Expert Judgment.	Ministry of Food and Agriculture – SRID. UN FAO. AFOLU Team	The Ministry of Food and Agriculture publishes Agriculture Facts and Figures online annually. However, the metadata for the publication is not available. The team considers the lack of metadata an area for improvement.
3.B1	Forest land	Land-use maps, land-use change map, land-use change matrix.	Forest Preservation Program, 2012, National Forest Reference Level, 2017.	Forestry Commission, Ghana	Land-use maps are not published at any scheduled time. They are generally produced as part of projects.
		Biomass estimates for 5 IPCC pools (AGB, BGB, deadwood, herb, litter, and soil).			Biomass estimates across all ecological zones were produced in 2014 as part of the Forest Preservation Programme. There are scheduled updates.
		Climate zones, soil stratifications and ecological zone maps.	IPCC database	IPCC Forestry Commission	One-time GIS layers for climatic zones, soil classification and ecological zones exist.
		Industrial round wood.	RMSC, FAOSTAT	Forestry Commission FAO	Industrial round wood harvest figures are available quarterly at RMSC but not published online. It is considered an

					administrative request via an official letter.
		Wood fuel production.	Energy Statistics	Energy Commission	The total wood fuel supply is published in the Energy Statistics every year.
		Areas affected by fires.	REDD+ National Forest Reference Level, 2017.	Forestry Commission	One-time GIS map produced by the Forestry Commission when developing the REDD+ FREL
3.B2	Cropland	Land-use maps, land-use change map, land-use change matrix.	Forest Preservation Program, 2012, National Forest Reference Level, 2021.	Forestry Commission	Land-use maps are not published at any scheduled time. They are typically produced as part of projects.
		Biomass estimate for 5 IPCC pools (AGB, BGB, deadwood, herb, litter, and soil).			Biomass estimates across all the ecological zones were produced as part of the Forest Preservation Programme 2014. There are scheduled o updates
		Climate zones, soil classification and ecological zone maps.	IPCC database	IPCC	One-time GIS layers for climatic zones, soil classification and ecological zones exist.
3.B3	Grassland	Land-use maps, Land-use change maps, and change matrices.	Forest Preservation Program, 2012, National Forest Reference Level, 2021.	Forestry Commission	Ditto
		Biomass estimate for 5 IPCC pools (AGB, BGB, deadwood, herb, litter, and soil)			Ditto
		Climate zones, soil classification and ecological zone maps	IPCC database	IPCC	Ditto
3.C1	Biomass burning	Areas affected by fire in cropland, forestland, and grassland	National Forest Reference Level, 2021.	Forestry Commission	Ditto

		Mass of fuel available for burning.	Forest Preservation Program, 2012 National Forest Reference Level, 2021.	Forestry Commission	Derived from biomass figures for each land-cover type.
3.C3	Urea application	Annual Urea consumption figures	Agriculture Facts and Figures	Ministry of Food and Agriculture – SRID	Agriculture Facts and Figures is published annually by the Ministry of Food and Agriculture online.
3.C4	Direct N_2O emissions from managed soils	Annual generic NPK consumption	Agriculture Facts and Figures	Ministry of Food and Agriculture – SRID,	Ditto
3.C5	Indirect N_2O emissions from managed soils	Annual crop production in tonnes per annum	Agriculture Facts and Figures	Ministry of Food and Agriculture – SRID	Ditto
3.C6	Indirect N_2O emissions from manure management	Animal population (cattle, goats, sheep, swine, donkey, poultry, horse)	Agriculture Facts and Figures	Ministry of Food and Agriculture – SRID	Ditto
		Fractions of manure management practices	Expert Judgment	AFOLU Team	Ditto
3.C7	Rice cultivation	Annual rice production areas	Agriculture Facts and Figures	Ministry of Food and Agriculture – SRID	Ditto
		Proportions of annual rice production area under rain-fed irrigated and upland systems	National Rice Development Strategy	Ministry of Food and Agriculture - SRID	Ditto
4. Waste					
4A	Solid Waste Disposal	Waste Generation, Population Figures, Composition, amounts of waste deposited, means of disposal and their various percentages	Published national reports. Ghana Statistical Service. Sanitation Directorate of MLGRD. World Bank Country Database. Private Waste Management Companies and Civil	National Environmental Sanitation Strategy & Action Plan (NESSAP). Population Census Reports and Ghana Living Standards Survey 2008. Private Waste Management Companies (Zoomlion Ghana Limited, Waste Care), and NGOs Academia (Civil Engineering Department, KNUST).	Solid waste data is not at a single location. Documentation is poor. Relied on multiple reports, literature and scattered data at the assemblies. A major national survey is needed.

			Engineering Department KNUST. EPA	Second National Communication Report.	
4B	Biological Treatment of Solid Waste	The fraction of waste composted and the number of composted plants	Private Waste Management	Private Waste Management Companies (Zoomlion Ghana Limited) and NGOs. Expert judgment by the Waste Team	Ditto
4C	4C.1 Waste Incineration	Amount and types of solid waste incinerated, type of incinerator including capacities and combustion efficiencies	Ghana Health Services. Ministry of Local Government and Rural Development.	National Environmental Sanitation Strategy Action Plan document. Ghana Health Service Facts and Figures. Expert Judgment by the Waste Team.	Data on incineration is scanty and scattered. The inventory team relied on different data sources. A major national survey is needed.
	4C.2 Open Burning of Solid Waste	Population, the proportion of population burning waste, duration of burning in the number of days per year, and the fraction of waste burnt relative to the total amount treated.	Published national reports, Ghana Statistical Services, Sanitation Directorate of MLGRD,	National Environmental Sanitation Strategy & Action Plan (NESSAP), Population Census Reports and Ghana Living Standards Survey 2008, Expert Judgment by Waste Team	Data on open burning is not adequate. The inventory team relied on different data sources. A major national survey is needed.
4D	4D.1 Domestic wastewater treatment and discharge	Population, Wastewater Generated per year, Wastewater treated per year, Wastewater Treatment Systems and their various percentages, Protein Consumption, GDP/capita	Ghana Statistical Service. Sanitation Directorate of MLGRD. World Bank, Ghana Health Service. Ministry of Food and Agriculture	National Environmental Sanitation Strategy & Action Plan (NESSAP). Population Census Reports and Ghana Living Standards Survey 2008. Multiple Cluster Indicator Survey Data World Bank Country Database & FAO. Expert Judgment by the Waste team.	Data on domestic wastewater are scattered. The inventory team relied on different data sources. A major national survey is needed.
	4D.2 Industrial wastewater treatment and discharge	Industrial coverage, Total Industry Product Quantity of wastewater generated, Type of Wastewater Treatment/Discharge System	Industry survey	Industrial output data was collected during the national survey. Environmental Management Plans. Expert Judgment by the Waste team.	The quality of the survey data and the Environmental Management Plans for Industries must be improved.

3.2 National GHG Inventory Results

3.2.1 Ghana's total GHG emission trends

In 2021, Ghana recorded 51.78 $MtCO_2e$ (million tonnes carbon dioxide equivalent) total net greenhouse gas emissions in 2021, representing 12% higher than the 2019 levels. Since 2010, energy has remained Ghana's largest greenhouse gas emissions source. Across the 2010 and 2021 period, the energy sector has averagely contributed 41% to the total national emissions. In 2021, the sector breakdown of the total emissions was 51.2% from the energy sector, followed by Agriculture (23%), LULUCF (15.3%), Waste (7.3%) and IPPU (3.2%).

When the net emissions from LULUCF are excluded from the national totals, the overall emissions amounted to 43.87 $MtCO_2e$ in 2021. In this respect, the energy sector was still the most dominant source, making 60.4% of the country's greenhouse gas emissions. Agricultural emissions (livestock, soil, and crop) constituted 27.2% of the total emissions without LULUCF then followed by the waste sector (8.6%) and IPPU (3.8%).

Generally, the total national emission levels steadily rose over three decades (1990-2021). Ghana's total greenhouse gas emissions have increased by 372.3% from 10.36 $MtCO_2e$ in 1990 to 51.78 $MtCO_2e$ in 2021 at an annual growth rate of 5.1% (Figure 5). In the latest near decade (2021-2010), the emissions showed a rising trend with an increase of 69.1% compared to the 2010 levels at a 4.9% growth rate. Since the recent inventory was published in 2019, the total emissions increased by 11.6%.

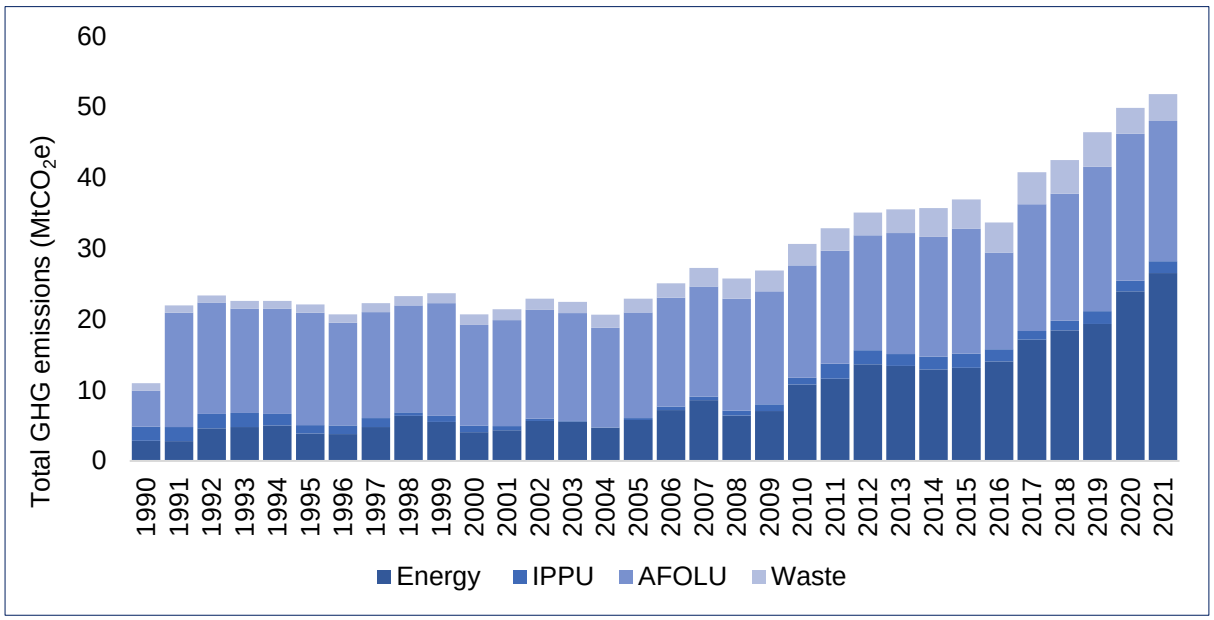


Figure 5: Total GHG emissions trends per sector for 1990-2021.

Greenhouse emissions from all the IPCC sectors showed different degrees of increase trends over the 2010-2021 time series. The energy sector recorded the highest rise of 145.1%, followed by IPPU (77.2%), Agriculture (38.9%), Waste (25.1%) and LULUCF (8.8%). Activities in the oil and gas, transport, and electricity generation drive the energy sector emission trends.

Carbon dioxide is Ghana's dominant direct greenhouse gas, followed by CH_4, N_2O, HFCs, PFCs and SF_6 in 2021. At 33.7 Mt, CO_2 accounted for 63.3% of the total national emissions in 2021. The rest of the emissions were CH_4 (17.9%), N_2O (15.9%), HFC (1.1%), PFC (0.95%) and SF_6 (0.86%) in the same year. Most CO_2 emissions, including LULUCF, were from the energy sector. The sector accounted for 74.8% of the total CO_2 emissions in 2021. Transport (61.5%) and electricity generation (27.1%) are the two largest contributors to CO_2 emissions in the energy sector. The remaining CO_2 is emitted from manufacturing industries and construction (6.8%) and other sectors (4.6%).

Road transport is responsible for 99.6% of the total transport CO_2 emissions. Within road transport, the breakdown of the CO_2 emissions are as follows: passenger cars (58.3%), two and three-wheeler motorcycles (22%), heavy-duty trucks and buses (11%) and light-duty trucks (8.8%). Increasing overaged fleets, traffic congestion in urban areas, and fuel quality influence road transport's CO_2 emissions. Thermal electricity generation, which accounts for 65% of the public grid, is fuelled mainly by natural gas and liquid fuels (crude oil, diesel, and heavy fuel oil drive the rising CO_2 trends in the energy sector.

LULUCF is the second largest source of CO_2 emissions, making up 23.4% of net CO_2 emissions in Ghana due to land use changes. Cropland contributed most of the net CO_2 emissions in the LULUCF category, whereas forestland and grassland served as a net CO_2 sink in 2021. Lands (mainly forestland and grassland) converted to cropland are the main source of net CO_2 in LULUCF. Forestland is net CO_2 sink through forestland remaining forestland and land converted to forest.

Regarding methane, in 2021, the agriculture and the waste sectors dominate the most. The agriculture sector alone accounts for 47.7% of methane emissions in the country, of which livestock contribute 80.9%, biomass burning (10.1%) and rice cultivation (9.1%). Methane from waste management makes up 43.7% of the national total. Most methane emissions from the waste sector were from unmanaged solid waste disposal sites, and wastewater treatment was the main source. Methane from unmanaged solid waste disposal sites is associated with unsustainable waste landfills and dumpsites practices. The common practice in the country is methane from landfills, and dumpsites are mostly unmanaged.

For N_2O, 86.6% were from aggregate sources and non-CO_2 emission sources in the land category under the AFOLU sector in 2021. Within this category, direct N_2O emissions from managed soils are the leading source of N_2O. The N_2O emission results from nitrogen addition to soils through the application of fertilisers. Domestic wastewater treatment accounts for 7% of the total N_2O emissions.

All industrial gases covered in this inventory, including HFC, PFC and SF6, were emitted in the IPPU sector. HFCs were from the product used as a substitute for ODS, whereas the PFCs were from the metal industry. Ghana is reporting on SF6 emissions under the sub-category “SF6 and PFCs from Other Product” for the first time. Table 5 presents emission results for 2021 while Table 6 showing shows the emission trends for selected years.

Table 5: Common reporting Table B for greenhouse gas emissions in 2021

Categories	Emissions (Gg)			Emissions CO_2 Equivalents (Gg)			Emissions (Gg)				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NOx	CO	NMVOCs	BC	SO_2
Total National Emissions and Removals	**33,725.2**	**336.2**	**24.9**	**581.5**	**507.5**	**0.5**	**913.5**	**1313.4**	**894.4**	**378.9**	**15,565.9**
1 - Energy	**25,226.8**	**32.8**	**1.6**	-	-	-	**913.5**	**850.2**	**894.4**	**378.9**	**15,565.9**
1. A - Fuel Combustion Activities	25,226.8	19.4	1.6	-	-	-	913.5	850.2	894.4	378.9	15,565.9
1. B - Fugitive emissions from fuels	0.01	13.5	0.0	-	-	-	-	-	-	-	
1. C - Carbon dioxide Transport and Storage	N/A	-	-	-	-	-	-	-	-	-	
2 - Industrial Processes and Product Use	**575.5**	**N/A**	**N/A**	**581.5**	**507.5**	**0.5**	**-**	**-**	**-**	**-**	
2. A - Mineral Industry	496.7	N/A	N/A	-	-	-	-	-	-	-	
2. B - Chemical Industry	N/A	N/A	N/A	-	-	-	-	-	-	-	
2. C - Metal Industry	76.8	N/A	N/A	-	507.5	-	-	-	-	-	
2.D - Non-Energy Products from Fuels and Solvent Use	2.1	N/A	N/A	-	-	-	-	-	-	-	
2. E - Electronics Industry	N/A	N/A	N/A	-	-	-	-	-	-	-	
2. F - Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	581.5	-	-	-	-	-	-	
2. G - Other Product Manufacture and Use	N/A	N/A	N/A	-	-	0.5	-	-	-	-	
3 - Agriculture, Forestry, and Other Land Use	**7,905.9**	**181.8**	**21.1**	**-**	**-**	**-**		**463.2**			
3. A - Livestock	N/A	147	-	-	-	-					
3. B - Land	8,421.3	N/A	N/A	-	-	-					
3. C - Aggregate sources and non-CO_2 emissions sources on land	2.79	34.8	21.1	-	-	-					
3.D - Other	(518.1)	N/A	N/A	-	-	-					
4 - Waste	**16.9**	**121.6**	**2.3**	**-**	**-**	**-**	**-**	**-**			
4. A - Solid Waste Disposal	N/A	55.7	N/A	-	-	-					
4. B - Biological Treatment of Solid Waste	N/A	1.9	0.2	-	-	-					
4. C - Incineration and Open Burning of Waste	16.9	4.9	0.1	-	-	-		463.2			
4.D - Wastewater Treatment and Discharge	N/A	59.1	2.1	-	-	-					
Memo Items (5)											
International Bunkers	583.9	0.0217	0.0163	-	-	-					
1.A.3.a.i - International Aviation (International Bunkers)	562.2	0.0197	0.0157								
1.A.3.d.i - International water-borne navigation (International bunkers)	21.8	0.0021	0.0006								
1.A.5.c - Multilateral Operations	-	-	-	-	-	-					

Table 6: Emission trends for selected years per category

Emission sources/sinks	Total emissions ($MtCO_2e$)							% Change
	1990	2000	2010	2012	2016	2019	2021	[2019-2021]
National Emissions with LULUCF	10.96	20.68	30.62	35.09	33.68	46.42	51.78	12%
National Emissions without LULUCF	8.74	11.93	22.42	26.12	28.82	36.12	42.21	17%
1. Energy	2.86	4.07	10.82	13.64	14.06	19.36	26.52	37%
1A1, 1A2, 1A4 (Stationery combustion)	1.16	1.74	4.85	6.10	7.61	10.01	10.25	2%
1A3 Transport	1.70	2.33	5.94	7.52	6.33	9.23	15.93	73%
1B2 - Oil and Natural Gas	-	-	0.03	0.02	0.13	0.12	0.34	180%
2 Industrial Processes and Product Use	1.96	0.90	0.94	2.01	1.69	1.82	1.66	-9%
2A Mineral Industry	0.01	0.04	0.40	0.52	0.35	0.53	0.50	-7%
2C Metal Industry	1.95	0.86	0.01	0.73	0.75	0.60	0.58	-3%
2D Non-Energy Products from Fuels and Solvent Use	-	0.00	0.00	0.00	0.00	0.02	0.00	-90%
2F Product Uses as Substitutes for ODS	-	-	0.52	0.75	0.58	0.59	0.58	-2%
2. G - Other Product Manufacture and Use	-	-	-	0.00	0.02	0.07	0.00	-99%
3 - Agriculture, Forestry, and Other Land Use	5.11	14.23	15.85	16.21	13.68	20.37	19.83	-3%
3A Livestock	1.94	2.37	3.04	3.28	3.93	4.44	4.77	7%
3B Land	6.66	7.59	7.80	7.79	7.71	9.22	8.42	-9%
3C Aggregate sources and non-CO_2 emissions sources on land	2.91	4.01	5.55	5.96	6.58	7.45	7.15	-4%
3D - Other	(6.40)	0.26	(0.53)	(0.83)	(4.55)	(0.75)	(0.52)	-31%
4 Waste	1.02	1.48	3.01	3.23	4.25	4.87	3.77	-23%
4. A Solid Waste Disposal	0.26	0.48	1.38	1.51	2.26	2.58	1.39	-46%
4. B Biological Treatment of Solid Waste	0.09	0.06	0.07	0.07	0.11	0.10	0.11	9%
4C Incineration and Open Burning of Waste	0.03	0.03	0.07	0.07	0.08	0.15	0.16	6%
4D Wastewater Treatment and Discharge	0.64	0.90	1.49	1.58	1.81	2.04	2.10	3%

3.2.2 Short-lived climate pollutant trends

Short-lived climate pollutants are powerful greenhouse gases and local air pollutants emitted through economic activities in the country. Controlling short-lived climate pollutant emissions has both global climate development and local air quality benefits. Therefore, Ghana voluntarily reports on GHG and non-GHG short-lived climate pollutants such as CH_4, BC and HFC. In this report, Ghana has presented the results of some selected short-lived climate pollutants for the 1990-2021 period. Figure 6 shows direct SLCPs (CH_4, BC and HFC) trends for 1990-2021.

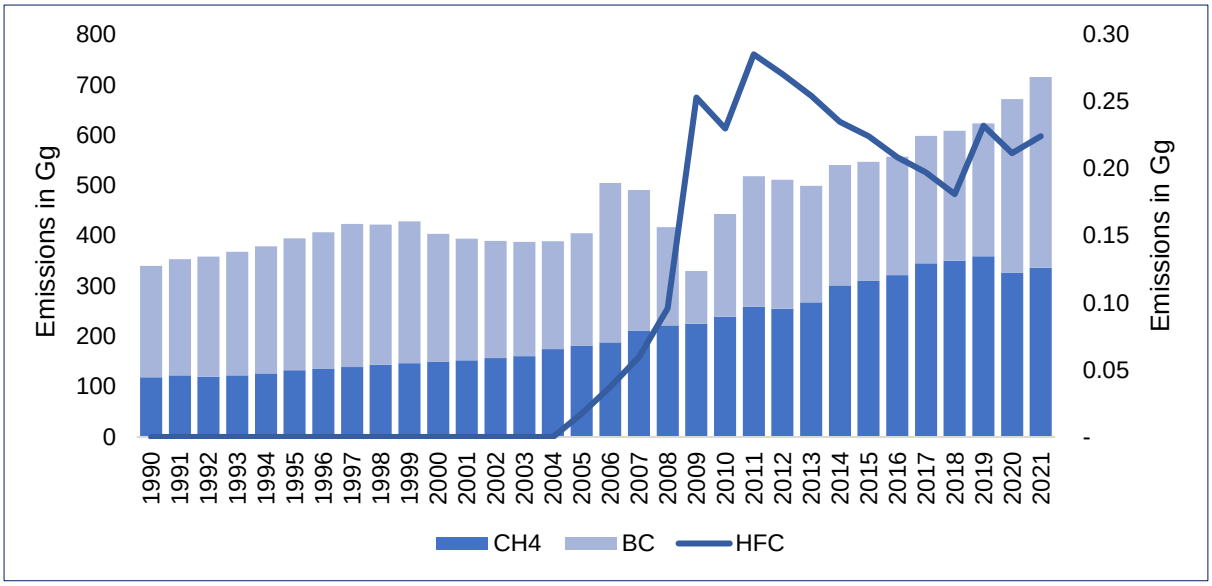


Figure 6: Trends of selected short-lived climate pollutants for 1990-2021.

Ghana's largest short-lived climate pollutant is methane. They are mostly emitted from unsustainable agriculture practices, waste disposal, and oil and gas operations. In 2021, the total methane emissions were 336.19 Gg, representing a 6.3% reduction from the 2019 levels due to some improvements in solid waste disposal. Most of the methane was emitted from the animal husbandry practices. In 2021, enteric fermentation from livestock produced 41.7% of total methane. The waste sector was the second-largest source of methane in Ghana. In 2021, methane emissions from waste disposal accounted for 36.2% of the national total. Solid waste disposal and domestic wastewater contributed to 45.8% and 48.6% of the methane emissions in the waste sector. Oil and gas operations and residential cooking with solid biomass accounted for 41% and 34% of the methane in the sector.

Black carbon is the second dominant short-lived climate pollutant, mostly from the energy sector (biomass and diesel consumption). BC levels increased by 43.4% from 264.2 Gg in 2019 to 378.9 Gg in 2021. The 2021 BC emissions were mainly from biomass fuel for cooking (53.6%) and diesel engine vehicles (30.6%) all within the energy sector. All (100%) emissions were associated with HFC-refrigerant consumption in the air-conditioning and refrigeration. HFC emissions declined by 3.4% between 2019 and 2021. The reduction related to the impact of Ghana's HFC phase and management programme.

3.2.3 Drivers of the GHG emission trends

The observed trends of GHG emissions are attributed to the impacts of recalculations and the effect of carbon-intensive economic policies. Recalculation was implemented throughout the time series mainly due to the discovery of new datasets in the IPPU and LULUCF, changes in the methodology for calculating emissions in the oil and gas and corrections in the previous calculations. Details on the reasons and the impact of the recalculations on the emission in the BUR4 are provided in the recalculations section of the report.

Despite the reductions in GHG emissions due to the impacts of recalculations, the emission levels showed rising trends due to economic, policy and demographic factors. Ghana's continued reliance on hydrocarbons, precious minerals, timber, and cocoa to drive exports to support economic advancement also contributes to the rising emission levels. These commodities' production, processing utilisation and rising urban population significantly influence Ghana's GHG emissions. The extraction of timber, gold and cocoa cultivation has been associated with high deforestation in the country. Below is the summary of the key drivers of greenhouse gas emissions in Ghana:

- **Growing urbanisation, rising individual vehicle ownership and traffic congestion** – the fraction of the population living in urban areas is at a record high of 58% in 2021, leading to high demand for transfer services, which are fossil-fuel-centric and individualised road-space use. Ghana's total cumulative vehicle population has increased from 2.1 million in 2016 to 6 million in 2021, of which more than 70% are in urban areas. Road space use is still dominated by private passenger cars. These factors drive fuel consumption and the release rate of greenhouse gases (predominantly carbon dioxide) on road transport.

- **Increasing shift to natural gas-based thermal grid electricity**– In early 2000, Ghana's electricity generation capacity was predominantly hydro (98%) with 2% thermal. Over 22 years, the grid mix has seen a complete transition to become dominated by thermal (65%), hydro (35%) and renewable (0.7%) of the total generation of 23,163 GWh in 2021. For thermal components, while fuel oil consumption declined by 48%, natural gas almost tripled over the same period. The shift to more natural-gas-based electricity influences the CO_2 emission trends.

- **Dynamic landscape transition pathways** - The combined effect of the upsurge of cultivated lands, built-up areas including mining and the sustained effort of converting land to forest (Reforestation) and keeping the forest intact (conservation and sustainable forest management practices) drive the net CO_2 emissions in LULUCF. The supply of harvested wood products also contributes to determining net CO_2 emissions.

- **Waste disposal, livestock, biomass burning, and rice cultivation influence methane emission levels** – The rising methane levels in the country are closely

associated with waste disposal practices, animal husbandry and traditional irrigated and flooded rice cultivation.

3.3 Key Category Analysis

3.3.1 KCA levels assessment

Key Category Analysis (KCA) for 2021 was based on the level assessment. The trend assessment was used to identify key categories for 2012 and 2021 emissions. The 2012 base year for trend analysis to ensure consistency with inventory timelines. The 2021 level assessment identified twenty-five key category sources and removals with net emissions of 48.9 $MtCO_2e$ (Table 7). Of the 25 KCA list, 5 were in the energy sector, 7 in LULUCF, 6 in agriculture (livestock, soils and biomass burning), 4 in the waste sector and 3 in IPPU. In terms of greenhouse gas emissions, CO_2 is associated with 13 KCA lists, followed by CH_4 (6 KCA lists), N_2O (4 KCA lists), PFC (1 KCA list) and HFC (1 KCA list). Without the LULUCF, there were eighteen key categories with a total emission of 41.3 $MtCO_2e$.

Table 7: Level assessment key category list in 2021

Categories	Ex, t ($MtCO_2e$)	Lx, t (%)	Gas	Contribution to level
1.A.3.b - Road Transportation	15.45	24.17	CO_2	24.17%
3.B.2.b - Land Converted to Cropland	12.06	18.86	CO_2	43.03%
1.A.1.a.i - Electricity Generation	6.71	10.49	CO_2	53.52%
3.C.4 - Direct N_2O Emissions from managed soils	5.39	8.42	N_2O	61.94%
3.A.1 - Enteric Fermentation	3.48	5.44	CH_4	67.39%
3.B.1.a - Forest land Remaining Forest land	-2.20	3.44	CO_2	70.83%
3.B.3.b - Land Converted to Grassland	-2.09	3.27	CO_2	74.09%
1.A.2 - Manufacturing Industries and Construction	1.73	2.70	CO_2	76.79%
4.A.2 - Unmanaged Waste Disposal Sites	1.39	2.18	CH_4	78.97%
3.B.1.b - Land Converted to Forest land	-1.28	2.00	CO_2	80.97%
3.B.2.a - Cropland Remaining Cropland	1.10	1.72	CO_2	82.69%
3.A.2 - Manure Management	1.10	1.72	N_2O	84.41%
4.D.1 - Domestic Wastewater Treatment and Discharge	0.79	1.23	CH_4	85.64%
4.D.2 - Industrial Wastewater Treatment and Discharge	0.69	1.08	CH_4	86.72%
1.A.4.b - Residential	0.67	1.04	CO_2	87.76%
4.D.1 - Domestic Wastewater Treatment and Discharge	0.63	0.98	N_2O	88.74%
2.F.1 - Refrigeration and Air Conditioning	0.58	0.91	HFC	89.65%
3.B.5.b - Land Converted to Settlements	0.53	0.83	CO_2	90.49%
3.D.1 - Harvested Wood Products	-0.52	0.81	CO_2	91.30%
2.C.3 - Aluminium production	0.51	0.79	PFC	92.09%
2.A.4.d - Other (please specify)	0.47	0.73	CO_2	92.82%
3.C.1 - Emissions from biomass burning	0.46	0.72	CH_4	93.53%

3.C.1 - Emissions from biomass burning	0.42	0.66	N_2O	94.19%
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	0.42	0.65	CO_2	94.85%
3.C.7 - Rice cultivations	0.41	0.64	CH_4	95.49%

The levels and trends KCA assessment identified common activities. Those activities are considered a priority of the KCA list, which will receive additional attention regarding resource allocation to improve the estimation methodology and inform mitigation planning. Table 8 shows the KCA list identified in the levels and trend assessments.

Table 8: KCA list identified in level and trend assessments.

Sector	Category	Activity	Gas
Energy	Transport	1.A.3.b - Road Transportation	CO_2
AFOLU	LULUCF	Land Converted to Cropland	CO_2
Energy	Stationary combustion	Electricity Generation	CO_2
Agriculture	Soils	Direct N_2O Emissions from managed soils	N_2O
Agriculture	Livestock	Enteric Fermentation	CH_4
AFOLU	LULUCF	3.B.1.a - Forest land Remaining Forest land	CO_2
AFOLU	LULUCF	3.B.3.b - Land Converted to Grassland	CO_2
Energy	Stationary combustion	1.A.2 - Manufacturing Industries and Construction	CO_2
Waste	Solid waste	4. A - Solid Waste Disposal	CH_4
AFOLU	LULUCF	3.B.1.b - Land Converted to Forest land	CO_2
AFOLU	LULUCF	3.B.2.a - Cropland Remaining Cropland	CO_2
Agriculture	Livestock	3.A.2 - Manure Management	N_2O
IPPU	HFC consumption	2.F.1 - Refrigeration and Air Conditioning	HFC
AFOLU	LULUCF	3.B.5.b - Land Converted to Settlements	CO_2
Agriculture	Crops	3.C.7 - Rice cultivations	CH_4

3.3.2 Time-series completeness

As part of the good practice of ensuring time-series completeness, Ghana performed recalculation and used notation to report emissions from all identified sources/removals. Where there are gaps, Ghana adopted the appropriate splicing techniques to fill the gaps.

3.4.1 Recalculations

The recalculations were made on the GHG inventory estimates Ghana reported in BUR3 from 1990-2019 due to the discovery of new datasets, changes in methodologies and the revisions of coefficients. The specific reasons are provided below:

- **Oil and gas** - changes in the conversion factors and units of oil and gas production figures. The changes were applied to the oil and gas productions (activity data) from 2010 to 2019.
- **Harvested wood products** – Net CO_2 emission from harvested wood products was calculated using tier-1 methodology for 1990-2021. The input data were obtained from the timber production and export from the Forestry Commission.

- **Changes in sectoral fuel consumption figures in the energy statistics** – the updated 2023 energy statistics changed some of the sectoral fuel consumption figures. Changes were made to the activity data of the fuel consumption manufacturing industry and construction, transport, and other sectors.

- **Inclusion of SF6 emissions** – the discovery of SF6 import and consumption figures led to the calculation and inclusion of SF6 emissions into IPPU from 2001 to 2021.

The recalculations led to a 9.7% increase in the total cumulative emissions between 1990-2019. The spikes in the emissions trends in 2011 and 2017 reported under the BUR3 were addressed by the impacts of the recalculations. Positive and negative large differences were also observed over the period the recalculation was applied. The largest negative differences (lower emissions) of -35%, -22.9% and -22.7% were observed in 1990, 2017 and 2011, respectively. Conversely, the highest positive difference (increased emissions) was recorded in 2009. Figure 7 shows the trends of the impacts of recalculations between 1990-2019.

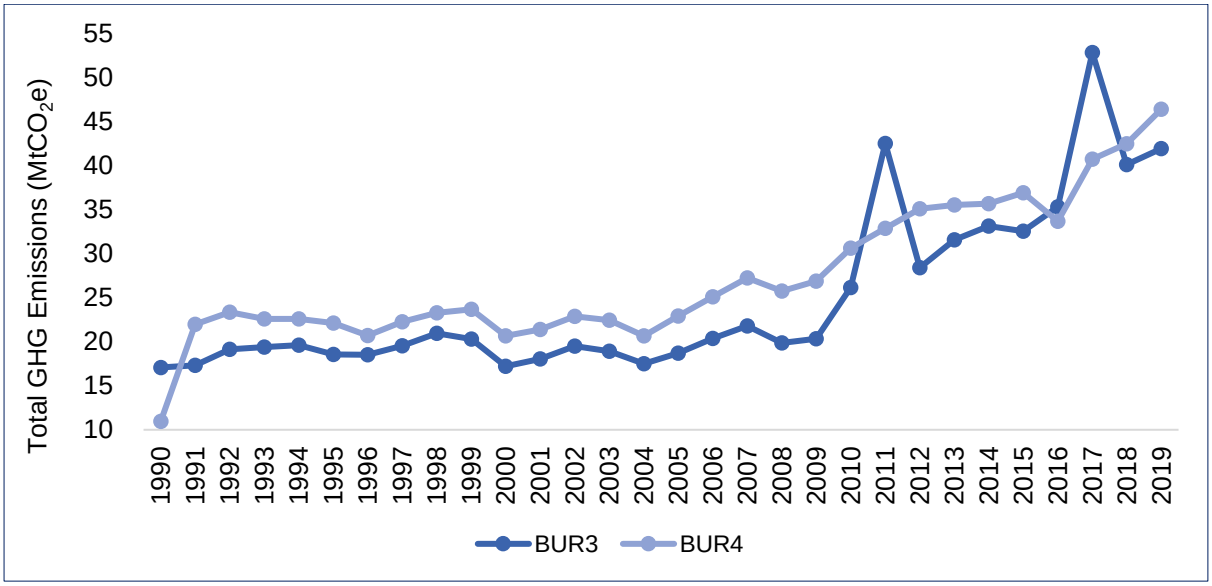


Figure 7: Differences between total national emissions in BUR2 and BUR3

3.4.2 Completeness check

Ghana's greenhouse gas inventory covers sectors and activities outlined in IPCC 2006 guidelines occurring in Ghana's territory during the inventory period. The emissions from the distribution of oil products (1B.2a.iii.5) and Liming (3C.2) are not included in the BUR4 inventory due to a lack of activity data. All the direct gases - CO_2, CH_4, N_2O, PFCs (CF_4 and C_2F_6), HFCs, and SF_6 have been covered for the entire time series (1990-2021).

The inventory only includes activities captured in the official records published by State institutions. For example, unreported fuel use, household animals not captured in the livestock census, unaccounted harvested wood, etc.

3.4.3 Filling of time-series gaps

In the inventory where we observed time series data gaps across the years, interpolation and extrapolation techniques were used to resolve them. Table 9 Lists the categories of interpolation and extrapolation techniques used to fill time series gaps. In developing the activity data from land representation, Ghana used base maps for 1990, 2000, 2015, 2019 and 2021. The rest of the activity of the intervening years was created using interpolation and extrapolation techniques.

Table 9: Techniques for filling time series data gaps

Sector	Category	Activity data	Technique used
LULUCF	Land – areas of land-use representations	Missing 2016 land category areas	Extrapolation
		Missing land use areas for the intervening years, 1991-1999, 2001-2011, 2013-2014, 2019- 2020.	Interpolation
		Missing land use areas for 2017, 2018	Interpolation
		20-year time points	Extrapolation
	Land – areas affected by fire	1991-1999 missing, 2001-2009, 2011-2014, 2015	Interpolation
		2017, 2018, 2019, 2020	Extrapolation
	Timber harvesting	Missing 2016 activity data	Extrapolation
Agriculture	Fertiliser application	Missing years – 1991 -1994	Interpolation
	Areas under rice cultivation	Missing for 2020 to 2021	Extrapolation
	Livestock population	For 2021	Extrapolation
Waste	Solid Waste Disposal (4A)	Missing data of annual per capita solid waste generation 1950-1989, 1990-2004, 2006-2014, 2016	Trend extrapolation and interpolation
	Biological treatment of solid waste (4B)	Missing data on the amount composted from 1990-1993	Extrapolation
	Wastewater discharge and treatment (4D)	Missing data income class, which was derived from urban and rural population classification for 1990-1995, 1997-2004, 2006-2009 and 2011-2016	Interpolation and extrapolation
		Distribution of the share of the population in different income classes using different waste treatment facilities for 1990-1995, 1997-2004, 2006-2009 and 2011-2016	Interpolation
Energy	Road transport	Fraction of fuel consumption per vehicle technology category for 2008 to 2021	Exploration based on 2008 field survey and 2012 field survey for LPG consumption for vehicles.
	Manufacture of solid fuels (charcoal	Percentage of total biomass production, biomass consumption and fraction of biomass as input for charcoal production for 2021, 2020 and 2019 missing	Interpolation based on available 2018 figures reported in energy statistics.

	Other sectors	Missing fuel allocation for agriculture and offroad vehicles for 2017	Interpolation
	Energy industries	Flaring of isopentane gas from Ghana National Gas Company for 2020 and 2021.	Surrogate data on total wet gas throughput.
	Manufacturing industry and construction	Missing RFO and wood fuel consumption for pulp and paper industries from 2009 to 2021	Extrapolation
		LPG consumption from 1990-1997 and 1998 to 2009 missing	Interpolation
		Diesel consumption in Construction for 2020 to 2021 missing	Extrapolation
		RFO consumption in the wood processing industry from 2010 to 2021	Extrapolation

3.5 Comparison of fuel combustion CO_2 emissions

As a good practice, Ghana calculated CO_2 emissions using the Reference Approach (RA) and Sectoral Approach (SA) methods. Table 10 presents RA and SA CO_2 emissions and differences in the results over the inventory time series. The differences in CO_2 emissions between RA and SA range from -0.1% to 52%. The observed inconsistencies in RA and SA CO_2 were due to the statistical differences among petroleum products and observed variations associated with secondary data used to derive the stock change. Since submitting the BUR4, Ghana has taken steps to improve fuel allocation formulae in the energy balance, which has corrected the large inconsistencies recorded in the previous report. Even the differences in CO_2 exist in the latest years (2021, 2020 and 2019) because of the corrective measures to improve fuel allocation. They are not as large as in previous years.

Table 10: Comparison of the differences in CO_2 emissions estimated using RA and SA

Year	Reference Approach (Mt)			Sectoral Approach (Mt)			Difference (%)			
	Liquid fuel	Solid fuel	Gas fuel	Liquid fuel	Solid fuel	Gas fuel	Liquid fuel	Solid fuel	Gas fuel	Total
1990	2.5	-	-	2.5	-	-	1.3	0.0	0.0	1.3
1991	2.5	-	-	2.4	-	-	0.4	0.0	0.0	0.4
1992	2.5	-	-	4.2	-	-	-40.5	0.0	0.0	-40.5
1993	2.9	-	-	4.4	-	-	-32.7	0.0	0.0	-32.7
1994	3.1	-	-	4.6	-	-	-32.9	0.0	0.0	-32.9
1995	3.5	-	-	3.5	-	-	0.5	0.0	0.0	0.5
1996	3.7	-	-	3.4	-	-	9.7	0.0	0.0	9.7
1997	6.6	-	-	4.3	-	-	52.	0.0	0.0	52.0
1998	6.2	-	-	5.9	-	-	5.7	0.0	0.0	5.7
1999	5.1	-	-	5.0	-	-	1.3	0.0	0.0	1.3
2000	4.4	-	-	3.7	-	-	16.6	0.0	0.0	16.6
2001	3.7	-	-	3.9	-	-	-7.0	0.0	0.0	-7.0
2002	5.2	20.9	11.7	5.3	20.9	11.7	-0.9	0.0%	0.0	-0.9
2003	5.3	29.2	15.6	5.63	29.1	15.6	-6.4	0.0%	0.0	-6.4
2004	4.1	34.6	42.3	4.28	34.6	42.3	-4.7	0.0%	0.0	-4.7
2005	5.0	38.3	-	5.25	38.3	-	-4.6	0.0%	0.0	-4.6

2006	6.3	15.0	-	6.67	15.0	-	-5.6	0.0%	0.0	-5.6
2007	7.4	40.0	-	8.13	40.0	-	-9.0	0.0%	0.0	-9.0
2008	5.8	30.7	-	5.93	30.8	-	-1.5	0.0%	0.0	-1.5
2009	6.5	9.6	-	6.43	9.6	-	0.7	0.0%	0.0	0.7
2010	9.2	18.4	1,057.2	9.67	18.5	795.9	-5.3	0.0%	32.8	-5.3
2011	9.9	24.9	4,489.9	9.06	24.9	1,791.5	9.7	0.0%	150.6	9.7
2012	11.2	9.91	1,045.9	11.9	9.9	914.7	-6.4	0.0%	14.3	-6.4
2013	12.4	12.9	783.4	12.2	12.9	663.3	1.7	0.0%	18.1	1.7
2014	12.4	2.3	1,664.0	10.7	2.3	1,448.6	15.7	0.0%	14.9	15.7
2015	11.0	3.50	3,183.2	9.99	3.5	2,599.9	10.2	0.0%	22.4	10.2
2016	11.5	26.8	1,848.8	11.5	26.8	1,574.9	-0.1	0.0%	17.4	-0.1
2017	14.3	0.5	3,077.9	12.9	0.5	2,619.7	10.5	0.0%	17.5	10
2018	12.4	1.0	3,919.1	13.4	1.0	3,285.4	-8.0	0.0%	19.3	-8.0
2019	12.8	0.5	5,320.2	13.2	0.54	4,577.2	-3.6	0.0%	16.2	-3.6
2020	14.2	1.1	7,721.2	13.3	1.1	6,616.1	6.5	0.0%	16.7	6.5
2021	12.5	0.5	7,133.9	14.1	0.5	6,653.9	-11.9	0.0%	7.2	-11.9

3.6 Uncertainty assessment

The IPCC guidelines require that inventory estimates are reported with the uncertainty range using a tier 1 uncertainty analysis across the sectors. Ghana used the IPCC tool for Approach 1 uncertainty analysis to quantify the uncertainty of the GHG inventory for 2010 and 2021. The uncertainty in the total inventory was estimated at 49.7%. The highest contributor to the uncertainty is the LULUCF sector. Table 11 presents the uncertainty assessment results of the inventory.

Table 11: Approach Uncertainty analysis results

Sector	Emissions/ removals in 2010	Emissions/ removals in 2021	Contribution to total uncertainty by sector in the year 2021
	Mt CO_2 equivalent	Mt CO_2 equivalent	%
Energy	10,820.20	26,515.22	24.5
IPPU	939.69	1,664.93	12.7
AFOLU	15,851.80	19,829.88	34.8
Waste	3,010.57	3,765.60	28
Total	30,622.27	51,775.63	100.00
Uncertainty in total inventory			49.75

The approach for allocating uncertainty range for the AD and EF in each sector was ad hoc as there was no credible basis to assign the default range in the tool due to the absence of requisite meta-data, particularly for the country-specific activity data. The reason is that most of the activity data were from secondary sources that hardly reported uncertainty ranges in their metadata; qualitative approaches backed by experts' judgment were used to assign the uncertainty ranges based on the data sources consistently and transparently. Although the IPCC tools provide the methodology for uncertainty assessment and even the inventory software has a sub-menu of uncertainty values to choose from, in the case where the supplier of the activity data does not publish enough

background data to allow for the quantitative calculation of the uncertainty, the assignment of the error range becomes arbitrary. In this regard, the EPA is working with the relevant state institutions to develop practical approaches to statistically quantify uncertainty levels associated with inventory.

3.7 QA/QC protocols

Within Ghana's greenhouse inventory system, the EPA has the responsibility to generally oversee the QA/QC procedures in the inventory and perform the following routines:

- Ensures that the sector teams follow the QC checklist.
- Collect and review the completeness checklist submitted by the sector inventories.
- Organise technical reviews of the inventory both in-country and at the international level.
- Follow up with the implementation of the recommendations in the previous review.
- Revive the roles of the QA/QC lead institution.

Ghana has prepared and adopted a new QA/QC plan. The team followed the tier 1 general QC procedures in Table 12 this inventory.

Table 12: List of QC procedures followed in the inventory.

QC tasks	Description of specific tasks	Responsibility
Internal consistency	Ensured that the total GHG emissions equal the sum of the individual emissions from the sectors and categories.	EPA
	Confirmed the total GHG emissions equal the sum of the emissions by gas.	EPA
	Compared data in the tables to calculation spreadsheets and the text to confirm that all reported emissions estimates, activity data and emission factors are the same.	EPA
	Ensured that parameters used in multiple categories (e.g., the population of livestock or Quantity of Lubricant use) are consistent across categories	EPA
	Confirmed that the emissions data is reported in a manner consistent with the calculation tables in the non-Annex 1 National Communications Reporting Guidelines	EPA
	Confirmed that the selection and application of the estimation methods were consistent with IPCC guidelines.	EPA
Documentation	Created back-ups of all documentation in hard and soft copies and uploaded files in the datahub	All sectors webmaster
Data gathering, input, and checks	Checked assumptions and criteria for selecting activity data and emission factors are well documented.	EPA
	Checked for transcription errors in data input and reference	EPA

Calculation Checks	Check methodological and data changes resulting in recalculations	EPA
	Check that emissions/removals are calculated.	EPA
	If available, compare current inventory estimates to previous ones for each category. If there are significant changes or deviations from expected trends, re-check estimates and explain any large difference. Significant changes in emissions or removals from previous years may indicate possible input or calculation errors.	EPA

3.8 Addressing GHG improvement list

Ghana keeps track of its progress in addressing the improvement list. The list consists of areas in the GHG inventory identified by Ghana or through the ICA process that need immediate and long-term improvement. It included data gaps, capacity constraints, inability to meet reporting requirements, and institutional challenges. As part of the BUR4, Ghana has reported on the status of implementing the priority improvement list. Information on how Ghana addresses recommendations and capacity gaps identified in the third round of ICA is also presented in this report. Table 13 presents the planned improvement list overviewed by recommendations and capacity gaps from the third ICA.

Table 13: Issues tracking table for the inventory improvement list.

Sector	Main issues	Description of issue and critical recommendations	Timelines	Actions taken	Status
Recommendations from the third round of technical analysis					
Cross-cutting	Data sources	The BUR 3 did not clearly report information on specific AD, including the amounts of fuel used, industrial production levels, and livestock.	BUR4	Data sources are provided under the GHG inventory of the BUR4.	Resolved in BUR4
	Reporting SF6 as “NE”	SF6 emissions were reported as “NE” in Ghana’s BUR 3, and the TTE did not explain why these emissions were not estimated.	BUR4	SF6 emission reported under 2G of IPPU	Resolved in BUR4
	Use of Notation keys	The Party did not use notation keys in the summary tables (BUR 3 annexe I, tables 1–2);	BUR4	Appropriate notation keys have been in reporting the emission in tables 1-2	Resolved in BUR4
LULUCF	information on annual changes in carbon stock	Ghana did not report comparable information addressing the tables included in annexe 3A.2 to the IPCC good practice guidance for LULUCF and the sectoral reporting tables annexed to the	BTR1	Data reconciliation is ongoing to report information	Being resolved

		Revised 1996 IPCC Guidelines.			
LULUCF	Exclusion of net emission from HWP	The shares of emissions that different sectors contributed to the Party's total GHG emissions, excluding land and HWP, as reported by the Party in 2019	BUR4	Net CO_2 emission from HWP reported under 3D.	Resolved in BUR4
Cross-cutting	Arrangement for data source	The BUR 3 does not include a detailed list of institutions that provide data or detail the procedures and arrangements in place.	BUR4	Information on data sources provided.	Resolved in BUR4
	Uncertainty assessment	The Party did not provide information on the uncertainty level or assumptions or explain how they affect the overall emission estimates.	BUR4	Information on uncertainty reported	Resolved in BUR4

During the technical analysis of the BUR 3, the TTE and Ghana jointly identified a list of capacity needs. As a result, Ghana has reported on the progress in addressing capacity needs (Table 14). It will be observed that most of the capacity needs persist due to the lack of access to adequate finance.

Table 14: Status of capacity needs identified during ICA 3

Identified capacity needs	Status	Remarks
Enhancing the capacity to develop country-specific EFs for key categories and improve the accuracy of estimated emissions for key categories	*Being addressed:* Emission factors being developed for livestock with support from the Government of New Zealand	Financial and technical support are needed to develop the capacity to develop country-specific EF for electricity, transport, and waste disposal.
Enhancing the technical capacity to develop country-specific EFs for road transport, livestock and solid and liquid domestic waste, and improve data collection systems		
Enhancing the technical capacity to conduct uncertainty analysis for specific sources and sinks,	*Being addressed:* Ghana inventory team members attended UNFCCC training on uncertainty analysis.	Ghana performed tier 1 uncertainty and reported the same in BUR4.
Enhancing the capacity to apply the 2006 IPCC Guidelines	*Being addressed:* Ghana inventory team members attended UNFCCC training on IPCC guidelines.	Fresh entrants and experienced experts have been on the IPCC guidelines.
Enhancing the technical capacity to estimate and report SF_6 emissions.	SF6 emissions reported in BUR4	Additional work must be done to improve the quality of the activity data.

Enhancing the capacity to estimate fugitive emissions from oil and gas	Not addressed	Lack of financial and technical support.
Enhancing the capacity to develop and improve energy statistics;	*Being addressed*: Ghana benefitted from the UNFCCC and IEA support on the improvement of Energy statistics preparation	Additional technical and financial support is needed.
Enhancing the capacity to collect data for the agriculture sector, including the disaggregation of livestock data and allocation of data for manure management systems;	Not addressed	Lack of financial and technical support.
Supporting the expansion of the current facility-level carbon accounting programme	*Being addressed:* Two facilities (VRA and VALCO) are participating in the voluntary facility-level emission inventory programme	Additional technical and financial are needed to expand the programme to include more facilities.
Enhancing the capacity for continuous provision of data, including helping data providers to enhance the quality of their data sets	Not addressed	Lack of financial and technical support.
Enhancing the technical capacity to improve data collection on wood fuel supply and consumption.	*Being addressed:* The initial study was completed with technical and financial support from the World Bank and FAO	No comments
Enhancing the technical capacity to perform QA/QC activities for the information received from data owners.	Not addressed	Lack of financial and technical support.

GHG mitigation actions and their effects

4 Mitigation actions and their effects

4.1 Progress GHG mitigation planning and policy actions

Ghana presents information on the update of progress in improving GHG mitigation planning and policy formulation since the submission of BUR 3. The information on progress covers (a) updates policy and regulatory changes for GHG mitigation, (b) impacts of mitigation actions, and (c) steps envisaged to sustain and enable mitigation actions. On the policy front, Ghana's GHG mitigation strategy broadly aims to promote low-carbon measures for sustainable development. Ghana's NDC documents the mitigation targets and strategies to achieve them spanning 2020 to 2030. The priority GHG mitigation measures focus on the following themes:

- Renewable energy promotion.
- Doubling energy efficiency in homes and services.
- Promoting clean cooking.
- Electricity mobility and fleet renewal.
- Landscape restoration and sustainable forest management.
- Green cooling in air-conditioning.
- Innovative waste management and circularity.

In pursuing a low-carbon development agenda, Ghana continued introducing new reforms or adopting new policies supporting mitigation actions. Since the submission of BUR3, Ghana has engaged in the following policy initiatives:

- Revised national energy policy, 2023, to be responsive to the global energy transition.
- Adopted national energy transition and investment, 2023, to guide the orderly energy transition by 2060.
- Published the national electric vehicle strategy in 2023.
- Ghana's automotive development policy to facilitate domestic production of electric vehicles[7].
- Released Ghana's framework for international carbon crediting and non-market approach, 2022.
- Hydrochlorofluorocarbon phase-out management plan for Ghana.
- Integrated recycling and composting programme in the sanitation sector.

4.2 GHG emission projections

In this BUR4, Ghana has reported information on the approaches and results of the updated GHG emission projects since the BUR3 submission to UNFCCC. The emissions projections according to sectors are expressed in carbon dioxide equivalent (CO_2e) using

[7] https://ghanaautodevcentre.org/ghana-automotive-development-policy-gadp/

the 100-year global warming potentials in the IPCC 4th assessment report. Ghana's future greenhouse gas emission projections metric also include:

- Base year: 2019 (recalculated)
- Target year: 2030
- Mitigation goal type: BAU scenario (but started absolute goal type)
- Sectors:
    - Energy (power plants, transport, direct combustion, and fugitive emissions).
    - Industrial processes and product use
    - Agriculture
    - LULUCF
    - Waste
- Gases: CO_2, CH_4, N_2O, PF_6, and HFCs

The emission projections and target-setting processes are based on the recently adopted mitigation policies and measures outlined in national climate and development documents such as the NDC, Ghana @100 framework, CPESDP, and MTDP. Under the business-as-usual scenario (BAU), Ghana's emissions are projected to increase by 70% from ~59 $MtCO_2e$ in 2019 to 100 $MtCO_2e$ by 2030 (Table 15). Without LULUCF, the BAU emissions were projected to increase by 87% over the same period. The expansion of fossil-fuel-intensive manufacturing and electricity, urban road transport, gas flaring, and solid waste disposal will lead to the expected rise in emissions.

Table 15: Summary of emission projections by sectors

Sector/Categories	Historical emissions/ Removals [$MtCO_2e$]	GHG emissions projections [$MtCO_2e$]			Change [%]
	2019	2020	2025	2030	2019-2030
Fossil power plants	6.20	6.69	9.77	13.18	113
Direct combustion	4.01	4.75	8.50	12.40	209
Transport	9.22	9.85	13.00	16.17	75
Fugitive emissions	8.05	8.45	12.47	16.57	106
Industrial processes	1.73	2.07	2.39	2.93	69
Agriculture	10.89	11.25	13.21	15.50	42
Land	14.52	14.73	15.86	17.07	18
Waste	4.12	4.26	4.99	5.89	43
Total with LULUCF	58.75	62.05	80.19	99.73	70
Total without LULUCF	44.23	47.32	64.33	82.65	87

Ghana's NDC also contained the absolute mitigation target of 68.2 $MtCO_2e$ out of the total mitigation potential of 100 $MtCO_2e$. The mitigation target is expected to be achieved by implementing 34 measures in the Energy, Transport, Industry, Oil and gas, IPPU, LULUCF, and Waste sectors. Nature climate solutions, waste management and clean cooking, are mitigation measures with the highest mitigation potential.

Nature climate solutions account for 35% mitigation target, followed by waste (26%), clean cooking (13%), Bioenergy (7%) and Low-carbon electricity (6%) (Table 16). Regarding abatement, electric buses, renewables and avoided flaring present a high marginal cost among the top mitigation measures. The unit abatement cost ranges from -1717.05 US$/$tCO_2$ to 1,448.71 US$/$tCO_2$. A total of $9.3 billion in investments is required to achieve the projected 68.2 $MtCO_2e$ by 2030.

Table 16: Mitigation measures, emission reduction potential, and investment needs

Scope of mitigation measures	Mitigation measure types	US$/ tCO_2	Mitigation potential by 2030 [kt/year]	Investment required by 2030 (million $)
Sustainable transport	Shifting freight transport from road to rail	-1717.1	10.8	1000
	Electric 12m buses	1,448.7	18.8	187.5
	Restriction on import of used cars	-391.7	25.2	1
	More efficient diesel cars	-340.8	0.2	3
	New bicycle lanes	-284.8	54.9	4
Clean cooking	Efficient wood stoves	-998.4	8278.5	783.9
	LPG stoves replacing wood stoves	493.5	159.8	2.5
Bioenergy	Landfill gas plant with power production	-11.6	3288.1	108.4
	Biogas from Municipal Solid Waste	0.3	4.4	2.0
	Charcoal production	2.7	1542.9	24.7
Low-carbon electricity	Switch from fuel oil to natural gas	-714.2	4174.8	1.1
	Single-cycle to combined-cycle	90.1	264.6	141.3
	Hydropower connected to the main grid	-94.2	314.9	170.7
Renewables	Wind turbines, onshore	-110.3	431.3	243.8
	Solar PVs, large grid	105.1	348.4	622.5
	Solar house PVs	140.6	226.7	449.9
	Solar/diesel mini-grid	155.9	17.2	17.7
Clean lighting	Solar LED lamps	-236.2	175.1	35.7
	Efficient lighting with LEDs	-175.2	243.9	14.6
Energy efficiency	Efficient residential air-conditioning	-117.8	11.4	1.8
	Efficient water pumping	-112.4	0.7	0.2
	Efficient room air conditioner	-99.5	37.9	3
	Efficient office lighting with LEDs	-70.7	19.1	6.9
	Energy efficiency in the industry	1.7	1480.7	14.8
	Efficient refrigerators	10.9	1586.2	336.6
Nature climate solutions	REDD: Avoided Deforestation	-18.6	1505.9	165.7
	Reforestation with agroforestry	-1.3	14996.7	5521.5
	Wildfire Management	0.0	11.7	2
	Forest Conservation	0.0	634.1	20
	Reforestation	27.6	6416.7	1050
IPPU	ODS phaseout	0.0	3874.2	7.4
Waste	Composting of Municipal Solid Waste	0.1	18020.5	30.9
Oil and gas	Reduced flaring at the oil field	45.4	12.2	5.9

4.3 Policies supporting Ghana's mitigation targets.

Ghana continues to implement major mitigation policies and measures that are aimed at promoting national sustainable development and, at the same time, contribute to achieving emission reduction outcomes.

The typology of the mitigation policies and measures includes technology promotion, fiscal measures, regulatory controls, and lifestyle changes. Sections 5.2 and 4.2 of the BUR4 document some of the major mitigation policies Ghana has adopted to support the achievement of the mitigation commitments. The measures include electric mobility in urban areas, scaling up renewable energy, promoting natural climate solutions, low carbon electricity, doubling energy efficiency in homes and services, market-based clean cooking, sustainable waste management and phasing down HFCs. Additionally, some of the policies involving fiscal and regulatory measures that enable mitigation actions have been highlighted in this BUR4.

4.4 Progress and achievements of mitigation measures

4.4.1 Cross-cutting mitigation measures

Since Ghana's BUR3 was submitted, the effort to align the economy along a sustainable low-carbon development pathway has continued and increased in scope. Below are updates on some of the major mitigation policies in the country:

Promotion of electric mobility

- *Adoption of national electric vehicles policy, 2023* – The policy aims to contribute to the net-zero emission future of Ghana's development aspirations, emphasising promoting Battery Electric Vehicle and includes two and three-wheelers (E2&3W), Light-duty vehicles, Compact vehicles, and Medium and Heavy-duty vehicles.

- *Eight-year tax rebates for public electric vehicle imports and components - In* the 2024 national budget, the Government announced import tax rebates for electric vehicles or wholly knocked or partially knocked down parts for assembly for public transport for eight years.

- *Review of automotive policy to include electric vehicles* – the Ministry of Trade and Industry is reviewing the national automotive development policy to comprehensively address incentives for importing electric vehicles and components and local production of electric vehicles.

- *Drive Electric initiative – The Energy Commission launched the "Drive Electric Initiative*" in 2019 to promote electric vehicles on roads to create demand and drive the productive utilisation of electricity in the system. Since the submission of the BUR 3, the following has been achieved:

- Organised Ghana's first e-mobility conference in 2021 to bring together major stakeholders such as policymakers, car importers, manufacturers, and charging station operators.

- Organised Ghana's first public charging forum in collaboration with Dundee City Council and IEA, among other international players. The forum brought together current and potential charging station operators, public and private agencies, international operators, and countries.

- Initiated the process to develop standards and regulations for EVs and charging infrastructure.

- Conducted industry study to collect data, analyse, and establish a baseline for EVs in the country.

- Four electric vehicle public charging stations have been established in Accra.

- International Trade Centre data indicates that 17,660 Plug-in EVs were imported into Ghana between 2017 and 2021.

- *Investment into e-vehicles* – KOFA, WAHU and Solar Taxi are three major private companies seeking to mobilise investment into electric motorbikes and buses. WAHU aims to introduce 117,000 e-bikes to displace 2 billion kilometres annually from fossil fuel 2-wheeler vehicles for the gig economy. Solar Taxi is exploring financing options for investing 200 electric vehicles for inter-city and intra-city transport.

Strengthening vehicle registrations, inspection regimes and standards

- *Digitalisation of vehicle registrations* – The Driver Vehicle Licensing Authority (DVLA) has introduced electronic vehicle registration in the country. This initiative is expected to improve access to vehicle information.

- *Decentralisation of vehicle inspections* – The Ministry of Transport has authorised the twenty-seven Private Vehicle Test Stations (PVTS) to conduct roadworthiness inspection tests using state-of-the-art equipment, and results are automatically recorded, transferred, and printed. Most PVTS have emission testing equipment available for voluntary testing. The voluntary testing results are not included in the consideration of roadworthiness.

- *Vehicles emissions standard* – Ghana has adopted motor vehicle emission standards, and the EPA has developed a regulation to support their implementation. The motor vehicle regulation is yet to be implemented.

Just and an orderly energy transition in Ghana

- *National Energy transition framework and energy transition and investment plan* – In 2023, Ghana adopted the national energy transition framework and an energy transition and investment plan to guide a just and orderly energy transition in Ghana.

- *Amendment of Renewable Energy Act (Act 1045, 2020)* – Parliament passed the Renewable Energy Act 1045, 2020, establishing a competitive procurement scheme and a net metering scheme regarding electricity generated from renewable energy sources. The amended act also makes it mandatory for fossil-based wholesale electricity suppliers, producers of fossil fuels and any company that contributes to greenhouse gas emissions to invest in non-utility renewable energy to offset greenhouse emissions.

- *National Energy Policy* – the Ministry of Energy has completed the revision of the National Energy Policy. The new policy, among others, seeks to strategically position Ghana as the global community to work toward a sustainable energy transition.

- *Ghana ISO Standard for biomass and charcoal stoves* – Ghana adopted GS ISO 19867-1, which requires all improved cook stoves to be tested in accordance with the national standard (GS ISO 19867-1 laboratory test protocols).

- *Legislation on restricted gas flaring* – Ghana enacted the Petroleum Exploration and Development Act, 2016 (Act 919) to restrict gas flaring in petroleum exploration and development unless the regulator grants permission to the producers to flare. In addition, the Ghana National Gas Company was established to uptake and process gas for the Ghanaian downstream market.

Promoting landscape restoration

- *Forest and Climate Leadership Partnership (FCLP)* – Ghana and the US assumed co-chairmanship of FCLP in 2023 to mobilise global leadership to halt forest loss by 2030. As a result, Ghana launched its FCLP's country package initiative dubbed "Resilient Ghana" to boost economic growth, protect forests and people and reduce emissions.

- *Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition* – The Forestry Commission, under the auspices of the Ministry of Lands and Natural Resources, has signed Emission Reductions Payment Agreement (ERPA) with Emergent Forest Finance Accelerator Incorporated (Emergent), a US-based non-profit organisation that serves as the convenor and coordinator of the (LEAF) Coalition. The agreement will see Ghana receiving payment of up to 50 million US dollars for emission reductions of up to five million tonnes of carbon dioxide equivalent at a unit price of US$10 per tonne of carbon dioxide equivalent.

- *First payment under Ghana Forest Cocoa REDD+ Programme* – Ghana received payments of about 4.8 million US dollars for reducing 972,456 tons of carbon. This payment represents June to December 2019 carbon emissions in the Cocoa Forest Mosaic landscapes.

Biological treatment of solid waste

- *Integrated recycling and composting initiative* – a private-sector-led initiative on the integration of waste processing and recycling company established to receive, sort, process and recycle Municipal solid waste to produce organic compost for agronomic purposes in Ghana and the sub-region. The aim is to establish Integrated recycling and composts in all 16 regions in Ghana.

Promoting sustainable rice cultivation

- *Alternate Wetting and Drying (AWD) for rice cultivation* – Ghana is promoting AWD among 11,000 irrigation rice farmers by introducing intermittent flooding practices that support yield increase, reduce water loss and mitigation methane emissions. The UNDP leads the initiative with the involvement of the Ghana Irrigation Development Authority, the Ministry of Food and Agriculture and the Ministry of Environment, Science, Technology, and Innovation.

4.4.2 Aggregate impacts of Ghana's mitigation measures

Ghana continued to implement mitigation actions as part of its low-emission development strategy. In this BUR4, Ghana has updated the information on the progress of the implementation of 17 mitigation actions across the energy, forestry, waste, transport RAC and Agriculture sectors.

It covers technology, fiscal and regulatory instruments, capacity development and awareness measures. Implementing the 17 mitigation actions aims to generate GHG emission reduction and mitigation co-benefits outcomes. Of the 17 actions, 13 are under implementation, and 4 are scheduled for implementation. Three mitigation actions (Biomass power plant, electric vehicles and alternate wetting and drying) are being developed under Article 6 of the voluntary cooperation of the Paris Agreement with the Swiss Confederation.

The GHG impacts of 13 mitigation actions amount to 29.3 $MtCO_2e$/year of emission reductions. The emission saving represents a 43.4% decline relative to the 2021 total national emissions of 51.2 $MtCO_2e$/year. The emission reduction potential of the remaining 4 mitigation actions is estimated at 0.81 $MtCO_2e$/year. When LULUCF and large hydro dam are excluded from the actual emission savings in 2021, the total GHG impacts are 26 $MtCO_2e$/year and 25.9 $MtCO_2e$/year, respectively. Table 17 shows the breakdown of the GHG impacts and co-benefits of climate actions in Ghana.

Table 17: GHG mitigation actions per category

Sector	Mitigation Theme	Mitigation actions	Saving ($MtCO_2e$/year)	ERP ($MtCO_2e$/year)
Energy	Low carbon electricity	Open cycle to combine cycle	0.41	
		Fuel oil to natural gas	2.97	
		Transformative biomass power plant		1.2
	Renewable energy	Renewable energy	0.17	
		Large hydro-dam	3.32	
	Energy Efficiency in homes and businesses	Energy efficiency	3.97	
	Clean cooking solutions	LPG stoves	0.29	
		Improved cookstove	4.70	
Water and Sanitation	Alternative waste management	Compost	3.7	
Environment	Green cooling	HFC phase-down	0.34	
	Decarbonisation of oil and gas production	Restricted flaring	6.10	
Transport	Urban transit	Fleet renewal and BRT	0.02	
	Electric mobility	electric vehicles	0.011	0.034
Forestry	Plantation development	Tree plantation	2.33	
	Result-based REDD+	Cocoa Forest REDD+	0.97	1.8
	Shea landscape emission reduction	Shea Landscape REDD+		0.88
Agriculture	Sustainable rice cultivation	Alternate wetting and drying		0.14

Regarding achieving mitigation outcomes by individual actions, restricted gas flaring recorded the largest GHG emission savings. In the period under review, restricted gas flaring measures generated 6.1 $MtCO_2e$/year, followed by improved cookstoves (4.7 $MtCO_2e$/year) and energy efficiency (3.97 $MtCO_2e$/year) (Figure 8). The rest are compost (3.7 $MtCO_2e$/year), large hydro-dam (3.32 $MtCO_2e$/year) and switch from fuel oil to natural gas in thermal plants (2.97 $MtCO_2e$/year). Regarding the planned mitigation action, with the total emission reduction potential of 4.1 $MtCO_2e$/year, the highest contributions of Cocoa Forest REDD+ of 1.8 $MtCO_2e$/year and transformative power plant of 1.2 $MtCO_2e$/year were expected to be generated (Figure 8).

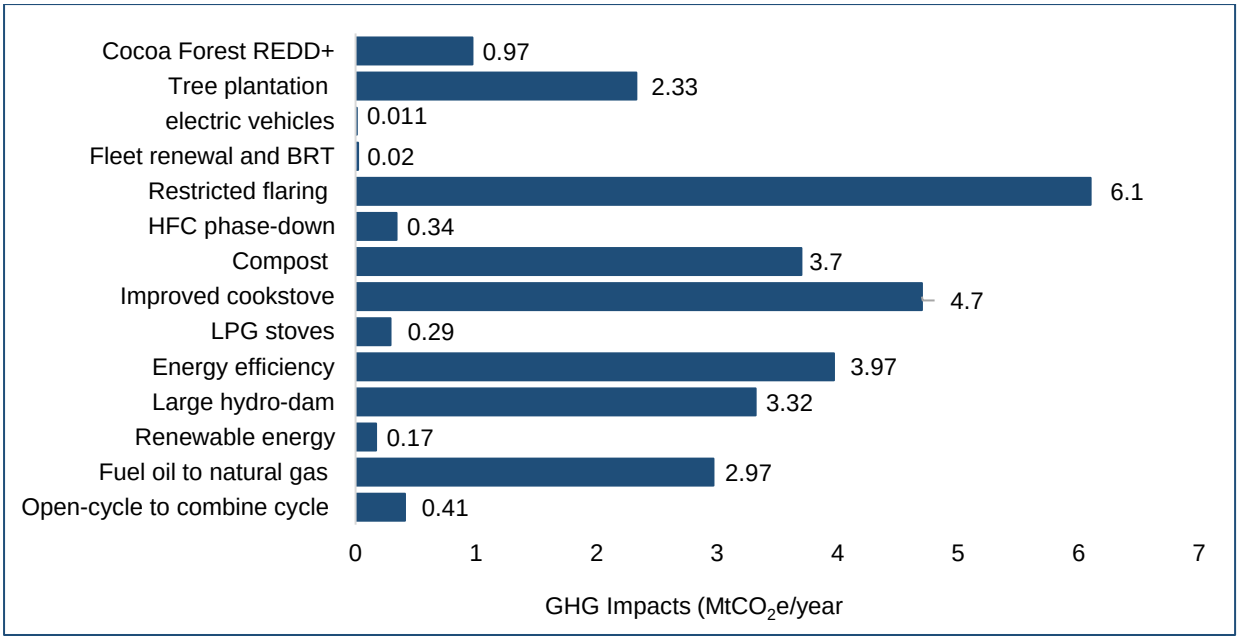


Figure 8: Summary of individual mitigation actions and their GHG effects.

4.4.3 Achievements of sector-specific mitigation measures

4.4.3.1 Energy sector mitigation measures

The imperative for a just and orderly global energy transition is pivotal to net zero global emissions by 2050 and keeping the 1.5-degree temperature goal alive. The UAE consensus from COP28 nailed the call to transition away from fossil fuel by tripling renewable energy and doubling energy efficiency. Ghana has responded to the global efforts for sustainable energy transition. As a result, the priority of its energy policy focuses on attaining energy sufficiency by developing and utilising its domestic energy resources and promoting bio and nuclear energy. That is why Ghana's energy mitigation policy aims to make energy services universally accessible and readily available in an environmentally sustainable manner.

The flagship 2023 national energy policy is the primary document driving the mitigation efforts in the sector. It has specific strategies for achieving universal access to electricity, renewable energy penetration, natural gas commercialisation, infrastructure, LPG use and, recently, nuclear energy development. The following document outlines strategies for policy objectives and interventions toward achieving the clean energy, energy security and climate protection goals in the 2023 national energy policy:

- Sustainable Energy for All Country Action Plan (2012)
- Mini-grid Electrification Policy (2015, revised in 2017)
- National Gas Master Plan (2016)
- Integrated Power System Master Plan (2021)
- Renewable Energy Master Plan (2019)
- National LPG Promotion Policy (2017)
- Ghana Nuclear Power Programme (2021)

- Rate Setting for Guidelines for Net Metering of Renewable Energy Generation System Connected to Distribution Network in Ghana (2023)8
- Net Metering Code for Net Metering of Renewable Energy Generation System Connected to Distribution Network in Ghana (2023)
- National Energy Transition Framework (2022)
- National Energy Transition and Investment Plan (2023)
- Renewable Energy Licence Manual
- Energy Efficiency Guidelines for Regulated Electronic Appliance (2023)

The Ministry of Energy is leading in implementing specific programmes that deliver GHG mitigation outcomes in:

- low-carbon electricity
- renewable energy
- clean cooking
- energy efficiency in homes and commerce
- electric mobility.

Table 18, Table 19 and Table 20 present information on the low-carbon electricity mitigation actions in Ghana. It includes fuel switch, single cycle to combined cycle and biomass energy action in electricity production.

[8] https://www.purc.com.gh/attachment/772548-20221128101136.pdf

Low carbon electricity actions

- **Single cycle to combined cycle in thermal power.**
- **Fuel switch from heavy fuel oil to natural gas thermal power.**
- **Biomass renewable energy power.**

4.4.3.1.1 Low carbon electricity

Table 18: Single cycle to combined cycle in thermal power plants.

Name	Conversion from an open-cycle gas power plant to a combined-cycle power plant.
Action type	Fuel savings through energy efficiency improvement in power plants (technology)
Sector	Energy
Implementors	Volta River Authority and Independent Power Producers
GHGs	CO_2, CH_4 and N_2O
Objectives	Increase the installed capacity of the thermal plant by converting an open-cycle gas power plant to a combined cycle, using steam instead of fossil fuel to reduce greenhouse gas emissions. Upgrade the installed capacity of three open-cycle thermal power plants to 330 MW through retrofits to use steam.
Description	Electricity generation capacity doubled from 2,165 MW in 2010 to 5,445 MW in 2021. Fossil-fuel thermal power accounts for 57% of electricity generation. Ghana has adopted a policy to retrofit existing and new thermal plants to combined-cycle power plants to reduce reliance on fossil fuels.
Period	2014 till date (ongoing)
Steps taken or envisaged to achieve the action	Completed upgrade of steam capacity of the following thermal power plants: • 120 MW by TICO • 110 MW by TAPCO • 247 MW by Karpowership Additional planned steam capacity includes: • 110MW by KTTP • Installation and coupling of 110MW steam component onto TT1PP (110 MW) and CENIT (110 MW) gas thermal power plants, resulting in a combined capacity of 330 MW. • 40MW Takoradi 3 Thermal Plant
Results Achieved	• Upgraded 477 MW steam capacity in three existing thermal power plants. • Three existing thermal power plants expanded steam capacity.
Impacts	**GHG impacts** • 0.41 $MtCO_2e$/year **Non-GHG impacts** • Fuel cost savings over the project's lifetime are expected to be between US$94 million and US$109 million, based on the mid-level gas demand projection. • Increase electricity supply to meet the annual 10% growth in demand. • 1,321 GWh of total electricity saved through the efficient use of steam to generate electricity.
Progress indicators	• Steam capacity increase in MW. • Share of steam electricity generation (MWh)

Methodology/ Assumptions	• Calculation based on approved CDM methodology (CDM ACM0007) • Fuel consumption to operate the project power in combined cycle mode. • Plant utilisation time is 6000 hours per year. • Efficiency is estimated at 51%. • Mitigation outcomes will not be authorised for international transfer. • Unconditional NDC mitigation measure.

Table 19: Fuel switch from heavy fuel to natural gas in thermal power plants

Name	Fuel switch from heavy fuel oil to natural gas thermal power plants
Action type	Replacement of high carbon-intensive fuel oil with natural gas (technology)
Sector	Energy
Implementors	Ministry of Energy, Volta River Authority, and Independent Power Producers
GHGs	CO_2, CH_4 and N_2O
Objectives	The objective is to replace the utilisation of heavy fuel oil (LCO or HFO) with gas to reduce the cost of electricity generation and emissions. It also involves developing gas infrastructure to facilitate production, transportation, and natural gas processing as primary fuel inputs to generate thermal electricity.
Description	It involves investing in gas infrastructure development to facilitate natural gas production, transportation, and processing as primary fuel inputs for thermal electricity generation. To this end, Karpower, AKSA, CENIT, TAPCO, TICO, TT1PP, and TT2PP should use gas for power generation.
Period	2010 till date (ongoing)
Steps taken or envisaged to achieve the action	• Invested nearly $13.2 billion (Tweneboa-Enyenra-Ntomme (TEN) and ENI/Vitol, (Sankofa) fields (ENI/Vitol - $7.28 billion, TEN - $5.9billion) in natural gas production and infrastructure development. • Commissioned a natural gas processing facility in 2012. • Relocation of Karpower from the Eastern Power enclave to the Western Power enclave of the country.
Results Achieved	• Commissioned three gas production fields (Tweneboa-Enyenra-Ntomme (TEN) and ENI/Vitol (Sankofa) and (NI/Vitol) with an initial production capacity of 300 MMscf daily. • Commissioned and operated a first-ever natural gas processing plant with a 150m standard cubic feet capacity daily (MMscfd). • Ghana Gas Company has processed and supplied 5016.29 ktoe of natural gas to VRA thermal plants for electricity generation since 2011. Specifically, TAPCO, TICO, TT1PP, TT2PP, and Karpower now use natural gas for power generation. • In 2021, TAPCO generated 2,130 GWh, TICO generated 1,998 GWh, TT1PP generated 404 GWh, TT2PP generated 90 GWh, and Karpower generated 2,132 GWh with natural gas as input fuel.
Impacts	**GHG impacts** • 2.97 $MtCO_2e$/year **Non-GHG impacts** • Reliance on competitively priced domestic natural gas is the most cost-effective means of providing the primary energy needed to fuel power stations and satisfy Ghana's growing demand for electric power.
Progress indicators	• Thermal capacity switch from fuel oil to natural gas (MW). • Natural gas-based electricity generated (GWh). • Quantity of natural gas consumed instead of crude oil (tonnes).

Methodology/ Assumptions	• Calculation based on approved CDM methodology (CDM ACM0011) • Power plant efficiency is estimated at 42% for using natural gas. • Capacity factor estimated 6000 operating hours. • Mitigation outcomes will not be authorised for international transfer. • Unconditional NDC mitigation measure.

Table 20: Biomass renewable energy power

Name	Transformative Biomass Power Plant
Action type	Displace fossil fuel with biomass fuel for electricity production (technology)
Sector	Energy
Implementors	Zuza Akyem (ZA), USTA Power Africa
GHGs	CO_2
Objectives	The measure is a 40 MW biomass renewable energy (RE) project that is the singular catalyst to enable the initiative to reverse decades of land degradation from unsustainable mining activities, regenerate the local ecosystems, and restore biodiversity while offsetting CO_2, combatting climate change, and providing local farmers' opportunities to derive a meaningful livelihood.
Description	The Project operates on ~10,000ha of land leased directly to the Project for a 40-year period by the Akyem Abuakwa Kingdom (AAK) in the Eastern Region of Ghana. The action is designed to function as the commercial and economic nexus of a new renewable baseload power plus agroforestry-anchored economy for the region. It consists of two fundamental, symbiotically interrelated components: the power plant and the Multi-Strata Agroforestry component, consisting of ~5,500ha of Project, mechanically planted and harvested feedstock that we grow year-round.
Period	Planned (2024 to 2030)
Steps taken or envisaged to achieve the action.	• Establish a Community Development Trust to facilitate the implementation of community-selected development initiatives funded by the Trust. • Work with the Engineering, Procurement, and Construction (EPC) firm Murray & Roberts (M&R) to construct the power plant. • Work closely with the ECG on an ongoing basis to ensure the dispatch of power generated at the MA's power facility. • Undertake routine, year-round planting and harvesting of biomass feedstock for the power plant. • Conduct ongoing logistics work related to the running and maintenance of the power plant and feedstock systems.
Results Achieved	• Has secured a 20-year power purchase agreement (PPA) with the Electricity Company of Ghana (ECG). • Has secured a contract for land-lease contract for the 10,000-ha farming/feedstock system and for the power plant 50-acre campus. • Is currently in the process of raising Senior Debt and • Has completed the following necessary studies: ▪ Grid Impact Study. ▪ Environmental & Social Impact Study (ESIA) for the farming system. ▪ Environmental & Social Impact Study (ESIA) for the power plant. ▪ Life Cycle Analysis (LCA)
Impacts	**GHG impacts** • 1.2 $MtCO_2e$/year (Emission Reduction Potential from 2025)

	Non-GHG impacts • Rehabilitate 5,500ha of degraded land due to illegal mining. • Potential to create jobs in the community. Number of jobs is unknown.
Progress indicators	• Bagasse-based electricity generated (GWh) • Quantity of bagasse consumed instead of crude oil/natural (tonnes)
Methodology/ Assumptions	• Calculation is based upon the ACM0006 version 15.0 CDM methodology. • Mitigation outcomes from 2024 to 2030 will be authorised for international transfer. Those beyond 2030 will be used against Ghana's NDC for 20 years. • Unconditional NDC mitigation measure.

Renewable energy actions

- **Scaling up deployment of renewable energy.**

4.4.3.1.2 Scaling up Renewable Energy

The description of implementation information on the renewable energy mitigation actions is captured in Table 21 below.

Table 21: Renewable energy technology deployment

Name	Scaling up deployment of renewable energy
Action type	Renewable energy technology deployment backed by fiscal and regulatory instruments (technology and regulation)
Sector	Energy
Implementors	Ministry of Energy, Energy Commission, Volta River Authority, Bui Power Authority, IPP, Individuals, Hotels, Hospitals, Banks, etc.
GHG	CO_2
Objectives	Increase the contribution of renewable energy share in the overall energy mix while ensuring efficient production and utilisation of biomass energy resources to reduce greenhouse gas emissions and achieve the scaling-up of renewable energy penetration to 10% by 2030.
Description	A government-wide cum private-sector initiative led by the Ministry of Energy promotes renewable energy technologies at all economic levels. The action has the following components: • Utility-scale renewables • Distributed solar PV. • Mini Hydropower • Off-grid renewables • Replacement of kerosene lamps with solar lamps
Period	2012 to 2030
Steps taken or envisaged to achieve the action.	• Renewable Energy (Amendment) Act, Act 1045, establishes a competitive procurement scheme and a net metering scheme regarding electricity generated from renewable energy sources. • The amended act also makes it mandatory for fossil-based electricity suppliers, producers of fossil fuels and any company that contributes to greenhouse gas emissions to invest in non-utility renewable energy to offset greenhouse emissions. The Amended Act also removed the 100MW threshold for hydro dams to qualify as a renewable source and allowed all existing large hydro to qualify as renewables. • Implementing the following sub-measures: ▪ RE licensing framework and ▪ Mini-grid electrification policy. ▪ Scaling-up RE programme Investment Plan. ▪ Net metering policy • Plans to establish the following by 2030. ▪ Install 300 MW distributed solar PV. ▪ Solar 300 mini grids translating into 14.22MW. ▪ Attain utility-scale solar electricity installed capacity of 527.1MW

	▪ Increase utility-scale wind power capacity up to 375MW. ▪ Increase installed hydro capacity from 1580.045 MW to 1730.45MW. ▪ Increase kerosene lamp replacement with solar lanterns in rural non-electrified households to 2 million. • Adoption of net metering codes and rate setting for guidelines for net metering of renewable energy generation systems connected to the distribution network in Ghana. • Helio Solar Company is planning to install a 16.8 MWp Mega Warehouse Rooftop PV project in the Tema Free Zone Enclave, with an estimated 25 GWh/year plant output.
Results Achieved	**<u>Grid-connected.</u>** **Utility-scale renewables** • Installed 112.04MW utility-scale RE plants including: ▪ Completion of 2 utility-scale grid-connected solar PV plants by VRA involving 13MW at Kaleo and 6.5MW at Lawra. ▪ Completion of Bui Power Authority's 50MW utility-scale grid-connected solar PV plant at Bui. ▪ 100kW utility-scale grid-connected waste-to-energy plant at Ashaiman. **Distributed solar PV**. • Installed individual solar PV adding up to approximately 42.8MW, including: ▪ Installation of 1,081kWp grid-connected solar PV system at Guinness Ghana Breweries Limited. ▪ Installation of 400.4kWp grid-connected solar plant at Kasapreko Company Limited. ▪ Installation of 704kW grid-connected solar plant at Miniplast. ▪ Installation of 527kWp grid-connected solar plant at Regional Maritime University. ▪ Installation of 1000kWp grid-connected solar plant at Special Ice Company Limited. ▪ Installation of 400kWp grid-connected solar plant at Royal Nick Hotel. ▪ Installation of 500kWp grid-connected solar plant at Cal Bank. ▪ 534 kW individual distributed solar PV system, including household installations. **<u>Hydropower</u>** • Installation and completion of 45kW Micro hydropower project at Tsatsadu Falls in the Volta Region. • 1,580MW large hydropower connected to the grid. • Pre-feasibility studies on 10 potential medium-sized hydro sites have been conducted. **<u>Mini-grids</u>**

	• Installation of five mini-grids translating into 314 kW off-grid solar PV and wind systems. • An additional thirty-five mini-grids to be installed under the Scaling-up Renewable Energy Program (SREP). **<u>Off-grid</u>** • Installed 7.4 MW solar PV. • Installation of 0.02 MW onshore wind farm. **Replacement of kerosene lamps with solar lamps** • Distributed 180,468 solar lanterns distributed nationwide
Impacts	**GHG impacts (3.39 $MtCO_2e$ with hydro, 0.17 $MtCO_2e$ without hydro)** • Grid-connected solar PV – 0.13 $MtCO_2e$/year. • Off-grid solar PV – 0.01 $MtCO_2e$/year. • Mini-grid solar/wind – 0.00046 $MtCO_2e$/year. • Wind – 0.00004 $MtCO_2e$/year. • Grid connected large hydro – 3.32 $MtCO_2e$/year. • Mini hydro off-grid – 0.00015 $MtCO_2e$/year • Solar lamps – 0.0296 $MtCO_2e$/year **Non-GHG impacts** • The percentage renewable share of the national energy mix currently stands at 2.92%. • Jobs creation in the solar value chain is conservatively estimated at 550 jobs. • 1,068 households have installed SPV corresponding to 534kW of installed capacity. • All installed capacity (utility-scale & distributed generation) to generate approximately 238.7 GWh of renewable energy annually.
Progress indicators	• Capacity of renewable energy installed (MW) • Share of the renewable energy capacity of national installed capacity (%) • Quantity of renewable energy generated and consumed (GWh) • Number of renewable energy installations (No).
Methodology/ Assumptions	• Calculation based on approved CDM methodology (CDM AM0019, AMS-I.A, AMS-I.L) • Grid Emission Factor (combined Margin (CM) solar & wind) – 0.40 CO_2/MWh) • Hourly consumption of kerosene (0.05 litres) • Hours of lantern use (4 hours per day) • Efficiency factors of solar home PV (80%), • Daily insolation (5 hours).

Energy efficiency actions

- **Energy Efficiency Improvements in homes and businesses.**

4.4.3.1.3 Energy efficiency in homes and businesses

Table *22* shows the summary of information on energy efficiency measures in Ghana.

Table 22: Energy Efficiency improvements in homes and businesses

Name	Energy Efficiency Improvements in homes and businesses
Action type	Technology-backed regulation/enforcement and awareness creation.
Sector	Energy
Implementers	Ministry of Energy, Energy Commission, Ghana Standards Authority and Millennium Development Authority (MiDA).
GHG	CO_2
Objectives	• Promote energy-efficient appliances and transform the electrical appliance market into an energy-efficient one. • Develop and enforce energy efficiency standards and regulations for 20 more electrical appliances. • Revise and upgrade 3 existing standards for refrigerators, light bulbs, and air conditioners. • Creating energy efficiency awareness nationwide and training all security agencies (Military, Police, Fire Service, Prisons, Immigration and Customs) in energy efficiency and conservation. • Distribute at least 4,000 energy efficiency and conservation educational materials yearly. • Training of energy managers in Government institutions and agencies • Prohibit through regulations the importation and sale of used refrigerators, air conditioners and incandescent bulbs. • Training of Public Sector Procurement Managers, Administrators, Accountants. • Introduce financing mechanisms/incentive schemes to make energy-efficient appliances more affordable to consumers. • Distribute 12 million LED Bulbs (6 watts, 9 watts and 13 watts) to households, schools, institutions, and businesses. • Install 500,000 LED streetlights to replace existing high-energy-consuming streetlights.
Description	The key components of the energy efficiency and conservation action are: • **Expand and update the energy efficiency appliance application (APP) and database annually** with data on efficient refrigerators, air conditioners and lighting bulbs approved for importation in the country to enable consumers to verify certified energy-efficient appliances and identify retail shops for energy-efficient appliances. • **Development of Energy Efficiency Standards and Regulations** – Development of new standards and regulations for Twenty (20) more commonly used electrical appliances (TV sets, ceiling fans, etc.) to improve energy use efficiencies.

	• **Enforcement of Energy Efficiency Regulations –** Currently enforcing 3 existing air conditioners, refrigerators, and lighting devices and 1 regulation prohibiting the importation and sale of used ACs, refrigerators and incandescent bulbs. Importers of new air conditioners, refrigerators and lighting bulbs must register with the Energy Commission and submit a test report on the appliances for study and approval before importation into the country. As per the requirements, the appliances must arrive in the country labelled with the yellow Ghana energy efficiency label. • **Consumer awareness creation and training in energy efficiency and conservation** through training workshops, TV adverts, jingles, radio interviews/discussions, posters, and flyers. In addition to this public awareness and campaigns, the Commission also holds energy efficiency and conservation training workshops for identifiable consumer groups. The training workshops are held to equip consumers with energy efficiency, conservation benefits, and measures to improve their energy use efficiency. • **Distribution of LED bulbs to consumers -** under a nationwide Government free LED bulb distribution programme. • **Installation of LED streetlights** - under an ongoing Government and Millennium Development Authority (MiDA) Energy Efficiency and Demand Side Management Project (Ghana Power Compact) LED street lighting programme.
Period	2005 to date (ongoing)
Steps taken or envisaged to achieve the action.	• **Expand and update the energy efficiency appliance application (APP) and database** – Systems for market surveillance and data collection, analysis and archiving put in place for approved and energy efficient appliances imported into the country. A dedicated team has also been established to undertake these activities annually to ensure the system's effective functioning. Awareness creation and sensitisation on the database and APP are ongoing. Measures are being implemented to expand the database and the APP to include more regulated appliances. • **Development and enforcement of Energy Efficiency Standards and Regulations** – New energy efficiency standards and regulations have been developed to cover over twenty new electrical appliances. A technical committee consisting of experts from the Energy Commission, Ghana Standards Authority and key stakeholders put in place and developed about 17 new standards and regulations for the selected appliances. The Attorney General's office played and key role in reviewing and submitting the draft regulations to parliament through the Ministry of Energy. Revision and upgrade of two existing refrigerators and air conditioners standards have been undertaken to increase the energy efficiency thresholds. The testing facility for air conditioners has been completed and is in operation. The test facility will ensure that appliances meet a Minimum Efficiency Performance Standard

	(MEPS) and contribute to the efficient use of electricity. The existing three regulations for ACs, refrigerators and lighting devices, and prohibiting the importation and sale of used ACs, refrigerators and incandescent bulbs are being enforced at the Ports and on the market. The Law banning the importation and sale of used appliances is also being revised and upgraded to include more appliances and accessories apart from refrigerators, air conditioners and incandescent bulbs. Enforcement of the regulations on lighting bulbs, refrigerators, and air conditioners is being undertaken at the country's ports of entry. Importers of these regulated appliances must submit an energy efficiency performance test report for verification and approval before importation can go ahead. • **Consumer awareness creation and energy efficiency and conservation training** – Public awareness creation and training systems put in place, and a dedicated team established for energy efficiency and conservation. Awareness creation and training in energy efficiency and conservation are now yearly activities undertaken by the Energy Commission. Thousands of educational materials are printed for free distribution to consumers. Documentaries and jingles on energy efficiency and conservation developed for airing on radio and TV. • **Making highly efficient cooling appliances affordable to consumers (Introduction of the highly efficient appliance through ECOFRIDGES) -** The ECOWAS Refrigerators and Air Conditioners Initiative (ECOFRIDGES) is a joint project by the Governments of Ghana and Senegal, the United Nations Environment Programme's United for Efficiency (UNEP U4E) initiative and the Basel Agency for Sustainable Energy (BASE). In collaboration with regional and local partners, ECOFRIDGES aims to accelerate the adoption of energy-efficient and climate-friendly domestic refrigerators and room air conditioners, saving consumers money on their electricity bills, relieving demand on the power sector, and mitigating environmental impacts. A cornerstone of ECOFRIDGES activities in Ghana is a Green On-Wage (GO) financial mechanism to help make these cooling products more affordable. Through ECOFRIDGES GO, local financial institutions aim by 2023 to unlock at least USD 11 million in financing in Ghana to support the purchase of over 15,000 more sustainable cooling appliances and entice the replacement of old existing equipment. It sets strict energy performance requirements and limits on the refrigerants of participating products to keep a lid on greenhouse gas emissions. The eligible criterion for refrigerators is a 5-star energy efficient rating with R600a refrigerant. The Criteria for air conditioners, on the other hand, are 3-star and above energy efficiency ratings and R32 refrigerant. Eligible participating banks and vendors who meet the criteria have been selected to supply the products in the case of the vendors.

	Some selected banks who showed interest were also added to provide an innovative financial scheme for the consumers to take care of the initial cost. The upfront cost of the appliance is paid for while the consumer has a repayment period of 12 months at zero per cent interest. The environment has been created in terms of demand and supply to make it self-sustaining. • **Developed building code backed by regulation** – A building code has been developed to ensure that buildings are designed, constructed with suitable materials, fitted with energy-efficient appliances, and managed efficiently and sustainably. Regulations to make the building code enforceable are being developed. • **Energy performance certification** – Energy Performance assessment and certification tools have been developed and piloted successfully. The tools will be used to assess the energy consumption of buildings to determine their specific energy consumption (energy consumption per square meter). The assessed buildings will be issued with energy performance certificates based on their specific energy consumption levels. Development of a **National Database** on the Energy Performance of existing buildings will be undertaken as part of the process. • **Establishment of Sustainable Energy Service Centres (SESCs)** – Three Sustainable Energy Service Centres have been established nationwide to train energy professionals (Energy Managers, Energy Auditors, etc.) who will assist facilities and organisations to practice cost-effective energy efficiency/saving measures in their operations. The centres have offices, energy audit instruments, IT equipment and operational vehicles. • **Distribution of LED bulbs to consumers** - 12 million imported for free distribution by the Government. The Government officially launched the programme in March 2020, and a distribution mechanism by the Ministry of Energy. Consignments of the LED bulbs are being dispatched to all the target beneficiaries, including the security agencies, communities, and institutions. Municipal and District Chief Executives are spearheading the community distribution of the bulbs. It is envisaged that the quantities to be given for community distribution will be 50,000 pieces for the Metropolitan area, 40,000 for the Municipal area and 30,000 for districts. In collaboration with the Ministry of Energy, the Energy Commission monitors and compiles data on the free distribution of the bulbs to estimate the energy and emission savings impacts. • **Installation of LED Street lights** – The Ministry of Energy and the MiDA have initiated measures to install several thousands of LED streetlights in towns, cities, and communities. Feasibility studies have been undertaken, and MIDA has placed an order to supply the bulbs for installation. A Government-led initiative involves the free distribution of LED streetlights to communities and replacing high-consuming streetlights with energy-efficient LEDs.
Results Achieved	• **Expand and update the energy efficiency appliance application (APP) and database –** Database on energy-efficient refrigerators,

	air conditioners and lighting bulbs established and updated. The associated certified appliance application (App) expanded to include data on lighting bulbs (LEDs and CFLs) and is available for free downloads by consumers. An IOS version of the Certified Appliance APP has been developed for download to expand access. Appliance Database with related App Updated with 2021 Market Data. Regulated appliances product registration/register created for Refrigerators, air conditioners and lighting appliances. • **Development of Energy Efficiency Standards and Regulations** – Completed the development of regulations for 20 Electrical Appliances (i.e., Microwave, Washing Machines, Computer, Electric Motor, distribution transformers, kettle, comfort fans, ventilating fans, industrial fans, water heaters, Television, public lighting, set-top boxes, rice cookers, solar panels, inverters, Renewable Energy Batteries, refrigerators, air conditioners and improved biomass cookstove). Two prohibition regulations have also been developed. One of the imports of used electrical appliances, and the other prohibiting the manufacture of incandescent Filament lamps. The Legislative Instruments have been developed and laid before parliament, awaiting the mandatory 21 sitting days to become law and make them enforceable. The air conditioner testing laboratory has been installed at the Ghana Standards Authority and is operational. • **Enforcement of Standards and Regulations** Enforcement of energy efficiency standards has resulted in the following: ▪ 2,548,508 new refrigerators imported (2016 – 2021). ▪ 858,155 new air conditioners imported (2016 – 2021). ▪ Prohibited importation and prevented sales of 49,764 old and inefficient refrigerators and 11,750 RACs at the ports of Tema and Takoradi. ▪ Achieved 97% compliance for implementing the appliance energy efficiency standards and labelling regime. • **The appliance market has been transformed** from one that imports and sells old/inefficient appliances to one that now imports new/efficient appliances. • **Consumer awareness creation and training in energy efficiency and conservation** – A total of 6,531 officers of the security agencies trained in energy efficiency and conservation nationwide from 2018 to 2022. • **Installation of LED Streetlights –** 367,348 LED streetlights have been installed in cities, towns, and communities to give better illumination at night and reduce the power consumption and cost of street lighting.
Impacts	**GHG impacts (3.97 $MtCO_2e$/year)** • New refrigerators – 3.1 $MtCO_2e$/year

	• New ACs – 0.72 $MtCO_2e$/year • LED streetlight – 0.15 $MtCO_2e$/year **Non-GHG impacts** • Reduced energy cost: The total cumulative electricity savings from MEPS implementation from 2016 to 2020 was 9,172.9 GWh, with an electricity cost reduction of USD 886 million. Reduced power consumption means lower household expenditure and running costs of businesses. Products and services of businesses such as MSMEs become more competitive and profitable. Households experience reduced financial burden, especially in low-income households with high energy bills. • Improvement of energy security: reducing energy consumption and, consequently, demand reduces the strong reliance on imported energy. • Total finance mobilised: The Ecofridges has mobilised a total of Ghana cedis 8.68 million from its inception in 2020 to July 2022. • Ecofridges reduction in energy consumption as of July 2022 was 18,624 MWh of total energy savings.
Progress indicators	• Number of inefficient appliances replaced (No) • Energy and cost savings achieved (US$/kWh) • Number of buildings retrofitted (No) • Number of people trained (No) • Number of cooling appliances sold through Ecofridges (No) • Number of imported new refrigerators (No) • Number of imported air conditioners (No) • Number of intercepted used fridges and air conditioners (No)
Methodology/ Assumptions	Three appliance energy efficiency impact evaluation models were reviewed, as they can be used to evaluate the energy, financial and greenhouse gas (GHG) impacts of improvements in market product energy efficiency levels. They include the Product Policy Analysis Tool (PPAT), Bottom-Up Energy Analysis System (BUENAS) and Mepsy. Mepsy is an online digital tool designed to model efficiency policies' cost, energy, and carbon reduction impacts. Pre-loaded with data from 162 countries, it supports the analysis and prioritisation of the most energy-intensive appliances and equipment. The Mepsy model presented helpful features in this evaluation exercise, mainly because macroeconomic data for economies under analysis are already available. The data already refers to possible sources of information and can be updated as required if more recent data becomes available. This can greatly reduce an analyst's time compiling data for multiple economies. • Built-in saturation functions to forecast appliance ownership levels for two appliances under analysis (refrigerators and air conditioners). • It can conduct a cost-benefit analysis of potential policies. • It uses the bottom-up stock accounting approach. • It can perform multi-tie analysis.

	• Factors in grid losses, power plant emissions, and electricity tariffs. **Assumptions** • Before standards are established, all products on the market operate at a well-defined baseline efficiency. • Unit electricity consumption (UEC) is constant from year to year, and • Residential electricity tariff (P) is constant yearly, set at 10 US¢/kWh. • 95% of imports taken as sales • Installation of LED streetlights ▪ Hours of usage of streetlights (6 pm - 6 am each day) is equivalent to 12 hours. ▪ 150W LED will replace the 250W sodium bulbs

Clean cooking actions

- **Promotion of clean cooking solutions.**

4.4.3.1.4 Clean cooking solutions

Table *23* is on clean cooking measures covering LPG promotion and access to energy efficient cookstoves.

Table 23: Clean cooking technologies in Ghana

Name	Promotion of clean cooking solutions
Action type	Improved cookstoves and clean cooking fuels, regulation, and capacity development (technology, regulation, and awareness)
Sector	Energy
Implementors	• **Ministry of Energy** - Set the policy direction for the clean cooking sector. • **Energy Commission** – Develops regulations for biomass cookstoves and the wood fuel sector, promoting efficient end-use devices and sustainable use of woodfuel resources. • **National Petroleum Authority** - Implementation of the National LPG Promotion Policy.
GHG	CO_2, CH_4 and N_2o
Objectives	The mitigation action aims to promote and adopt clean cooking solutions in households, commerce, and service sectors. It has two main components: an LPG promotion programme and wood-fuel users' access to energy-efficient and improved cookstoves. The objectives are to improve access to LPG for cooking; improve access to energy-efficient cookstoves by wood fuel users, translating into 50% of residential, commercial, and industrial users adopting LPG as the primary fuel for cooking and heating by 2030 and adopt 3 million improved biomass stoves by households by 2030.
Description	**Component 1 (LPG Promotion Programme)** • Rural LPG Promotion Programme (RLPGPP) • Migration to cylinder recirculation model of distribution (CRM) • LPG for Development **Component 2 (Access to energy-efficient and improved cookstove for wood fuel users)** • Implement standards and labelling scheme for improved biomass cookstoves. • Promotion of energy-efficient biomass cookstoves
Period	2020 to 2030 (ongoing)
Steps taken or envisaged to achieve the action	**Component 1** **Approval was received for the implementation of the following:** • Public education and behavioral change sensitisation strategy to promote CRM and LPG use in the country. • Nationwide monitoring and evaluation framework for CRM; and • LPG price build-up to accommodate the cylinder investment margin and bottling plant margin. **Pilot implementation of CRM in 2 phases** • Phase 1: Eastern Region (Kade Municipal & Akwatia District) and Ashanti Region (Obuasi Municipal & Adansi North District)

	• Phase 2: Western Region and Northern Region. • Phase 3: Volta (Hohoe/Anloga) Region: Put on hold due to COVID-19. • The NPA contracted Ghana Cylinder Manufacturing Company to procure and brand 56,106 cylinders in varying sizes of 14.5kg, 6kg, and 3kg for distribution to the LPGMCs in the pilot areas. • Blue Ocean Plant ready to be utilised. **Component 2** • A baseline report on the technical performance of commercially available improved biomass cookstoves on the Ghanaian market was updated with support from the World Bank. • Built capacity of selected local manufacturers of biomass cookstoves and liners in cookstove design and development with support from the African Development Bank through the Clean Cooking Alliance. • New Regulations to implement standards and labelling scheme for improved biomass cookstoves were published in November 2021. • ISO accreditation for the cookstove testing laboratory at the CSIR Institute of Industrial Research has commenced. The African Development Bank supports it through the Clean Cooking Alliance • Ministry of Energy partnered with the Climate Change Centre of Korea to implement a 500,000 improved cookstove project for urban and peri-urban households. • Developing Ghana's National Clean Cooking Strategy document and investment prospectus.
Results Achieved	**Component 1 (LPG Promotion Programme)** • Increased awareness of the benefits of LPG use and the negative impacts of using wood fuel in inefficient stoves. • Extensive regional and national stakeholder consultations were held on the CRM. • GOIL, New Gas and Blue Ocean have been issued a license to build and operate an LPG bottle plant. • No new cylinder exchange points have been established due to the CRM pilot. Existing outlets are doubling as filling and exchange points for the CRM pilot. **Component 2 (Access to energy-efficient and improved cookstove for wood fuel users)** • From 2020 to 2021, donor- and private-sector-led interventions disseminated about 1,859 improved institutional biomass (charcoal, firewood, and palm kernel) stoves for general cooking, agro-processing, and fish smoking. • About 1,161,102 domestic biomass (charcoal and firewood) stoves have been disseminated from 2020-2021.
Impacts	**GHG impacts (4.99 $MtCO_2e$/year)** • LPG promotion programme: 0.29 $MtCO_2e$/year • Improved cookstoves: 4.7 $MtCO_2e$/year **Non-GHG impacts**

	• Created over 1,431 jobs (permanent and casual) across the biomass cookstove supply chain. • Require US$ 57.5 million to achieve the mitigation outcomes.
Progress indicators	• The number of improved cookstoves distributed and in use (No). • Percentage of households using LPG fuel for cooking (%).
Methodology/ Assumptions	• Methodology as based on Methodology AMS-II G • The assumption in the methodological included the following: ▪ Fraction of non-renewable biomass (ranged from 25.2% to 31.1%) ▪ Efficiency of improved cookstove (36%) ▪ Carbon content of wood (2.6 tC/yr)

Minimising gas flaring

- **Recovery of associated and non-associated gas from oil and gas fields**

4.4.3.1.5 Recovery of natural gas from oil and gas fields

Table 24 presents information on natural gas recovery measures in oil and gas.

Table 24: Natural gas recovery from three oil and gas fields

Name	Recovery of associated and non-associated gas from oil and gas fields
Type of action	Recovery of associated and non-associated natural gas from oil fields that would otherwise be flared or vented (technology)
Sectors	Energy and Environment
Implementing entities	Petroleum Commission, Ghana National Gas Company, Environmental Protection Agency, Jubilee Partners, ENI
GHG	CH_4
Objectives	Recover associated and non-associated gas from the three oil fields for Ghana National Gas Company to produce downstream products.
Description	The mitigation action resulted from Government policy to expand the domestic gas market and led to the investment in national gas infrastructure to facilitate the harnessing and processing of natural gas. The measure aligns with the restricted flaring policy in Section 33 of the Petroleum (Exploration and Production) Act 919, 2016.
Period	2014 to date (ongoing)
Steps taken or envisaged to achieve the action.	• Commissioned ENI's integrated Oil and non-associated Gas (NAG) Offshore Cape Three Points fields in 20179. • Ghana plans to establish a second gas processing plant north of the Atuabo Gas plant by 2024 to uptake and process more gas. • Enacted the Petroleum (Exploration and Production) Act 919, 2016. • Ghana established sub-Saharan Africa's first liquefied natural gas-to-power project as it is a hub for cleaner and cheaper fuel in the region.
Results Achieved	• Investment of $ 1 billion in Gas Processing Plant managed by the Ghana National Gas Company (GNGC). • The share of natural gas flared of the total gas production in all three fields has decreased from 44% to 8% in 2011-2021. • Gas lift to GNGC processing has increased by 50.8% from 1,910.1 MMscf in 2014 to 98,900.6 MMscf in 2021
Impacts	**GHG impacts** • 6.1 $MtCO_2e$/year **Non-GHG impacts** • Avoided 270.9 MMscf per day of natural gas flare. • Invested over US$ 1 billion in the downstream gas market

[9] https://www.eni.com/assets/documents/eni-ghana2017.pdf

Progress indicators	• Amount of natural gas recovered for utilisation (MMscf) • Share of natural recovered of the total gas production (%)
Methodology/ Assumption	**Methodology** • Based on approved CDM Methodology AM0009 version 4. **Assumptions** • Average net calorific value of recovered gas (0.00001911 TJ/m^3) • Net calorific value of recovered gas with low content of condensable hydrocarbons (487.67 BTU/Ft3). • 1-year equals 365 days.

4.4.3.2 Transport Sector Mitigation Measures

The transport sector mitigation strategy aims to promote low-carbon mass transport mobility in the long term. This strategy is anchored on the national transport policy. It focuses on electric mobility (e-mobility), fleet renewal, efficient vehicle inspections, and rail-based transit to realise GHG mitigation outcomes. As part of the fleet renewal efforts, the Ministry of Transport has introduced a facility to put 400 euro-3 high occupancy buses into service to increase mass transport in cities.

One hundred buses will operate, whereas the remaining 300 will start in 2020. The Ministry of Transport also has a policy to improve the vehicle inspection regime, allowing private sector participation to bring innovation and efficiency. Table 23 presents the mitigation outcomes of the urban transit mitigation made of Bus Rapid Transit (BRT), fleet, and better inspection measures.

Electric vehicles' policy and incentive environment remain attractive to the private sector. The Energy Commission continued to implement the “drive electric initiative, " from which 4 public charging stations have been established in Accra. The Ministry of Transport has adopted the national electric vehicle policy. As a result, the 2024 national budget announced an import tax rebate for electric vehicles and components (for local assembly) for public transport. So far, 17,660 Plug-in EVs were imported into Ghana between 2017 and 2021.

KOFA, WAHU and Solar Taxi are three major private companies seeking to mobilise investment into electric motorbikes and buses. WAHU aims to introduce 117,00 e-bikes to displace 2 billion kilometres annually from fossil fuel 2-wheeler vehicles for the gig economy. Solar Taxi is exploring financing options for investing 200 electric vehicles for inter-city and intra-city transport.

Table 25 and Table 26 details the information on transport sector mitigation actions in electric mobility (e-mobility), fleet renewal and efficient vehicle inspections.

Transport sector mitigation actions.

- **Promotion of electric vehicles in Ghana**
- **Urban road transit measures**

4.4.3.2.1 Promotion of electric vehicles

Table 25: Electric vehicle initiatives in Ghana

Name	Promotion of electric vehicles in Ghana
Action type	Policy, incentive, technology-led regulation, and awareness of electric vehicles.
Sector	Transport and Energy
Implementing bodies	• Ministry of Transport (Developed the national electric vehicle policy) • Ministry of Energy (Developed national energy transition and investment plan) • Energy Commission (Implementing drive electric initiative) • Ministry of Finance (Implementing import tax rebate on electric vehicles) • Ministry of Trade and Industry (Implementing automotive development policy) • Private sector companies (investing in electric bikes, cars and buses).
GHG	CO_2
Period	2016 – to date (ongoing)
Objectives	Establish the policy and regulatory framework to promote investment in electric vehicles in Ghana. The framework focuses on electric vehicle policy, import tax incentives for electric vehicles and components, and energy for charging stations. It also involves efforts to sensitise the public and businesses to the opportunities and perceptions of electric vehicles.
Description	Ghana's electric vehicle initiative has three components as follows: **Component 1: Policy and regulation** • Under this component, Ghana seeks to create an enabling policy and regulatory environment. The policy and regulation development includes the Ministry of Transport, the Ministry of Trade and Industry and the Energy Commission. **Component 2: Drive Electric Initiative (DEI)** • The aim is to promote electric vehicles to create demand and drive the productive utilisation of our excess electricity supply in the system while creating responsible and sustainable electricity in the country. DEI aims to increase electricity demand sustainably to match supply to partially address the electricity generation over capacity. **Component 3: Infrastructure and vehicle investments** • The focus is to support a private sector-led investment into importation and the local assembly of electric buses, e-bikes, individual electric cars and charging infrastructure.
Period	2019 to date (ongoing)
Steps taken or envisaged to achieve the action.	**Component 1:** • The Ministry of Transport published Ghana's national electric vehicle policy to guide the decarbonisation of the transport

	sector in line with the national energy transition plan. • The Ministry of Finance, in the 2024 national budget, announced an import tax rebate for electric vehicles and wholly/semi-knocked down part for local assembly of electric vehicles for public transport for eight years. • Ministry of Trade and Industry plan to incorporate electric vehicle components into the Ghana automative development strategy. **Components 2:** • E-mobility conferences and public charging forums created public awareness. • Development of baseline study report on EVs in Ghana. • Development of standards and Regulations for EVs and Charging Infrastructure. **Component 3:** • Three more stations were added in 2021, making the total number of public stations up to four. • More than 10 private companies have expressed interest in installing charging stations. • 13,312 EVs have been registered in Ghana from 2016 to 2021. Of the total, 12,372 were PHEV and 940 BEV. • WAHU plans to produce 117,000 e-bikes for the gig economy with carbon finance. • Solar Taxi is developing project involving 200 electric buses for inter and intra-city transport with carbon finance. • Jospong Group of Companies is evaluating the feasibility of retrofitting 1000 diesel trucks with electric batteries.
Results Achieved	**Component 1:** • Updated NDC with electric vehicle as priority climate action submitted to UNFCCC in 2021. • A national energy transition and investment plan was adopted in 2023. Transport electrification plays a key role in achieving energy transition by 2060. • A national electric vehicle policy was adopted in 2023 to operationalise the role of electric vehicles in achieving Ghana's energy transition goal by 2060. • Announced a year import tax waiver for electric buses for public transport in the 2024 national budget. • Announced eight years of import tax waivers for wholly knocked or semi-knocked down components for local assembly of electric vehicles for public transport announced in the 2024 national budget. **Component 2:** • Development of baseline study report on EVs in Ghana – Inter-institutional committee established; Commission has embarked on an industry study to collect data, analyse, and establish a baseline for EVs in the country. Data has been collected from eight regional capitals of the country. Work is ongoing to analyse and prepare a report. • Development of standards and Regulations for EVs and Charging Infrastructure - Process initiated for the procurement

	of external consultants to develop standards and regulations for electric vehicles and charging infrastructure. • Awareness creation - Ghana's first e-Mobility conference was organised by the Energy Commission in September 2021 to bring together major stakeholders such as policymakers, car importers, manufacturers and charging station operators. • 582 in-person and online participants joined the conference with over 3,000 combined views at the end of 2021. A total of nine electric vehicles were exhibited: four cars, three E-minibuses, one four-wheel drive, and one 3-wheeler. • The Commission also organised Ghana's first public charging forum in collaboration with Dundee City Council and IEA, among other international players, in March 2022 at Alisa Hotel. • The forum brought together current and potential charging station operators, public and private agencies, international operators, and countries. Further, Hyundai KONA and ORA Black Cat electric vehicles were introduced to the market in 2021. The United Nations has included Ghana in its list of countries that have initiated e-mobility projects worldwide. **Component 3:** • 13,312 EVs registered as of 2021, with 12,372 PHEVs and 940 BEVs. • 4 public charging stations established in Accra. • 117, 000 e-bikes planned. • 200 e-buses planned. • 1000 e-trucks planned.
Impacts	**GHG impacts** • 13,312 PEVs - 0.011 $MtCO_2e$/year. • 117,000 e-bike (Emission Reduction Potential) – 0.02 $MtCO_2e$/year. • 200 e-buses (Emission Reduction Potential) – 0.0047 $MtCO_2e$/year. • 1000 e-trucks (Emission Reduction Potential) – 0.009 $MtCO_2e$/year. **Non-GHG impacts** • Create and improve 55,100 direct jobs. • Provide sustainable alternatives to cars, save money on transportation costs, improve public health, and reduce noise pollution
Progress indicators	• Amount tax waivers granted ($). • Number of electric vehicles registered (No). • Number of charging stations developed (No).
Methodology/ Assumptions	**Methodology** • Methodology is based on CDM methodology "AMS-III.C. Small-scale methodology: emission reductions by electric and hybrid vehicles version 16.0. **Assumption** • 90% of imports are taken as total EV vehicle imports and registered. • Unit electricity consumption (UEC) is constant yearly. • Grid emission factor equals 0.44 tCO_2MWh

4.4.3.2.2 Urban transport measures

Table 26: Urban transit measures

Name	Urban transport measures
Action Type	Promote better urban transit through BRT, fleet renewal and inspections.
Sector	Transport
Implementors	• Ministry of Transport • Greater Accra Passenger Transport Executive (GAPTE) • Private Vehicle Test Stations (PVTS) • Private businesses
Gas	CO_2,CH_4,N_2o
Period	2016 - to-date (on-going)
Objectives	• Promote road-based mass transportation system, including extending BRT corridors. • Introduce high occupancy buses and a better vehicle inspection regime.
Description	The goal of this action is to provide high occupancy mass transit buses which will alleviate the acute transportation difficulties facing Ghanaian workers and school children in the metropolis, municipalities, and districts in Accra/Tema Metropolitan area and Kumasi Metropolitan Area; provide safe and reliable public transportation to Ghanaians in the metropolis and municipalities and reduce the rate of avoidable accidents, and promote a shift to an environmentally safe mode of transport and clean technology.
Steps taken or envisaged to achieve the action.	• 200 buses provided for the MMT and STC coaches. • 445 buses were supplied between 2016 and 2020 (Accra services commenced in 2016 with 145 buses; Kumasi services commenced in 2018 with 60 buses; Takoradi services commenced in 2020 with 20 buses). • 3 BRT terminals were completed at Adentan and Tudu in Accra; 3 standard BRT terminals were completed at Amasaman, Pokuase, Achimota and one bus depot at Achimota. • 1km dedicated BRT lane created and gazette. • Quality Bus Services coordinating bodies/ Operator companies operational in Accra, Kumasi and Takoradi.
Results Achieved	• Develop a regulatory framework for urban transport. • Equipped transport departments in 3 District Assemblies to operate bus lanes and developed lanes, terminals, depots, and buses. • 3 operating companies were established to run a pilot programme of 60 buses at Amasaman and KMA. • 200 buses are provided for the MMT and STC coaches. • 445 buses were supplied between 2016 and 2020 (Accra services commenced in 2016 with a total of 145 buses).
Potential Impacts	**GHG Impacts** • 0.02 $MtCO_2e$/yr.
Progress indicators	• Length BRT route (km) • Number of high occupancy buses introduced (No)
Methodology/ Assumption	**Methodology** - The methodology is based on approved ACM0016 ver. 2 - Baseline Methodology for Mass Rapid Transit Projects **Assumption**: New buses displace inefficient single-model cars. The vehicle technology standard is Euro 3; the average fuel consumption baseline is 20 litres per km.

4.4.3.3 Forestry sector mitigation measures

The National Forest and Wildlife policy includes the forest sector's GHG mitigation strategy and aims to conserve and sustain forest and wildlife resources. The policy is operationalised through the Forest Plantation Development Strategy (FPDS), REDD+ Strategy (RS) and the Forest Development Masterplan. Generally, the FPD seeks to increase forest cover and restore degraded lands, whereas the REDD+ strategy addresses the key drivers of deforestation and forest degradation in cocoa, shea, and mangrove landscapes. Some of the specific collaborative initiatives underway nationwide include:

- Ghana Forest Investment Programme (GFIP)[10]
- Ghana Cocoa Forest REDD+ Programme (GCFRP)[11]
- Ghana Shea Landscape Emission Reduction Project[12]
- Dedicated Grant Mechanism (DGM)[13]
- Cocoa Forest Initiative (CFI)[14]
- Green Ghana initiative

Ghana submitted its second National Forest Reference Level (FREL) in 2021. After the submission, the UNFCCC secretariat undertook a Technical Assessment (TA) on the FREL. In this BUR4, Ghana has presented information on mitigation action related to Forest Plantation Development and REDD+ (Table 27 Table 28 and Table 29).

[10] http://mlnr.gov.gh/index.php/programs-projects/ghana-forest-investment-program-fip/
[11] http://www.ghanaredddatahub.org/ecozone/details/1/
[12] https://www.greenclimate.fund/project/fp137
[13] https://www.dgmglobal.org/ghana
[14] https://www.worldcocoafoundation.org/initiative/cocoa-forests-initiative/

Landscape restoration and REDD+

- **Forest Plantation Development**
- **Ghana Cocoa Forest REDD+ Programme.**
- **Ghana Shea Landscape Emission Reduction Project.**

4.4.3.3.1 Forest Restoration

Table 27: Forest Plantation Development

Name	Ghana Forest Plantation Programme (GFPS)
Type of action	Restoration of degraded forest lands
Sector	Forestry
Implementing entities	Forestry Commission and Private Companies
GHG	CO_2
Objectives	Develop a sustainable timber resource base that will satisfy the future demand for industrial timber and enhance environmental quality, thereby relieving the pressure on the natural forest and increasing forest cover.
Description	The GFPS is a public-private initiative targeting the restoration of degraded landscapes and covers forest landscape restoration activities involving (a) forest plantation development and (b) enrichment planting and trees on farms (farm forest). The establishment and management of planted forests are implemented through the following models: • Modified Taungya system (MTS) • Community Forest Management Project (CFMP) • Government Plantation Development Programme (GPDP) • Private developers on-reserve • FSD Plantation • Forest investment programme • Expanded plantation programme. • FC/Industry plantations • Large-scale off-reserve plantations. GFPS has the following quantitative target: • Establish and manage 625,000 ha of forest plantations. • Enrichment planting of 100,000 ha of poorly stocked and degraded forest reserve compartments. • Facilitate tree incorporation within farming systems (trees-on-farm), covering 3.75 million (ha) agricultural landscapes.
Period	2019 to date (on-going)
Steps taken or envisaged to achieve the action	• Signed land lease and benefit sharing agreements for commercial plantations and community groups. • Establishment of seed orchards to provide quality seeds. • Seed supplied to selected fringe communities and farmers. • The launched Greening Ghana Initiative in 2021 to continue. • Provision of incentives for private sector investments.
Results Achieved	• Plantation – restored 91,564.5 ha between 2017 and 2021. • Enrichment planting – Planted 22,037.7 ha over the period 2017-2021. • Tree on farm – 17,110,958 planted on farmland translating into an estimated area of 520,108.3 ha over 2017-2021.

Impacts	**GHG impacts (2.33 $MtCO_2e$/year)** • Tree plantation – 0.34 $MtCO_2e$/year • Enrichment planting – 0.081 $MtCO_2e$/year • Tree-on-farm – 1.91 $MtCO_2e$/year **Non-GHG impacts** • 633,709.8 ha plantation established under GFPS for the 2017-2021. • Between 2017 and 2021, 167,016.8 metric tonnes of food were produced. For the period 2017-2019, GFPS created 296,084 direct jobs. • Plantation timber export for 2017-2021 amount 675,527.2 m^3 • Invested ~ US$ 114 million in Forest Plantation Development between 2017 and 2021
Progress indicators	• Annual area planted (Ha) • Jobs created (No), • Amount of food produced (Mt) • Volume of plantation wood harvested (M^3)
Methodology/ Assumption	• Methodology as based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4 Agriculture, Forestry and Other Land Use. • The assumption in the methodological calculation included the following: ▪ 25-year rotation cycle after first year planting ▪ Annual increment in biomass is unchanged in the 25-year rotation cycle. ▪ The annual biomass increment depends on the degree of permanence determined by the risk posed by pests, fire and intermittent unplanned harvesting. ▪ Biomass stock before plantation (8.7 tonnes dm/ha) and biomass stocks after plantation (92.2 tonnes dm/ha)

4.4.3.3.2 REDD+

Table 28: Cocoa Forest REDD+

Name	Ghana Cocoa Forest REDD+ Programme (GCFRP)
Action type	Result-based REDD+
Sector	Forestry
Implementing entities	Forestry Commission (FC) and Ghana Cocoa Board (COCOBOD)
GHG	CO_2
Objectives	Significantly reduce carbon emissions from cocoa expansion through forest conversion by promoting appropriate climate-smart cocoa production approaches, including intensification and yield enhancement.
Description	The GCFRP is a government flagship initiative promoting sustainable and climate-smart cocoa production. Under the World Bank's Forest Carbon Facility Programme, it seeks to generate 10 million tonnes of carbon emission reduction in six years. The GCFRP has six pillars around which the interventions and activities are being implemented as follows: • Forest Reserve Restoration and Rehabilitation • Strengthen institutional coordination and MRV. • Facilitate landscape planning within Hotpot Intervention Areas • Ensure the implementation of Climate Smart Cocoa • Ensure reduction of Risk and management of Finance • Advocate for Legislative and Policy Reform
Period	2019-2024 (ongoing)
Steps taken or envisaged to achieve the action.	Meeting of three conditions precedent for the emission reduction payment agreement with the World Bank as follows: • Benefit-sharing plan finalised and approved by the World Bank. • Sign a framework agreement with at least 1 Hotspot Intervention Area. • Transfer of title to carbon emission reduction. Additionally, • Hotspot intervention consortium formed. All governance structures within 4 out of the 6 HIA_S are in place. • Developed safeguard action plans for the various sub-projects. • Received upfront advance payment of US$ 1.3 million. • Developed a benefit-sharing framework. • Draft manual developed for tree and farmer registration. • 2019-2020 Land use/Landcover map developed. • Preparing first GCFRP's performance monitoring report
Results Achieved	• The signing of the Emission Reduction Payment Agreement • Developed and finalised Benefit Sharing Plan • Received upfront advance payment. • Completed the declaration of emission reduction transfer title. • Governance Structures developed for 4 of the 6 HIAs. • Ghana received payments of about 4.8 million US dollars for achieving 972,456 tons of carbon reductions.

Potential Impacts	**GHG potential and actual Impacts** • 2.25 Mt/year translating into 10 Mt for 2019-2024 of reduction potential. • Achieved 0.97 Mt of carbon reductions for 2019. **Non-GHG potential impacts** • 20,000 Ha trees on the farm annually. • 700 ha enrichment planting annually. • 1,000 ha Modified Taungya Agroforestry System annually. • 4,000 ha Avoided deforestation. • 6,000 ha Avoided degradation. • Double the incomes of 126,000 farmers from $6.52/ha to $13.04ha • Invested US$ 234 Million to support climate-smart cocoa production
Progress indicators	• Avoided deforestation area (ha) • Fam yield (kg/ha) • Income levels of farmers ($)
Methodology/ Assumption	**Methodology** The methodology is based on the Methods and Guidance Document (MDG) developed by the Global Forest Observation Initiative (GFOI) as the FCPF methodological framework. **Assumption** • The methodological calculation assumes a conservative estimate of successfully reducing the rate of deforestation over the programme's lifetime, less a 15% risk buffer. • Not all emissions reductions are transferable to the Biocarbon Fund. The Forest Carbon Facility Programme will retain 95% of verified emission reductions. • Mitigation action is part of Ghana’s unconditional NDC measures.

Table 29: Shea Landscape REDD+

Name	Ghana Shea Landscape Emission Reduction project
Action Type	Climate finance for avoided deforestation
Sector	Forestry
Implementing entities	Forestry Commission (FC) – Executing entity. United Nations Development Programme - Accredited entity Global Shea Alliance – Responsible partner
GHG	CO_2
Objectives	Implement landscape measures to reduce/remove greenhouse emissions in the shea landscape of the Northern Savannah Zone. Funding comes from the Green Climate Fund and other streams of funds from the private sector and the government of Ghana. The aim is to mitigate GHG emissions of 6.1 $MtCO_2e$ over seven of the projects and further to 25.2$MtCO_2e$ in a 20-year timeframe through reduced emissions and enhanced removals from productive, sustainable management of savannah forests, shea parklands and forest plantations.
Description	The GSLERP is Ghana's leading effort to stem the increasing threats of deforestation and desertification targeting the Northern Savannah Zone (NSZ). It has 4 components implemented through a cross-sectoral, comprehensive, and comprehensive approach driven by communities and women's groups. It will serve as the basis for long-term community resource management, sectoral investments, capacity building, training, knowledge sharing, community monitoring and public-private partnerships at the landscape level. The expected results will come from the following: • Restore 200,000ha of off-reserve savannah forests/woodlands and place them under self-financing CREMA. • Restore 100,000 hectares of degraded shea parklands. • Establish 25,500 hectares of modified Taungya system/forest plantation in severely degraded forest reserves. • Implement an integrated monitoring system and strengthen the national REDD+ safeguards and forest monitoring and reporting systems.
Period	2021 – 2028 (on-going)
Steps taken or envisaged to achieve the action.	• The Green Climate Fund approved the Ghana Shea landscape emission reduction project in August 2020. • Project implementation planning. • Conducted assessment of project interventions' economic and financial sustainability, including the viability of the Community Resource Management Area (CREMA)and the Modified Taungya System models in the long term. • Public-private partnerships have begun with 15 entities to restore the shea parklands in the project coverage areas in the Northern Savannah Zone, and restoration activities have begun in degraded portions of some 26 different forest reserves. • Carried out Environmental and Social Impact Assessment (ESIA).
Results Achieved	• GCF Board fund approved the Ghana Shea landscape emission reduction project in 2020.

	• Received Notice of Effectiveness from the GCF on 10 May 2021. • Received ($7.2 million) the first two disbursements, $2.3 million and $4.9 million, in August 2021 and December 2022, respectively. • 15 Partnerships have been established amongst Global Shea Alliance members, Forest Sector-Based Non-Governmental Agencies, and Women's groups, leading to establishing 16 nurseries. • Developed communication and extension manual to sensitise communities on the impact of deforestation and the content been disseminated through radio programs in English and in the local languages such as Dagbani, Waala and Gruni. • 1,268,725 seedlings covering 1,427.99ha were planted in 26 forest reserves across the five regions. • 1,057 MTS farmers were engaged from 50 forest fringe communities. Tree species planted in the degraded forest reserves are teak, mahogany, acacia, etc., together with food crops, including cereals, tubers, and vegetables, as per the first steps of setting up the modified Taungya system.
Potential Impacts	**GHG potential impacts** • 6.135 million tonnes in emission reductions and removals over the first seven years of the project's lifetime. • 25.24 million tonnes over 20 years **Non-GHG impacts** • The restoration of the 1,427 hectares of degraded forest reserves through the modified Taungya system approach would improve the ecosystem resilience of • 158 women have been employed in the nurseries set up by the Project to help improve their livelihoods and acquire the technical expertise in nursery management practices to ensure the sustainability of the nurseries after project completion. • 1,057 MTS farmers (881 men and 176 females) from 50 forest fringe communities [were engaged in establishing the MTS plantation.
Progress indicators	• Area planted (Ha) • Deforestation rate (%) • People whose livelihoods are supported (No). • Males and females benefiting from the adoption of diversified, climate-resilient livelihood options (including fisheries, agriculture, tourism (No) • Tonnes of carbon dioxide equivalent reduced or avoided from sustainable management of forests and conservation and enhancement of forest carbon stock (tCO_2e).
Methodology/ Assumption	The methodology is based on the 2006 IPCC Guidelines Vol. 4 AFOLU Sector. The assumption is that since the project is at an early stage, the calculation of actual emission reduction will be done in the mid-term of 2024.

4.4.3.4 Waste Sector Mitigation Measures

Major cities in Ghana (mainly Accra, Tema, Kumasi, Tamale, Takoradi, Cape Coast, etc.) are experiencing rising urbanisation rates and attendant environmental challenges. New sprawling suburbs without access to roads, social infrastructure, or waste collection services worsen the situation. Waste management is a major part of the high-ticket budget lines of large cities. The environmental sanitation policy allows private sector participation in waste management to increase waste collection, transportation, and disposal effectiveness.

Adopting public-private partnerships (PPP) in waste management has enabled environmental services providers to increase the waste collection and disposal rates to 85%. Through various PPP models, the private sector[15] is expanding compost capacity and venturing into the waste to the energy and recycling market. There are PPP models in composting, recycling and landfilling.

The government has introduced a sanitation and pollution levy to help address sanitation financing in the country. An engineered sanitary landfill and material recovery facility is also being constructed in Accra. Furthermore, the Government is establishing a Circular Economy Framework (CEF-PS) for the plastics sector. Under this initiative, 12 SMEs in the plastics value chain have been selected to receive financial and technical support to produce biodegradable plastics from alternative feedstock and design packaging materials from non-fossil sources such as cassava-based biodegradable and other water-soluble fibre.

The Ministry of Sanitation and Water Resources, together with the private sector, commissioned five Integrated Recycling Compost Plants and one Wastewater Treatment Plant in Dambai, Goaso, Sefwi Wiawso, Damongo, James Town and Kumasi as part of the Government's efforts to ensure efficiency in the collection, transportation, and processing of solid waste into useful raw materials. The plants will process plastics, metals, paper, and organic compost. 4.4.3.4.1 Composting

Table *30* presents the overview of compost as a mitigation action in Ghana.

[15] https://espaghana.com/

Alternative waste management

- **Municipal solid waste to compost.**

4.4.3.4.1 Composting

Table 30: Compost as a biological treatment system of municipal solid waste

Name	Compost and recycling plant (technology and enabled by fiscal instrument)
Action type	Avoided methane emissions through composting of Municipal Solid Waste (technology)
Sector	Waste
Implementors	Ministry of Sanitation and Water Resources District Assemblies Jospong Group of Companies Ministry of Environment, Science, Technology and Innovation, Environmental Protection Agency
GHG	CH_4
Objectives	• Install compost recycling plants in all 16 regions of the country with various capacities depending on the MSW generated in the region (capacities various from 1,200 tonnes to 300 tonnes). • Divert the 40- 60% organic component/ stream of MSW from the landfill sites to the various compost plants. • Produce and encourage the use of pure organic compost fertiliser for agricultural use.
Description	The mitigation action is a joint effort between the District Assemblies and private businesses. The businesses have established compost facilities that receive municipal solid waste from the waste operators at an agreed tipping fee. The compost produced is sold as fertiliser mainly in the agricultural business. Ministry of Sanitation and Water Resources provides policy incentives to drive compost market development. Drive down the operating cost of compost plants by streamlining the tipping fee regime, promoting sorting at source and promoting local manufacture of compost machinery.
Period	2013 to date (ongoing)
Steps taken or envisaged to achieve the action	• Introduced Sanitation and Pollution Levy. • Three compost plants have been built in Accra and Kumasi. ▪ Accra Composting and Recycling plant Design capacity: 1200 tonnes per day of municipal solid waste. Cost: $ 20 million Start of Operations: 2012 ▪ Integrated Recycling and Compost Plant Limited (IRECoP) Expansion and retrofitting: $75 million Design Capacity: 400 tonnes of Municipal solid waste per day. Cost: $20 million Start of operations: 2019 ▪ Kumasi Compost and Recycling Plant (KCARP) Capacity: 2400 tonnes per day of municipal solid waste per day Cost: $ 40 million Start of operations: 2020

	There are plans to have one of such facilities in the rest of the regions beginning in 2022. The capacity will depend on the waste availability and may range from about 200-400 tons per day, depending on the area. Six compost facilities were established in the Volta, Bono, Savannah and Ahafo regions of Ghana, capable of processing over 2,600 metric tons of municipal solid waste daily.
Results Achieved	• Introduced a sanitation levy to address sanitation challenges in Ghana. • Established three compost recycling plants with a total capacity of 4,000 tonnes of MSW daily. • Produce 6,600 tonnes of compost every month from the three sites. • Additional six IRECOP sites with a processing capacity of 2,600 tonnes per day of municipal solid waste per day were established. • Ghana's total installed compost processing capacity amounts to 6,400 tonnes per day in nine sites.
Potential Impacts	**GHG Impacts** • 3.7 $MtCO_2e$/year **Non-GHG Impacts** • Produce 79,200 tonnes of compost per year for agricultural use. • Created some 800 direct and 1,500 indirect jobs. • Promotes high crop yields. • Invested over US$ 250 million in nine compost facilities
Progress indicators	• Quantity of MSW processed in compost facilities (Mt/day) • Compost installation capacity (Mt/day) • Quantity of compost produced (tonnes) • Number of jobs created (No)
Methodology/ Assumption	The methodology is based on approved CDM methodology AM0025 ver. 12 - Avoided emissions from organic waste through alternative waste treatment processes. The assumptions in the methodological calculation include. • All compost plants operate at full capacity. • All organic components of MSW collected are composted. • About 1.1 $MtCO_2e$ of emission reductions will be authorised for international transfer under Article 6.2 cooperation with Switzerland. • Compost plant life is 15 years. • Tonnage of municipal waste processed per day: 1142 tonnes. • Compost recoverable from municipal waste is 60%. • Other recoverable (plastics and metals) of total municipal waste to be processed at compost plant is 40%. • IPCC default CH_4 and N_2O emission factors.

4.4.3.5 HFC management in the AC sub-sector

Ghana's national ODS phase-out programme and Management of ODS and product regulation, 2005 (LI. 1812) (Government of Ghana 2005a) as part of its obligations under the Montreal Protocol on substances that deplete the ozone layer to completely phase out HCFCs by 2030. After ratifying the Kigali Amendment in August 2019, Ghana focused on phasing out HFCs by introducing an alternative technology.

In terms of institutional arrangement, EPA's National Ozone Unit Carries out GHG inventories for the RAC Sector while the Energy Commission (EC) operate a mandatory appliance standards and labelling regime designed to ensure that only appliances that meet MEPS enter the market.

Act 917 (which is implemented by the LI 2250 (Government of Ghana 2016) includes extended producer responsibility (for instance, the levy on appliances to be used for their proper dismantling and disposal of equipment). The Act includes both ACs and domestic refrigerators. The EPA hosts the National Ozone Unit (NOU) and implements the HFC Phase-out Management Plan (HPMP).

Under the HPMP, the EPA started training technicians from well-established air-conditioning installation workshops to convert existing R22 based air-conditioning units to run on Hydrocarbon R290. In 2019, the EPA hosted a week-long sub-regional training workshop for national ozone officers from the Western, Eastern, Northern and Southern regions of the Africa Anglophone Network in Accra. In 2021, the NOU led the preparation of a Ghana National Cooling Plan (NCP) as the framework for promoting green and energy-efficient cooling.

4.4.3.5.1 Green and energy-efficient cooling

Table 31 elaborates on the green cooling mitigation measures in the AC and Refrigeration.

HFC Management

- **Municipal solid waste to compost.**

4.4.3.5.1 Green and energy-efficient cooling

Table 31: Mitigation actions in the AC/Refrigeration

Name	Green and energy-efficient cooling in ACs and refrigeration
Action type	Green cooling in ACs (technology)
Sector	IPPU
Implementors	Ministry of Environment, Science, Technology, and Innovation Ministry of Finance Environmental Protection Agency Energy Commission Private sector Academia
GHG	HFCs
Period	2016 to date (on-going)
Objectives	• Shift Ghana's AC sector towards low carbon cooling by paving the way for green split ACs featuring high energy efficiency and low GHG emitting refrigerants.
Description	**Component 1: Domestic Fridges** • ECOFRIDGE initiative, which is a U4E initiative supported by K-CEP to use innovative financial mechanisms to facilitate the replacement of outdated refrigerators. The financing mechanism will make cost financing more affordable for households to replace old and inefficient split ACs and Refrigerators with energy-efficient ones and use low-GWP refrigerants. The fund allocated for the ECOFRIDGE project is 13 million dollars. **Component 2: ACs** **Kigali First Movers Initiative (Air Conditioning Rebate Scheme)** • Kigali First Movers Initiative seeks to provide a financing mechanism effectively and sustainably in the cooling sector to support the initiative countries in achieving mitigation efforts that also contribute to their National Determined Contribution. The initiative targets pushing low-GWP and energy-efficient split non-ducted units to the Ghanaian Market. The fund allocated for the KFM project is USD 6 million dollars. **Market Transformation through the introduction of green split AC** • Shift Ghana's AC sector towards low carbon cooling by paving the way for green split Acs featuring high energy efficiency and using low GHG emitting refrigerants. • It has three sub-components, including (a) financial incentives for green split ACs, (b) upscaling of RAC technicians' skills development and (c) support for end-of-life treatment. **Component 3: Outreach and communications and end-users** • Prepare industry, retailers, and services for compliance (MEPs, labelling, EE targets, etc.) and develop campaigns to educate the public on the labels.
Period	2016 to date (on-going)

Steps taken or envisaged to achieve the action.	• Ghana ratified the Kigali Amendment. • Implementing the HFC Phase-out Management Plan (HPMP). • Training technicians from air-conditioning installation workshops. • Adopted the national green cooling plan. • Developing Article 6 ITMOs programme for green split AC projects.
Results Achieved	• The private sector established end-of-life treatment facilities to recover high-GWP refrigerants in AC and refrigeration. • More than 300 AC and refrigeration artisans trained in recovering high-GWP refrigerants in AC and refrigeration. • Established a financial mechanism in the local banks to support financing upfront finance of AC.
Potential Impacts	**GHG Impacts** • 0.34 $MtCO_2e$/year
Progress indicators	• Number of AC or Refrigeration models in a year. • Number of AC or Refrigeration models installed in a year. • Quantity of refrigerant destroyed in a year.
Methodology/ Assumption	• The methodology is based on the approved standard VM0016 Recovery and Destruction of Ozone-Depleting Substances and CDM Tool 29: Determination of standardised baselines for energy-efficient refrigerators and air conditioners. • The following assumptions have been made: ▪ Grid emission factor is 0.40 kg CO_2/kWh. ▪ The physical leakage rate of refrigerant is estimated at 5%. ▪ The factor to account for annual autonomous efficiency improvement is set at 2%. ▪ The operating hours of ACs are estimated at 2000 per year. ▪ Leak rate of ODS refrigerant for existing equipment or remain in storage.

Agriculture mitigation actions

- **Sustainable rice cultivation in Ghana**

4.4.3.6 Agriculture sector mitigation measures

In Ghana, Agriculture GHG emissions come from crop production, animal husbandry and soil management. Methane emissions from rice cultivation are among the KCA list for 2021 and, thus, qualify as one of the priority areas for mitigation efforts. However, Rice is an important food crop for Ghana with current production deficits. The Government policy is to increase rice production to reduce the costs of imports.

The adoption of climate-smart agricultural practices, including the System of Rice Intensification (SRI), of which AWD is a core component, has been promoted by the Ghana CSIR-Crops Research Institute (CCSIR-CRI), which has the Government mandate to deliver sustainable water and nutrient management for rice, as a water savings technology.Table *32* presents the summary of the effort to promote alternate wetting and drying in irrigated rice fields in Ghana.

4.4.3.6.1 Sustainable rice cultivation in Ghana

Table 32: Promotion of alternate wetting and drying in rice cultivation.

Name	Promotion of climate-smart agriculture practices for sustainable rice cultivation in Ghana
Action type	Alternate Wetting and Drying (AWD) in Rice Cultivation
Sector	Agriculture
Implementors	United Nations Development Programme Ministry of Environment, Science, Technology, and Innovation Ministry of Food and Agriculture Ghana Irrigation Development Authority Environmental Protection Agency Commercial rice farmers Smallholder farmers
GHG	CH_4
Objectives	Promotes the adoption of climate-smart agriculture, of which Alternate Wetting and Drying (AWD) for rice cultivation is a core component.
Description	will target up to 20,500 ha per cropping season and 242,600 ha of irrigated rice fields over 8.25 years and 2 cropping seasons per year, approximately 78 per cent of the irrigated rice fields across the country. Farmers are expected to commonly practice AWD replacing continuous flooding, leading to a reduced carbon footprint in rice production. The results can be replicated across Ghana through strong and reinforced policy support. The action targets technical training for farmers. Ghana's rice farmers are used to flooding their rice fields throughout the cropping season. This practice leads to significant methane emissions. Through the AWD application, rice farmers reduce methane emissions and improve water use efficiency without reducing rice yields. AWD has been identified as an effective climate smart mitigation measure that reduces inefficient water management in irrigated rice ecosystems as directly associated co-benefits.
Steps taken or envisaged to achieve the action.	• Onboarding of rice farmers is ongoing country wide. • Training on AWD and monitoring protocols. • Development of training manual completed. • Online dashboard developed to serve as a database for project monitoring.

	• Adoption and monitoring of AWD is ongoing. • First third-party verification planned for 2024.
Results Achieved	• Mitigation action authorised by Ghana and Switzerland to transfer the resultant mitigation outcomes. • Initial report to UNFCCC published in September 2023. • About 8,200 ha onboarded across Upper East, Central, Western, Volta (Aveyime, Adidome, Weta), Greater Accra, Ashanti region.
Potential Impacts	**GHG Impacts** • 0.14 $MtCO_2e$/year (Emission Reduction Potential) **Non-GHG Impacts** • At least 100 farmers received training inclusive training continuously during programme implementation. • Minimum participation of at least 30 female farmers in the trainings. • Programme area of 8,000 ha in each cropping season because the water consumption for rice cultivation will be reduced to less irrigation events.
Progress indicators	• Total area planted (in ha) • Sowing or transplanting (date) • Fertilizer, organic amendments, rice straw management and crop protection application (date, quantity, and active ingredients). • Water regime on the field and in the rootzone (e.g., "dry/moist/flooded") and dates where the water regime is changed from one status to another through the use of an observation well. • Total number of irrigation events
Methodology/ Assumption	**Methodology** • The methodology is based on CDM methodology AMS-III.AU "Methane emission reduction by adjusted water management practice in rice cultivation. **Assumptions** • Baseline emission factor of 1.19 kg CH_4/ha/day (IPCC 2019/refinement value. • The rice farms are characterised by irrigated, flooded fields for an extended period during the cropping season. • Water regime on-season is dynamic type. • The number of cropping seasons is 2. • Number of cropping seasons

International market mechanisms

4.5 Information on International Market Mechanism

The international carbon market is integral to Ghana's greenhouse gas mitigation policy package. Ghana has been active in the CDM and voluntary carbon market space in the past. Recently, the country's updated NDC has identified participation in Article 6 cooperation as a strategy to mobilise carbon finance to increase the ambition of mitigation and adaptation actions.

4.5.1 CDM Projects and POAs

Ghana has onboarded 8 CDM projects in the UNFCCC pipeline (Table 33). The project scope includes crop cultivation, gas recovery, energy efficiency in thermal power, landfill gas management, and composting. Out of the 8 projects, the validation of 4 of them was terminated and did not proceed to the registration stage. The rest of the 4 projects on composting, oil field flaring reduction, single cycle to combined cycle plant and landfill gas flaring were approved and registered by the CDM Executive Board (EB). The four CDM projects are expected to generate 3.0 $MtCO_2e$ per year in the first crediting period.

Table 33: List of CDM projects in Ghana

Project Name	Category	Status	Crediting starts	CERs ($MtCO_2e$/yr) (1^{st} period)	Crediting period
Zoomlion Ghana Ltd Composting of Municipal Solid Waste in the Accra area	Composting	Registered	March 2012	0.069	
Jubilee Oil Field Associated Gas Recovery & Utilisation Project	Oil field flaring reduction	Registered	December, 2014	2.6	10
Project Asona - CCGT – Takoradi - Ghana	Single cycle to combined cycle	Registered	May, 2015	0.37	10
Oblogo 1 Landfill Gas Recovery and Flaring Project	Landfill flaring	Registered	June 2017	0.007	10
Large scale oilseed crop cultivation at Yeji in the Pru district, Ghana	Reforestation	Validation terminated	January 2009	2.0	20
Salt pond Oil Field Associated Gas Recovery and Utilisation Project	Oil field flaring reduction	Validation terminated	January 2014	0.084	10
Kpone Thermal Power Project of Volta River Authority, Ghana	New natural gas plant	Validation terminated	January 2014	0.39	10
Oblogo 1 Landfill Gas Recovery and Flaring Project	Landfill flaring	Replaced validation terminated	January 2014	0.022	10

Regarding the CDM Programme of Activities (POAs), Ghana is involved in 35 components of project activities (CPAs) as a host country into four POAs covering clean cooking, waste management, renewable energy, and water purification. The 4 POAs project to generate a total of 1.82 $MtCO_2e$ per year in the first crediting period. A total of 0.41 MtCERs have been issued to the 4 POAs, of which 0.051 MtCERs have been voluntarily cancelled.

Table 34: List of CPAs of CDM POAs hosted in Ghana.

CPA Title	Reductions/ year	End of the last PoA period	PoA Status
African Improved Cooking Stoves Programme of Activities -CPA No. 00001 (Ghana)	15477	05-Dec-19	Registered
African Improved Cooking Stoves Programme of Activities -CPA No. 00002 (Ghana)	47008	05-Dec-19	Registered
African Improved Cooking Stoves Programme of Activities CPA 00003 (Ghana)	47008	05-Dec-19	Registered
African Improved Cooking Stoves Programme of Activities CPA -00007 (Ghana) supported by Republic of Korea	46594	05-Dec-19	Registered
African Improved Cooking Stoves Programme of Activities CPA - 00008 (Ghana) supported by Republic of Korea	46594	05-Dec-19	Registered
African Improved Cooking Stoves Programme of Activities CPA - 00009 (Ghana) supported by Republic of Korea	46594	05-Dec-19	Registered
CPA-GA-001 GHANA	111401	29-Nov-26	Registered
Standard Bank Renewable Energy Programme - Navrongo solar CPA001	1074	01-Oct-19	Registered
CPA001 Kumasi Composting Plant at Adagya	27889	20-Dec-19	Registered
CookClean Ghana Limited - CPA01	136734	29-Nov-26	Registered
CookClean Ghana Limited - CPA02	145451	29-Nov-26	Registered
CPA-1: Oti Landfill gas capture, flaring and utilization at Kumasi (Ghana)	103249	15-May-21	Registered
20MW Ningo PV Power Generation Project in Ghana	20226	13-Nov-23	Registered
Man and Man Enterprise Improved Cooking Stoves CDM Programme in Ghana supported by the Republic of Korea	308860	30-May-25	Registered
Man and Man Enterprise Improved Cooking Stoves CDM Programme in Ghana supported by Republic of Korea - CPA002	155629	30-May-25	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 001	75795	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 002	67440	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 003	68134	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 004	70817	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 005	75797	31-May-27	Registered

Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 006	71558	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 007	70865	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 008	59167	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 009	68825	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 010	68835	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 011	68819	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 012	78966	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 013	88417	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 014	86541	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 015	79620	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 016	39096	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 017	14660	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 018	36653	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 019	23213	31-May-27	Registered
Ghana Improved Cookstove Project by EWP in Republic of Korea - CPA 020	8551	31-May-27	Registered

4.5.2 Voluntary carbon market projects

Ghana is also engaged in the voluntary carbon market (VCM) as a strategy to complement the interventions on the CDM market to reduce greenhouse gas emissions and contribute to sustainable development. In total, 29 mitigation projects have been onboarded on Gold Standard and VCS-Verra carbon standards. Of the 29 projects, 16 were onboarded on Gold Standard, and the remaining 13 are on VCS-Verra (Table 35).

On the Gold standard, 10 are certified (design and project), and the remaining 6 are listed category. The Gold standard certified project scope includes 6 improved cooking stoves, 3 water purification programmes and 1 jatropha plantation. Between 2007 and 2021, 8.7 Mt offset credits (each representing one metric tonne of CO_2-equivalent reduced or removed from the atmosphere) were issued to the 10 certified projects. The breakdown of the offset credit issuance is cookstove (8.6 Mt offset credits), clean water (0.092 Mt offset credits) and Afforestation/Reforestation (0.019 Mt offset credits). As of 2021, about 5.1 Mt offset credits were retired leaving the remaining 3.5 Mt offset credits.

The six listed projects on gold standard are as follows: GS936 CookClean Ghana Limited - CPA01; PowerUP Smart Electric Stoves for Clean Air-Ghana-VPA6; GS10789 VPA71: Efficient and Clean Cooking for households in Ghana; Improved Cookstoves and Sustainable Fuel Dissemination Program in Ghana; GS10789 VPA76 Efficient and Clean

Cooking for households in Ghana and GS1385 Man and Man Enterprise Improved Cooking Stoves Programme in Ghana - VPA004 (Central region).

Thirteen projects are onboarded on the VCS-Verra, including 6 afforestation/reforestation projects, 6 cookstoves projects and 1 ozone depleting substances recovery and destruction project. Of the 13 projects, 1 is under development, 1 is under validation, 4 have submitted registration requests to VCS-Verra, 4 have been registered on VCS-Verra, 2 have submitted registration and verification approval requested to VCS-Verra and 1 fall in the “units transferred from approved GHG program”. From 2012 to 2021 vintage years, a total of 1.2 Mt offset credits were issued from which 0.24 1.2 Mt offset credits were retired over the same period. The issuances of the 2021 vintage were the highest, with 0.41 Mt offset credits.

Table 35: List of VCM projects and the status of implementation hosted in Ghana.

Project ID	Project Name	Voluntary Registry	Voluntary Status	Project scope	Methodology	Developer	Total credit issued. (2007-2022)
GS1000	GS936 CookClean Ghana Limited - CPA01	GOLD	Listed	Cookstoves	AMS-II.G. Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass	ClimateCare Limited	0
GS11154	JOil Jatropha plantation in Ghana	GOLD	Gold Standard Certified Project	Afforestation/ Reforestation	Afforestation/Reforestation GHG Emissions Reduction & Sequestration Methodology	JOIL (S) Pte. Ltd.	18,752
GS11564	GS1385 Man and Man Enterprise Improved Cooking Stoves Programme in Ghana - VPA002	GOLD	Gold Standard Certified Design	Cookstoves	AMS-II.G. Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass	Man and Man Enterprise	0
GS11584	PowerUP Smart Electric Stoves for Clean Air-Ghana-VPA6	GOLD	Listed	Cookstoves	Methodology for Metered & Measured Energy Cooking Devices	TEECO UGANDA SMC LTD	0
GS11624	GS1385 Man and Man Enterprise Improved Cooking Stoves Programme in Ghana - VPA003	GOLD	Gold Standard Certified Design	Cookstoves	AMS-II.G. Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass	Man and Man Enterprise	0
GS11672	GS10789 VPA71: Efficient and Clean Cooking for households in Ghana	GOLD	Listed	Cookstoves	GS TPDDTEC v3.1	Burn Manufacturing Co.	0
GS11724	Improved Cookstoves and Sustainable Fuel Dissemination Program in Ghana	GOLD	Listed	Cookstoves	GS TPDDTEC V4.0: Reduced Emissions from Cooking And Heating Technologies And Practices To Displace Decentralized Thermal Energy Consumption	Cook Clean Ghana Limited	0

GS11739	GS10789 VPA76 Efficient and Clean Cooking for households in Ghana	GOLD	Listed	Cookstoves	GS TPDDTEC v3.1	Burn Manufacturing Co.	0
GS12233	GS1385 Man and Man Enterprise Improved Cooking Stoves Programme in Ghana - VPA004 (Central region)	GOLD	Listed	Cookstoves	AMS-II.G. Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass	Man and Man Enterprise	0
GS1264	Native Energy Hydraid BioSand Water Filter Programme West Africa	GOLD	Gold Standard Certified Design	Clean Water	GS TPDDTEC v 1.	Native A Public Benefit Corporation	0
GS1294	GS1264: NativeEnergy Clean Water Programme West Africa: VPA(01) Ghana	GOLD	Gold Standard Certified Project	Clean Water	Not provided	Native A Public Benefit Corporation	74,103
GS2094	GS1385 Man and Man Enterprise Improved Cooking Stoves Programme in Ghana - VPA001	GOLD	Gold Standard Certified Project	Cookstoves	AMS-II.G. Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass	Man and Man Enterprise	1,932,086
GS407	Gyapa Cook Stoves Project in Ghana	GOLD	Gold Standard Certified Project	Cookstoves	GS TPDDTEC v 2.	Relief International	5,156,577
GS413	*Improved Household Charcoal Stoves in Ghana	GOLD	Gold Standard Certified Project	Cookstoves	GS Methodology for Improved Cook Stoves and Kitchen Regimes v1.	E+Carbon Inc	1,534,448
GS5802	GS1264: NativeEnergy Clean Water Programme	GOLD	Gold Standard	Clean Water	GS TPDDTEC v 2.	NATIVE A PUBLIC BENEFIT	17,519

	West Africa- VPA (03) Santrokofi, Ghana		Certified Project			CORPORATION	
VCS1752	TW Ghana ODS Project	VCS	Registered	Ozone Depleting Substances Recovery & Destruction	VM0016	Tradewater, LLC	155,431
VCS2389	Clean Cook Stoves in Sub-Saharan Africa by ClimateCare Limited - CER Conversion	VCS	Units Transferred from Approved GHG Program	Cookstoves	AMS-II.G.	Credits transferred from approved GHG program	3,508
VCS2410	Reforestation of Degraded Forest Reserve Areas in Ghana, West Africa	VCS	Registered	Afforestation/ Reforestation	AR-ACM0003	Miro Forestry Developments Limited	178,535
VCS2928	North Bandai Bamboo Reforestation Project	VCS	Registration requested	Afforestation/ Reforestation	AR-ACM0003	EcoPlanet Bamboo Group	0
VCS2929	Bandai Hills Bamboo Reforestation Project, Ghana	VCS	Registration requested	Afforestation/ Reforestation	AR-ACM0003	EcoPlanet Bamboo Group	0
VCS3425	Kwamisa/Other Reserves Community Forest Project	VCS	Under development	Afforestation/ Reforestation	AR-ACM0003	Multiple Proponents	0
VCS3650	CPA1 - Man and Man Enterprise Improved Cooking Stoves Programme in Ghana (Brong-Ahafo region)	VCS	Registration and verification approval requested	Cookstoves	AMS-II.G.	Man and Man Enterprise	0

VCS3801	Improved Cookstove Distribution in Ghana by EKI	VCS	Registration and verification approval requested	Cookstoves	VMR0006	EKI Energy Services Limited	0
VCS3983	Improved Cookstove Distribution in Ghana by EKI Phase-II	VCS	Under validation	Cookstoves	VMR0006	EKI Energy Services Limited	0
VCS4126	Community Restoration of Native Ecosystems in Ghana	VCS	Registration requested	Afforestation/ Reforestation	AR-ACM0003	Multiple Proponents	
VCS4161	Installation of high-efficiency wood-burning cookstoves in Ghana	VCS	Registration requested	Cookstoves	VMR0006	C-Quest Capital CR Stoves Pte. Ltd.	
VCS983	African Improved Cooking Stoves Grouped Project	VCS	Registered	Cookstoves	AMS-II.G.	Vitol SA	
VCS987	Reforestation of Degraded Forest Reserves in Ghana	VCS	Registered	Afforestation/ Reforestation	AR-AM0003	Form Ghana Ltd	

4.4.3 Participation in Article 6 voluntary cooperation

Ghana is actively engaged in Article 6 voluntary cooperation to contribute toward achieving its NDC and increasing its ambition. Ghana is engaged in collaborative efforts to realise the full potential of Article 6 in scaling carbon finance, delivering sustainable development benefits, powering innovation, guaranteeing high environmental integrity carbon assets that promote ambition of climate action and support local communities. Ghana will continue contributing to the global effort to finalise the additional guidelines on Article 6 rules established in 2021 and join forces to promote high integrity standards for Article 6 implementation. We are open for business and will work with anyone. Below are some of the key milestones:

- MESTI has published Ghana's framework on the international carbon market and non-market approaches following the cabinet's approval to pave the way for implementing voluntary cooperation under Article 6 of the Paris Agreement.

- Ghana is also involved in 5 Government-to-Government (G2G) bilateral cooperative approaches as envisaged under Article 6.1 of the Paris Agreement and to guide Article 6 project developments in Ghana. The participating parties, with Ghana being the host country, include Switzerland, Sweden, Singapore, South Korea, and Liechtenstein.

- The Swiss agreement was signed in 2020 and is under implementation. Negotiations, legal reviews, and cabinet approval of the Sweden and Singapore agreement concluded in 2023. Both agreements are pending in Parliament for ratification.

- The drafting and negotiation of the South Korea framework agreement were concluded by December 2023, and the minutes of the adopted text were initiated at COP28. The next step is to kick-start internal government consultations, legal review, cabinet approval, and Parliament ratification. A letter of intent has been exchanged with Liechtenstein.

- Established the carbon market office (CMO) at the EPA to see to the operationalisation of Article 6. The CMO's Article 6 project pipeline stands at 35. The 35 pipeline activities cover 10 activity scopes, including:

    - Solar [2]
    - Clean cooking [14]
    - Transport [2]
    - Nature Based Solutions (NBS) [6]
    - Agriculture [4]
    - Landfill Gas Management [1]
    - Avoided methane [1]
    - HFC [1]
    - Bioenergy [3]
    - Low-carbon water purification [1]

- Ghana, through the Ministry of Environment, and Switzerland (through the Federal Office of Environment) have authorised 2 Article 6 projects in sustainable agriculture and waste to compost, totalling 2.7 $MtCO_2e$ of ITMOs.

- Article 6 Initial report and the authorisation statement have been submitted to the UNFCCC's Centraliased Accounting Reporting Platform (CARP)[16]. On the CARP, Ghana-Switzerland Cooperation ID for the Promotion of climate smart agriculture practices for sustainable rice cultivation in Ghana is CA0002.

- Chapter VI. A of the Annex to Decision 2/CMA.3 requires each participating Party in a cooperative approach to have access to a registry for recording and tracking ITMO transactions. The CMO manages the Ghana Carbon Registry (GCR) that performs MRV and database, transactional and accounting functions. The GCR's URL is gcr.epa.gov.gh.

- The CMO's IT has redesigned the GCR landing page and streamlined the functionality to align with participating Parties' requirements. The GCR's database and transaction functionalities are up and running. So far, 35 project mitigation identification numbers have been issued on the GCR, and 9 are fully onboarded.

- With support from the World Bank and UNDP, an expert team is assessing the GCR's readiness to meet the interoperability requirements of other national registries, private registries, and international registries. The team will also weigh Ghana's technical and legal options in connecting the GCR to the CAD Trust meta registry.

4.4.4 Result-based payment REDD+

In 2019, Ghana signed a landmark deal with the World Bank to generate carbon emissions and reduce deforestation. Under the World Bank's Forest Carbon Partnership Facility (FCPF), Ghana is implementing a result-based payment Cocoa REDD+ project to generate 10 million emissions reduction over six years. Ghana's five-year Emission Reductions Payment Agreement (ERPA) with FCPF Carbon Fund, which the World Bank administers, unlocks performance-based payments of up to US$50 million for carbon emission reductions from the forest and land use. Ghana received about 4.8 million US dollars for achieving 972,456 tonnes of carbon reductions. The second monitoring report is completed and is undergoing third-party verification.

[16]https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/cooperative-implementation/centralized-accounting-and-reporting-platform#Cooperative-approaches

4.4.5 Information on other climate finance instruments

4.4.5.1 Green credit lines

Sustainable Use of Natural Resources and Energy Finance

Agence Française de Développement (AFD) and the Energy Commission (EC) have signed a Technical Assistance Facility (TAF) to support local banks and energy businesses in Ghana. The Sustainable Use of Natural Resources and Energy Finance (SUNREF) programme is one of the most significant green finance projects to be deployed in Ghana. SUNREF Ghana is a tailor-made solution that enables companies to purchase better quality equipment, insulate buildings, reduce energy costs, and become more competitive. SUNREF also supports businesses offering goods and services related to energy and the environment (including waste and water management and pollution abatement).

In partnership with two local banks (Cal Bank & GCB), SUNREF Ghana offers private entities competitive loans and assistance structuring their green investments to seize green finance opportunities. A credit line of 30 million euros is provided by AFD on attractive terms to the Banks (concessional rate loans for long periods, grace period). A 2.5million euro investment to make green investments even more attractive. Final beneficiaries can benefit from a grant of approximately 10% of the loan amount up to the completion and verification of their project. SUNREF Ghana has achieved the following:

- Project Management Unit established at Energy Commission in September 2020.
- SUNREF launching event in July 2021 (great visibility in social media and many newspapers).
- 344 bank staff training on SUNREF products.
- 25 credit and assessment department experts received a 3-day extensive technical training.
- 2 projects have received technical assessment with an approved project investment value of USD 2.6 million.

Green credit line

KfW Development Bank is collaborating with the Ministry of Finance and Economic Planning to establish a green credit line for refinancing Renewable Energy and Energy-Efficient (RE/EE) investments for MSMEs and households in Ghana. The green credit line would help to achieve the climate protection goals in the NDC and the Renewable Energy Master Plan (REMP). On behalf of KfW, IPC designed a potential green credit line structure based on Ghanaian green lending market demand and supply. With seven potential Ghanaian partner financial institutions identified, the Ministry of Finance and KfW again contracted IPC to select three institutions as potential implementing partners for the RE/EE credit line and conduct their detailed institutional assessments.

On-lending climate finance through financial institutions

The Development Bank of Ghana (DBG) supports micro, small and medium-sized enterprises (MSMEs) with climate finance by on-lending through participating financial institutions (PFIs), which include commercial banks and specialised deposit-taking institutions (SDIs). The participating financial institutions include Fidelity Bank Ghana, Access Bank Ghana, Cal Bank, Consolidated Bank Ghana, ABSA Bank, Zenth Bank Ghana, Sinapi Aba Savings and Loans, Advans Savings and Loans and Opportunity International.

DGB and its partners, have introduced the Green Finance Investment Facility (DGFIF) programme to contribute to addressing the climate finance gap. The DGFIF offer solutions such as (a) reduced interest rates, (b) moratoriums, (c) technical assistance and (d) capacity building.

Furthermore, DBG through DGFIF has allocated $100 million to scale investments in low carbon emission and climate resilience in Ghana. DBG has already disbursed about 20 million Ghana cedis through it partner banks. DBG is committed to mobilising US$ 30 million in grants and funding over 3 years to support green projects. The bank is also exploring grant of Euro 18 million from KfW to blend with funds to bolster green lending to contribute to achieving Ghana's NDC commitment.

4.4.5.2 GSE sustainability disclosure standards

The Ghana Stock Exchange (GSE), in collaboration with its partners, Global Reporting Initiative (GRI), African Securities Exchanges Association, Swiss State Secretariat for Economic Affairs (SECO) and Seven Levers LLP launched the ESG Disclosures Guidance Manual[17] in 2022.

The Manual guides how GSE-listed *companies* in Ghana and other organisations interested in ESG (Environment, Social and Governance) can collect, analyse, and publicly disclose important ESG information using an approach that meets international standards in sustainability reporting. It also serves as a guide on progressively integrating ESG in strategy, operations, and performance management.

The manual recommends the adoption of the GRI (Global Reporting Initiative) Standards as the common framework for ESG reporting by listed companies in Ghana. The environmental component of the GRI includes information on GHG emissions from the list companies. The GSE sustainability disclosure standard is linked to the Ghana Security and Exchange Commission Governance indicators requirement for listed companies.

[17] https://gse.com.gh/wp-content/uploads/2022/11/GSE-ESG-DISCLOSURES-GUIDANCE-MANUAL-1-1.pdf

4.4.6.3 Bank of Ghana sustainable banking pprinciples

Bank of Ghana has developed guidelines[18] to help banks manage environmental and social risks. The principles assist banks in responding to emerging global megatrend issues, such as human security, anti-money laundering, socially responsible stewardship, information communication transparency and disclosure, corporate integrity, and environmental and climate change. It contains principles and guidelines on how financial institutions should support business activities such as Agriculture & Forestry, Mining and Oil & Gas, Construction & Real Estate, Power & Energy and Manufacturing activities in a sustainable way.

4.4.6.4 Green and social bonds

Ghana initiated its 2021 International Capital Market Programme to issue sovereign bonds in the last quarter of 2020. Subsequently, in November 2020, Parliament granted Government approval to issue bonds amounting to US$3.00 billion, of which proceeds of up to US$1.5 billion were to be applied to support the 2021 budget and growth expenditures. Parliament also approved a further issuance of up to US$ 2.0 billion for liability management purposes and reprofiling domestic debt, should market conditions prove favourable.

In March 2021, Ghana successfully issued bonds worth US$3.025 billion comprising the first 4-tranche Eurobond, including an innovative zero-coupon bond, under the 2021 ICM Programme. The 4-tranche transaction was executed after a three-day virtual roadshow with fixed-income meetings with investors mainly domiciled in North America and Europe. Based on feedback from various investor engagements, including the roadshow meetings in March, Ghana accelerated its plans to develop and establish a Sustainable Financing Framework (the “Framework”) that could be used in connection with any future ESG-linked or related capital markets issuance.

Through the Ministry of Finance, the Framework provides the Government of Ghana the criteria to screen programmes and projects with sustainable, green and/or social credentials that may require financing from the National Budget. Adaptation and mitigation activities in Ghana’s nationally determined contribution may be eligible for investment from the share of proceeds from the green and social bonds.

[18] https://www.bog.gov.gh/wp-content/uploads/2019/12/Ghana-Sustainable-Banking-Principles-and-Guidelines-Book-1.pdf

Domestic Monitoring Reporting and Verification (MRV) System

5. Ghana's Domestic MRV System

5.1 Status of the Domestic MRV System

In 2013, Ghana formally adopted the Climate Ambitious Reporting Program (GCARP) in response to the call by decision 1/CP.16 to establish and operate a domestic MRV system for climate action and support. The GCARP was set up as the national arrangement for effective compilation and timely communication of dependable, transparent, and comprehensive information on GHG emissions, climate actions (NDC and adaptation) and support under the existing international MRV and beyond (response to Decision 18/CMA.1 (MPG for Article 13). It is grounded on four operationally inter-woven pillars: institutional structure, data handling, protocol, IT infrastructure, and legal mandate. Since the establishment of the GCARP in 2013, some reforms have been introduced in several aspects to strengthen its operational and coordination functions. Below is the summary of the reforms:

Pillars: Institutional arrangement, capacity development and legal mandate

- The initial ad-hoc institutional arrangement was decentralised to selected line ministries and agencies, including the Forestry Commission, Forestry Commission, Ministry of Food and Agriculture, EPA (Built Environment), EPA (Manufacturing Industry) and EPA (Petroleum). EPA signed a Memorandum of Understanding (MOU) with lead government institutions to govern the smooth workflow of climate reporting among the actors.

- Part 5 of the new Environmental Protection Authority Bill, before Ghana's Parliament for consideration, is dedicated to climate change, covering issues such as domesticating Ghana's reporting obligations under the UNFCCC. When the law is passed, the national arrangement for international climate reporting (BTR, National Communication, AdCOMs, National GHG Inventory, Article 6 Reports) will be anchored on the new Environmental Protection Authority Act.

- The efforts on continuous training, skills improvements and development of tools and methods have also progressed relatively well. The capacity development initiatives contributing to improving skills and knowledge in the MRV include training received from the UNFCCC, the Low Emission Capacity Building Project, the Information Matters Project (IM Project), the CD-REDD project and the CBIT Project.

Pillars: Data handling, Tools, and IT Infrastructure

- The EPA has established an online database to host and facilitate data harmonisation, sharing and archiving. The database has four portals: GHG inventory, climate policies and measures, mitigation project registry, the NDC and the GCF project. The database's current challenges are irregular content updates, high license and maintenance fees, and low visits to the hub. As a result, the

database is not active online. The CBIT project strengthened the database by re-designing the interface and running on an open-source application[19].

- The carbon market office in EPA has established the Ghana Carbon Registry (GCR)[20] for tracking and recording ITMOs generated from mitigation activity under Article 6 of the Paris Agreement. The data from the GCR will be used for the NDC accounting (including the application of the corresponding adjustment to annual emission balance) and Article 6 reports (initial report, annual information, and regular information) to the UNFCCC Centralised accounting and reporting platform (CARP).

- Ghana has developed a mitigation action data template to collect data regularly to prepare the greenhouse gas inventory estimates and mitigation actions.

- Despite the reforms, the full implementation of the GCARP has not reached desirable levels. That is why Ghana's CBIT project seeks to address some of the persistent institutional and capacity challenges that impede the implementation.

5.2 Progress in Domestic MRV since BUR3

Below are the highlights of the key progress in the operationalisation of Ghana's domestic MRV system since the BUR3 submission to the UNFCCC:

Tracking NDC progress

- The National Development Planning Commission (NDPC) and the Environmental Protection Agency (EPA) have created a set of indicators to monitor the advancement of Ghana's Nationally Determined Contributions (NDC) at both national and sectoral levels. These indicators are utilised to generate a template for tracking Ghana's progress towards meeting its NDC targets, which various line ministries use for data collection and reporting purposes (see Annex 2).

- The EPA has developed an NDC accounting tool for anthropogenic GHG emission inconsistent with the Guidance for accounting for Parties' nationally determined contributions, referred to in decision 1/CP.21, paragraph 31. The tool will enable Ghana to regularly prepare, communicate and account for its nationally determined contributions under the Paris Agreement. EPA has tested the tool and is currently using it to record and track the progress and achievement of the NDC.

[19] https://climatedatahub.com.gh/
[20] https://gcr.epa.gov.gh/

EPA has started extensive training on the tool and helped the line ministries set up the system for regular data collection input. Ghana EPA manages the NDC accounting and will sectoral representatives as contact points (See Annex 3)

Adaptation reporting
Ghana is preparing its National Adaptation Plan (NAP) with financial support from GCF through the UN Environment. Under the NAP, Ghana is establishing an adaptation database to support and process data for effective communication.

Adaptation communication
Ghana has completed and submitted its first Adaptation Communication (AdCOM)[21] to the UNFCCC. The AdCOM aims to enhance the visibility and profile of adaptation in Ghana, providing input to the GST, strengthening adaptation action and support, and enhancing learning and understanding of adaptation needs and actions.

Tracking of climate finance
The Ministry of Finance leads Ghana's climate finance tracking. The Ministry has developed three sets of climate change finance tools to track the country's financial resources generated for climate change actions or external sources.

- The first tool (Climate finance tracking tool) was designed to track climate-relevant expenditures using the national budget codes to isolate climate-relevant public expenditure on climate change and international inflows.

- The second tool (MRV of finance guidance manual) was also developed to track Ghana’s climate finance, verify the completeness of data, and help demonstrate transparency of support and climate action.

- The third tool (Climate Change Finance Tracking tool (CLIMFINTRACK) updates the existing tracking tools to reflect the new policy, programme areas and budget codes to help capture relevant end-of-year outturn climate-relevant expenditures. The manual is firmly based on Ghana's existing policy planning and public financial management system.

- The CLIMFINTRACK is a tracking tool that allows users within the Public Sector domain to track finance on climate change-related activities in real-time, directly to their PCs, mobile phones, or handheld devices. It is a Microsoft Excel-based tool developed via Oracle Smart View for Office and provides a common Microsoft Office interface. With CLIMFINTRACK, users can view, import, manipulate, distribute, and share data on the Ghana Government’s budget for climate change

[21]https://unfccc.int/sites/default/files/resource/Ghana_AdCom%20to%20the%20UNFCCC_November%202021_Final%20with%20foreword.pdf

activities. The ability of CLIMFINTRACK to track the Ghana Government's budget is based on the codes used in the chart of accounts.

- Integrated MRV of Finance - The Finance tool is an integrated tool that seeks to provide a dashboard for tracking climate-specific funds, international financing inflows and national climate-relevant budgets and expenditures.

GHG Inventory

- Foundational Platform for REDD+ FREL – To support the regular preparation of the REDD+ FREL, the Forestry Commission has developed a Foundational Platform. The Foundational Platform is a calculation spreadsheet based on the 2006 IPCC GHG inventory guidelines and the 2019 IPCC Refinements of the 2006 Guidelines. The platform includes all relevant national data and IPCC equations and displays information by IPCC land-use classes (Forest land, Grasslands, etc.). This tool explicitly shows all steps in producing the final GHG inventory/ Forest Reference Level or MRV. The tool was used to compile Ghana's second FREL to the UNFCCC.

- The Forestry Commission has started work to establish a forest monitoring system to improve the forest monitoring capacities. As part of this initiative, the Forestry Commission has developed 12 standard operating procedures (SOPs) to guide the setting up of forest reference levels and LULUCF GHG inventory. The Forestry Commission has established an online database for forest monitoring systems[22].

- Incorporated GHG inventory data requirement into the Annual Environmental Report Template for the industry.

[22] http://www.ghanaredddatahub.org/

Climate Support Needed and Received

6. Climate support needed and received.

6.1 Climate finance needed and received.

6.1.1 Climate support needed.

The investment cost estimate for climate-secured and prosperous Ghana varies depending on the scope and the thematic focus. In the updated NDC[23], Ghana would require $9.3 billion to invest 47 adaptation and mitigation actions in 11 sectors by 2030. Furthermore, the country adopted Ghana's Climate Prosperity Plans (CPP)[24] to drive new investment in developing positive climate action in key areas such as food security, energy security and high-value industry opportunities.

Ghana will need $76 billion through 2030 to implement the keystone projects in the CPP. In its Energy Transition Plan (ETP), Ghana would need about $550 billion in capital investment into renewables, low-carbon hydrogen, battery electric vehicles, and clean cookstoves to achieve an orderly transition to net zero emission by 2060. Accessing adequate and predictable climate finance is critical to attaining the medium to long climate and development goals in the NDC, CPP and ETP.

6.1.2 Climate support received.

Ghana continues to mobilise finance across multiple sources (Government, International and private sector) to invest in its climate change actions. Therefore, at every stage of mobilising climate finance, it is important to gauge climate finance flows, distribution, scope, and channels. A better understanding of the climate finance flows will help to direct efforts to underserved areas. In BUR 3, Ghana reported results from annual surveys for tracking climate finance. The Ministry of Finance has started tracking domestic climate finance with its Climate Finance Tracking Tool (CLIMFINTRACK).

In the BUR4, Ghana has reported updates on funding and monetised inflows for 2002 to 2021, covering international and national climate flows. Financial inflows are reported in Ghana Cedi (Gh₵) and US Dollar (US) dominations. Non-US dollar-denominated flows have been converted to US$ using the December exchange rate for each year. Projects that started in 2011 and are still active have been included in the analysis.

Those projects that began and ended before 2011 have been excluded from the analysis. Projects that may have global or regional scope or are for several countries and the specific budget for Ghana are labelled as "unknown" " but are only included for an anecdotal purpose.

[23]https://unfccc.int/sites/default/files/NDC/202206/Ghana%27s%20Updated%20Nationally%20Determined%20Contribution%20to%20the%20UNFCCC_2021.pdf
[24] https://www.v-20.org/resources/publications/ghana-climate-prosperity-plan

Ghana has reported information on "committed funds" for the active projects because information on expenditures and their corresponding outputs are unavailable and may take more time to collate. Note that there may be a significant variation in amounts "committed", "disbursed", and "released", depending on the reporting period. All the results are presented without the loans except unless stated. Financial flows are considered and reported as non-ODA. The categorisation of projects in the OECD/DAC and the EPA dataset follows the Rio marker indicators (climate, adaptation, and mitigation outcomes) as principal, significant, and not targets.

A “significant” marker would indicate climate or adaptation and mitigation objectives are explicitly stated but not the fundamental driver or motivation for undertaking and designing the activity. A “principal” marker shows that the objectives are explicitly stated as fundamental in the design of, or the motivation for, the project. The EPA dataset was collected through a national survey and information published on the web pages of donor and recipient institutions. The information has been collected at the project level. All projects without adequate information and worth less than $10,000 are excluded because they do not meet basic analysis requirements and avoid double counting.

For the CLIMFINTRACK, the domestic climate finance budget or expenditure lines are based on the national budget code and the definition of keywords in the National Climate Change Policy. Climate change expenditure or budget can be searched according to the budget code and the corresponding keyword by policy theme in the database. The policy theme covers the following areas Across sectors: Agriculture and Food Security; Infrastructure, Disaster Preparedness, Forests and Carbon sinks; Ecosystem Management; Climate Change and Health; Climate change and gender; Climate change and migration; energy and infrastructural development. Furthermore, the CLIMFINTRACK also incorporate climate relevance scores in the unique tracking codes.

6.2 Climate finance tracking results

6.2.1 International climate finance commitments

The OECD/DAC and the EPA annual survey captured information on climate financial commitments for 963 projects valued at US$ 18.4 billion between 2012 and 2021. When Ghana National Gas Company’s (GNGC), TEN and ENI/Vitol’s debt financial investments (estimated at $14.2 billion) in the natural gas field development were excluded from the analysis, the total financial commitments for the period amounted to US$4.2 billion over the same period. investments contribute to decarbonising the oil/gas and electricity sectors in the NDC.

The financial commitment to mitigation projects amounts to $16.7 billion, whereas adaptation projects are valued at $1.6 billion, and projects that target adaptation and mitigation are valued at $0.34 billion. Of the 963 projects, 342 fall under the “*principal climate objective*” category per the OECD/DAC Rio markers classification and 621 are in the “*significant climate objective*” group. The financial commitments comprised grants, debt instruments, equity and a mix of loans, co-financing and grants or equity. Grants and

debt instruments are the dominant financial tools financial providers use. Grants comprise 96% (925) with a total financial commitment value of $2.1 billion. Debt instruments comprise 3% (27) of total financial commitment valued at $15.6 billion. The remaining 11 projects of value of $0.7 billion were mixed instruments by the financial providers. As we advance, the results will be presented without GNGC, TEN and ENI/Vitol's investment according to the (a) EPA annual survey and (b) OECD/DAC dataset.

6.2.1.1 EPA annual survey results

The EPA annual survey of international climate finance inflows captured 129 projects spanning 2002 to 2021 with a total value of $17.1 billion. When the financial commitment of $14.2 billion from the GNGC, TEN and ENI/Vitol are excluded from the calculations, the total cumulative international climate finance flows were $2.9 billion. For ease of reference, the rest of the results will be presented without the GNGC, TEN and ENI/Vitol investment. Financial commitment to projects with principal climate objectives accounts for $1.62 billion, whereas those with significant climate objectives were $1.5 billion (without GNGC, TEN and ENI/Vitol investment). Grants (32%), loans (23%) and guarantees (20%) are the three top financial instruments for delivering climate finance in Ghana. Followed by result-based payment (15%), equity (7%) and national budget (3%). Figure 9 presents the financial flows per instrument type for 2002-2021.

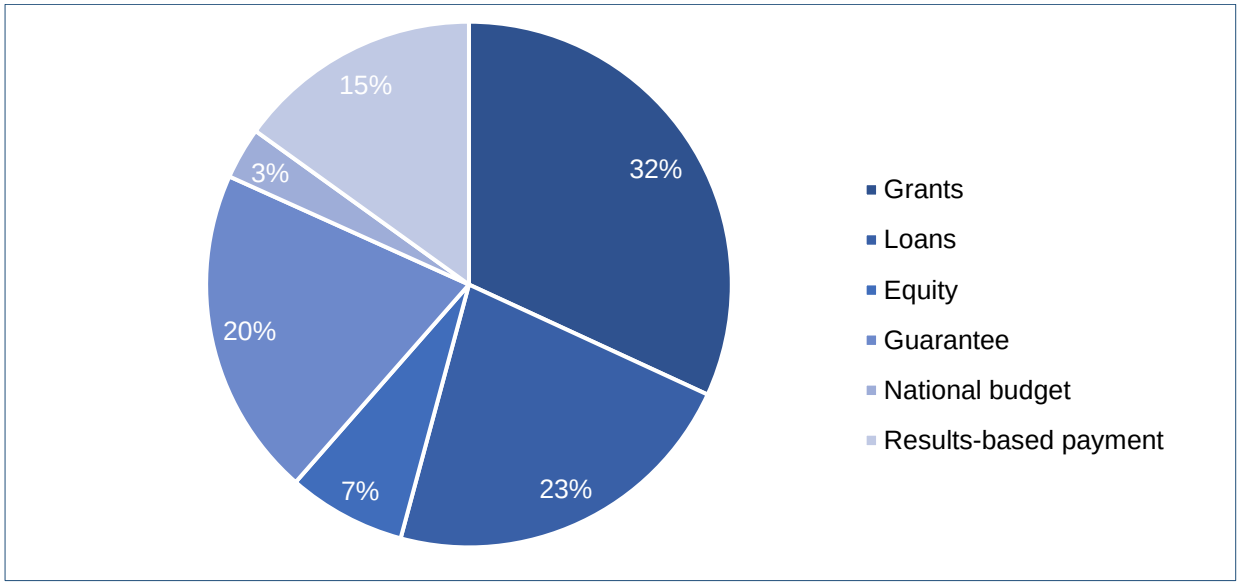


Figure 9: International climate finance commitment per instrument (2012-2021)

Financial commitment to mitigation projects dominated the climate financial flows. It comprised 75% of the total climate financial commitments from 2002 to 2021, followed by adaptation (22%) and 3% of cross-cutting projects (including sustainable development means of implementation and enabling activities. Table 36 showed that although grant financing was the common instrument for financial flows across the board, some loans were directed at adaptation projects.

Table 36: Financial commitment by climate objectives and financial instruments

Climate objectives and financial instruments	Financial resources committed (US$ 000)			
	Adaptation	Adaptation/ Mitigation/MOI	Mitigation	Total
Climate components	647,278.8	101,542.0	2,201,500.9	2,950.32
Significant climate objective	503,297.7	26,131.5	1,003,817.1	1,533.25
Principal climate objective	143,981.1	75,410.5	1,197,683.9	1,417.08
of which is a loan	35,000.0	-	29,390.0	64.39
of which is a grant	57,981.1	75,410.5	263,093.9	396.49
of which is a guarantee	-	-	700,000.0	700.00
of which is an equity	51,000.0	-	200,000.0	251.00
of which is the national budget	-	-	-	-
of which is RBP	-	-	5,200	5.20

The financial commitments trend to climate change projects has increased steadily from 2015, peaking in 2020, and started to decline marginally in 2020. In 2019 and 2021, financial commitment to adaptation increased expectedly as the Government continued to prioritise efforts on adaptation (Figure 10). Nevertheless, mitigation projects throughout the period attracted more financial commitments.

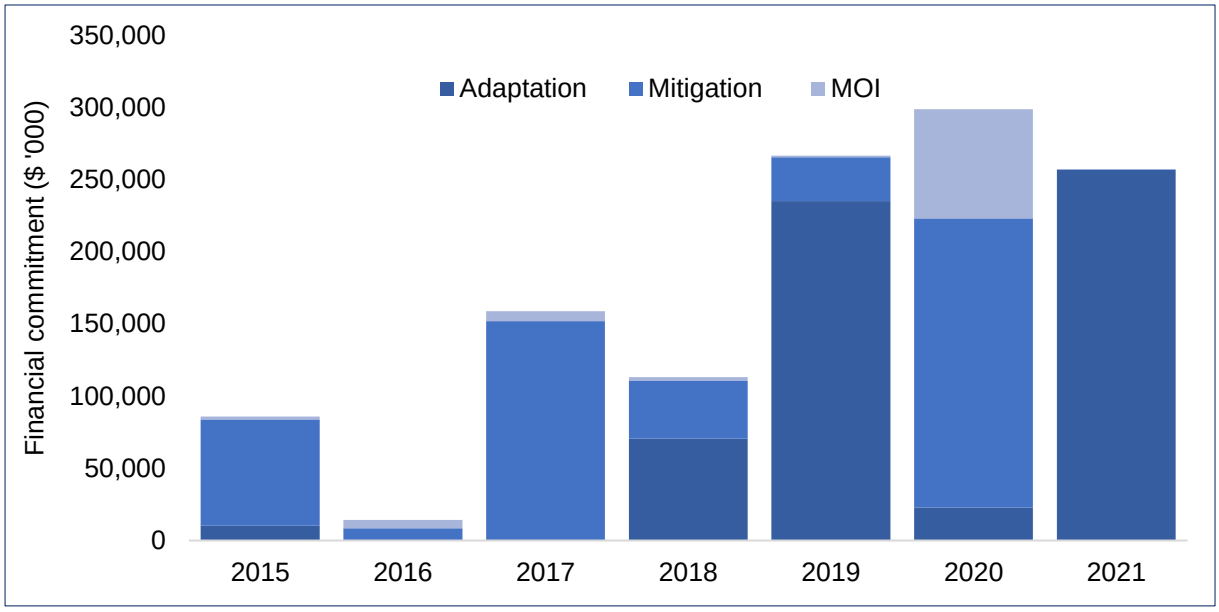


Figure 10: Trends of financial commitment to projects with climate objectives.

Regarding sources of financial commitment, multilateral and bilateral continue to dominate, followed by foundation/private sector and vertical climate funds. Throughout the period, 50% and 32% of all international climate financial flows were from multilateral and bilateral sources. The rest were from foundations/private sector and vertical funds. National funds appeared to complement international climate inflows. In 2020, climate financial flow to supporting means of implementation and enabling activities recorded the highest levels compared to the other years. Regarding the sources of financial commitment, multilateral and bilateral continued to dominate, followed by foundation/private sector and vertical climate funds.

Throughout the period, 50% and 32% of all international climate financial flows were from multilateral and bilateral sources (Figure 11). The rest were from foundations/private sector and vertical funds. National funds appeared to complement international climate inflows. The observed dominant flow of climate finance through multilateral and bilateral channels is consistent with the OECD/DAC data trends.

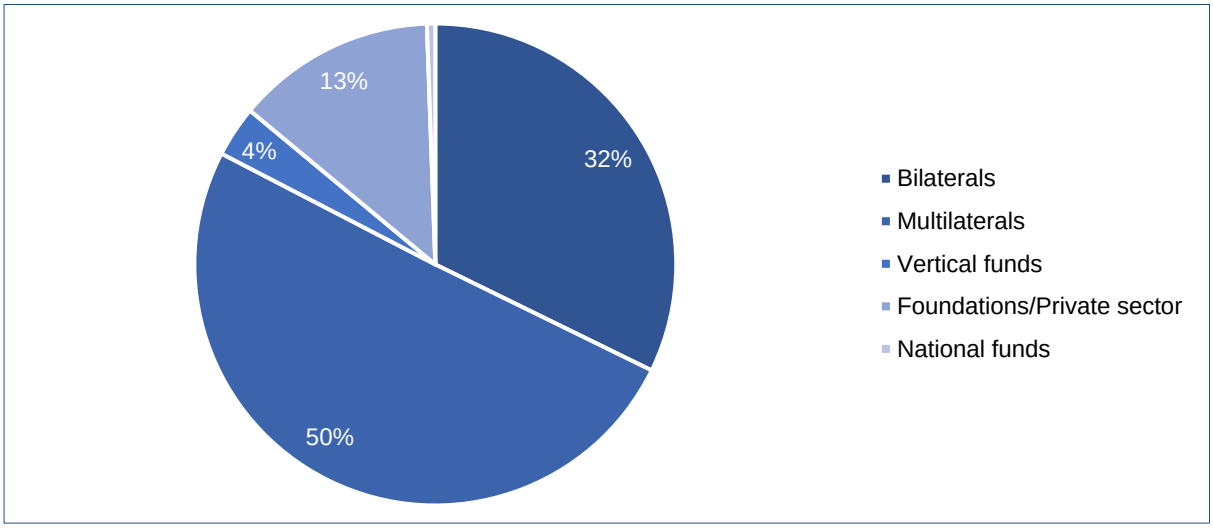


Figure 11: Financial flow per sector breakdown of the financial flow per sector.

Figure 12 presents the breakdown of the financial flow per sector. It shows climate financial commitment to Energy, Forestry and Water and Sanitation as the top 3. Agriculture, Environment, and transport sectors follow it. Even though transport is among Ghana's largest sources of greenhouse gas emissions, it attracted less climate investments than the other sectors.

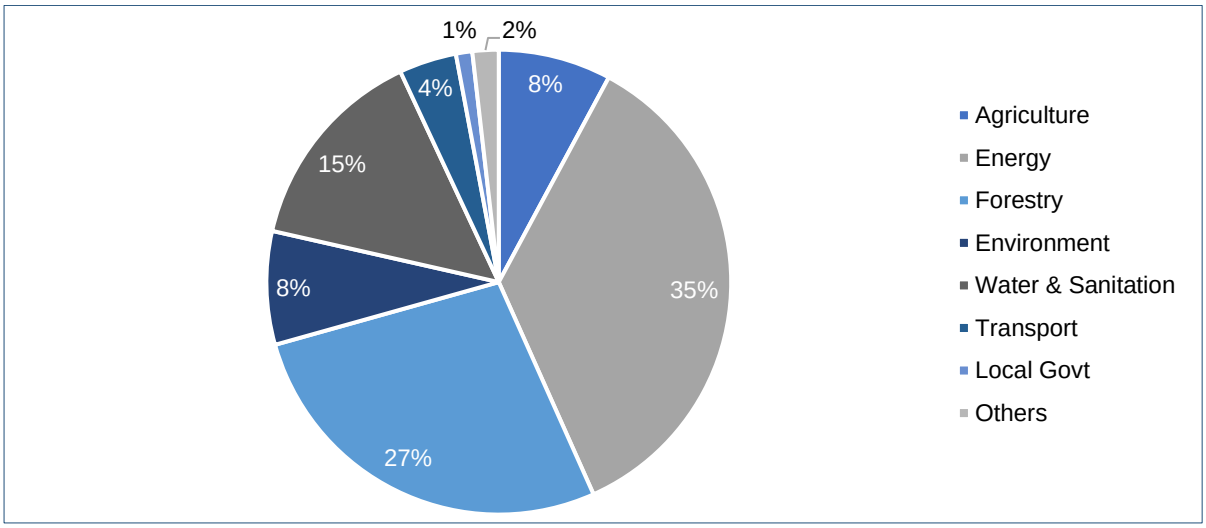


Figure 12: Financial commitments by sectors (2015-2021)

The agriculture and environment sectors, which are more vulnerable to the impacts of climate change, do not receive adequate climate finance commitment. Similarly, the financial commitment to climate actions at the local government level is underrepresented. It received only 2% of the total climate finance commitment over the period under consideration.

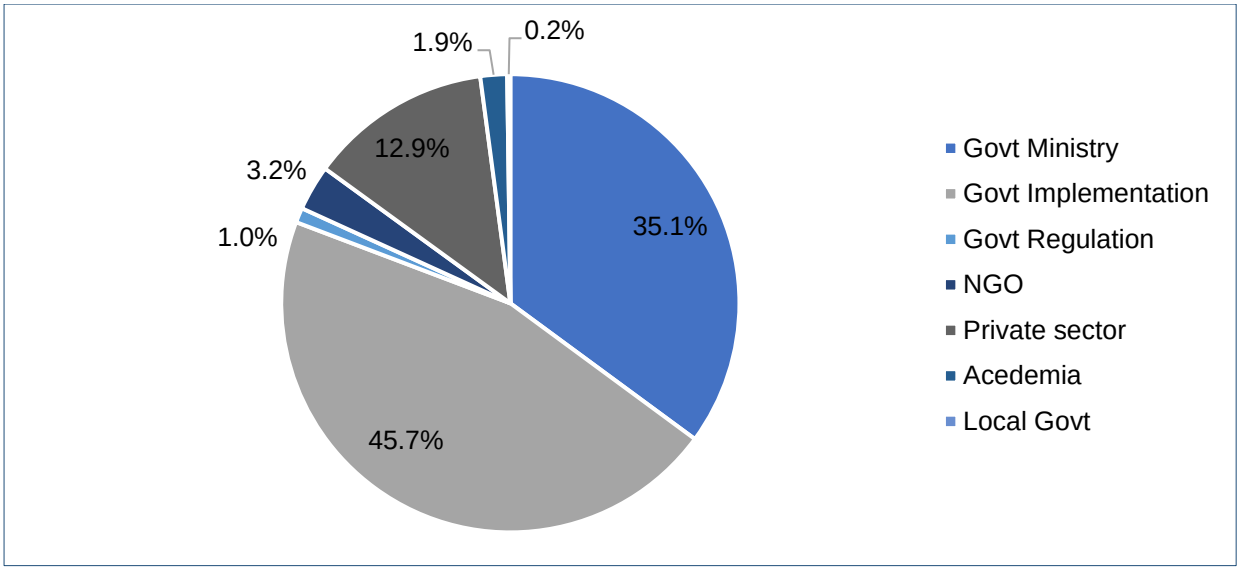


Figure 13: Share of climate finance flows per organisation.

Climate finance flowed to public and private institutions in Ghana. Most of the financial flows went to Government institutions. The Government institutions (Ministry, Implementing Agencies and Regulatory bodies) received 82% of the total climate finance flows. It is followed by the private sector (13%), NGOs (3.2%), Academia (2%) and Local Government (0.2%) (Figure 13).

6.2.1.2 OECD/DAC Data on Ghana

Ghana's OECD/DAC data was separately analysed from the EPA annual survey data. The duplicated data in the EPA and OECD/DAC were identified and deleted to avoid double-counting. As an additional caution to avoid duplication, the OECD/DAC must be read independently of the EPA survey results. It must not be viewed as additional to the figures reported in the EPA results.

Information on 990 projects was covered between 2012 and 2021, valued at $1.95 billion. Of the total, 282 projects have principal climate objectives and were valued at $0.87 billion. The remaining 708 projects are within the significant climate objectives category, receiving a $1.1 billion financial commitment.

Of the 282 projects with principal climate objectives, 154 have principal adaptation objectives valued at an estimated $25 million as grants. The breakdown of the amounts includes Health – 135.42 thousand, Water supply – 479.31 thousand, Agriculture – 10,566.97 thousand, Disaster – 15.78 thousand and Others – 13,734.99 thousand. Sixty projects with principal mitigation objectives received a $13.9 million financial grant commitment. The remaining 69 projects have significant climate objectives.

6.2.1.3 Climate finance flows from the national budget

In the BUR3, Ghana indicated its plans to continue reporting climate flows in the national budget. The domestic climate flows come from the CLIMFINTRACK system managed by the Budget Division of the Ministry of Finance.

The CLIMFINTRACK has tracked the approved national budget of 48,707 projects with climate outcomes in MDAs and MMDAs between 2015 and 2020. The projects have an approved budget value of Gh¢ 12 billion for the same period at an annual average of Gh¢2 billion. The approved budgets were earmarked from the consolidated fund, statutory payment, and internally generated funds. Within 2015-2020, the approved budget for the number of projects with climate outcomes increased 237% from 6,123 in 2015 to 20,642 in 2020. Most (52%) projects fall in the low climate policy coherence class. About 37% of the projects have high coherence, followed by 11% of projects with medium coherence. Figure 14 shows a generally rising trend in the national budget for projects with climate outcomes.

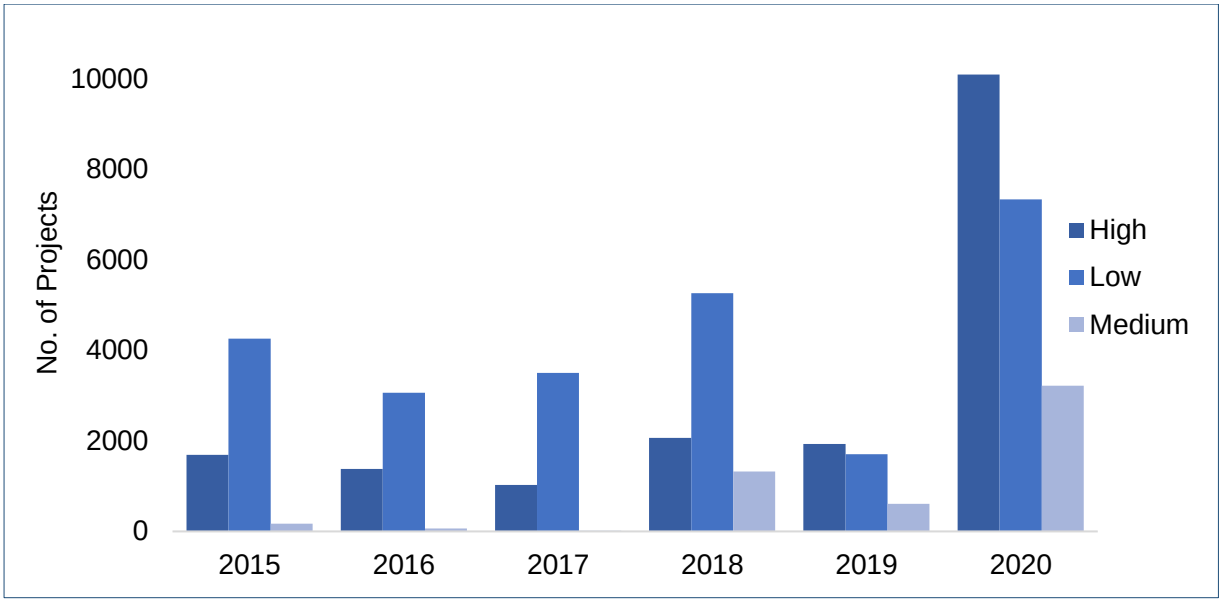


Figure 14: Trends of projects in the CLIMFINTRACK (2015-2020)

Table 37 presents the approved budget of the projects with high policy coherence. Of the total estimated Gh¢6 billion approved national budget over the five years, Agriculture and Food Security recorded the highest of 27%, followed by Water and Sanitation of 21% and Disaster Preparedness (21%). Over the years, the national budget allocations for projects with high climate outcomes contributed 28% and 48% of the total budget allocation for the same period. The highest budget allocation for the high policy coherence project was recorded in 2020. In the 2020 approved budget, Agriculture and Food Security, Climate change and migration, Disaster Preparedness, and Water and Sanitation policy received high budget allocations. The national budget trends are consistent with Ghana's priority of investment in climate change adaptation interventions.

Table 37: Approved national budget for projects with high climate policy coherence

National climate change policy themes	2015	2016	2017	2018	2019	2020	Total	Share (%)
Agriculture and Food Security	19.8	132.8	380.5	5.7	293.5	760.5	1,592.8	27
Climate change and gender	10.7	24.4	2.1	-	-	-	37.2	1
Climate Change and Health	-	-	-	171.3	43.4	4.0	218.8	4

Climate change and migration	-	-	-	1.3	173.4	749.5	924.1	15
Disaster Preparedness	77.7	47.6	50.9	106.8	14.2	679.6	976.8	16
Energy and Infrastructural development	146.9	40.9	0.7	0.0	41.4	20.2	250.0	4
Forests and Carbon sinks	132.9	74.3	214.7	-	0.1	4.3	426.3	7
Infrastructure	162.5	42.6	70.8	-	-	53.9	329.8	5
Water and Sanitation	100.3	46.6	65.8	50.6	388.0	594.3	1,245.6	21
Total	650.9	409.3	785.4	335.7	954.0	2,866.2	6,001.5	100

6.2.2 International climate finance commitments

The Real Sector Division of the Ministry of Finance is the National Designated Authority (NDA) for the Green Climate Fund (GCF). The Ministry of Finance coordinates the efforts to mobilise financial resources from the Green Climate Fund. An inter-agency technical committee supports the NDA work. The NDA's coordination activities involve the following:

- Facilitate the development of the GCF project pipeline among developers.
- Support for institutional designation as national implementing entities.
- Stakeholder engagement and awareness.
- Matchmaking among project developers.
- Liaison with the GCF secretariat.
- Participation in the global GCF activities.

Tables 38, 39 and 40 show the status of Ghana's GCF projects/proposal development in Ghana. So far, Ghana has received GCF board approval for eight projects total $ 2,546 million, with a direct GCF investment of $853.1 and a co-finance of $1,693 million. Five of the projects are regional projects of which Ghana is a participant.

Table 38: Approved GCF funding proposals

No	Project	Executing Entity	Accredited Entity/Delivery Partner	Date Submitted	Amount Approved ($ Million)		
					GCF	Co-Fin	Total
1.	Acumen Agricultural Fund (Regional project)	Demand Driven	Acumen Fund Inc.	March 2018	26.0	25.0	51.0
2.	Programme on Affirmative Finance Action for Women in Africa (AFAWA) (Regional project)	Ecobank Ghana	AfDB	July 2019	20.0	15.0	35.0
3.	Arbaro Fund – Sustainable Forestry Project (Regional project)	Micro Ltd	MUFG Bank	March 2020	25.0	175	200
4.	Ghana Shea Landscape	Forestry Commission	UNDP	September 2020	30.1	24.0	54.1

	Emission Reduction Project						
5.	Inclusive Green Financing Initiative (IGREENFIN) ***PPF & Funding Proposal	ARB Apex Bank	IFAD	February 2021	1.5	0.000	1.5
6.	Infrastructure Climate Resilient Fund	MOT	AFC	March, 2023	263.0	560.0	823
7.	Leveraging Energy Access Finance Framework project (Regional project: Nigeria, Kenya, Ghana, Tunisia, Ethiopia, Guinea) (Regional project)	Ministry of Energy	IFAD	March, 2021	170	723	893
8.	Project GAIA (Regional project)		MUFG	October, 203	152.5	15	35
Total					853.1	1,693	2,546

Table 39: List of Approved GCF Readiness and Preparatory Proposals

NO.	Project	Executing Entity	Accredited Entity/Delivery Partner	Date Submitted	Amount Approved ($Million)		
					GCF	Co-Fin	Total
1.	Drought Early Warning and Forecasting System: Improving the resiliency of crops to drought through strengthened early warning within Ghana.	Water Resources Commission	UN Environment	May 2017	0.300	0.000	0.300
2.	Strengthening national capacities to access climate finance through enhanced country strategies and stakeholder engagement in Ghana	NDA/UNDP	UNDP	Mar 2019	0.510	0.000	0.510
3.	Enhancing multi-sector planning and capacity for effective adaptation in Ghana	EPA	UN Environment	May 2019	2.960	0.000	2.960
4.	Ghana Industrial Energy Efficiency Readiness	UNIDO	UNIDO	Sep. 2020	0.533	0.000	0.533

Table 40: GCF Funding proposal is awaiting approval.

No.	Project	Executing Entity	Accredited Entity/Delivery Partner	Date Submitted/ Status	Amount ($ Million)		
					GCF	Co-Fin	Total
1.	Accelerated Solar Action Programme (ASAP)	Energy Commission	Ecobank Ghana.	9 Oct. 2018 / under review by GCF sec	15.0	15.0	30.0
2.	Climate-resilient landscapes for sustainable livelihoods in Upper East and Upper West Regions	MOFA and EPA	UN Environment	20 June 2018 / under review by GCF sec	17.0	9.3	26.3
3.	Greater Accra Resilient & Integrated Development Project	Min of Works & Housing	World Bank	20 Nov. 2019 / under review by GCF sec	75.0	201.0	276.0
4.	Accra City Electric Bus Project	Min of Transport	Ecobank / AFD	25 Sep. 2019 / under review by GCF sec	36.6	183.5	220.1
5.	Regional Off-Grid Electrification Project (ROGEP) (Regional project)	Energy Commission	IBRD	7 Sept. 2018 / under review by GCF sec	150.0	160.0	310.0
6.	Leveraging Energy Access Finance Framework project (Regional project: Nigeria, Kenya, Ghana, Tunisia, Ethiopia, Guinea)	Min. of Energy	Min. of Energy	22 Dec. 2020 / under review by GCF sec	170.0	723.0	893.0
7.	Building climate resilience of the agriculture sector in Ghana through improved climate information and early warning services	Water Resources Com.	UN Env.	22 Dec. 2020 / under review by GCF sec	10.0	1.0	11.0
8.	Green Cooling – Accelerating the transformation to climate-friendly and energy-efficient air conditioning (Costa Rica, Ghana (Amount: Euro 34.96Mn – rate Euro 6.82, US$5.72) (Regional project)	EPA	GIZ	22 Dec. 2020 / under review by GCF sec	41.7	15.8	57.4

6.3 Non-monetised climate support received.

Ghana continued to receive capacity-building, technical assistance, and technology support to strengthen its mitigation efforts. The summary of climate support received for 2016-2021 is shown in Table 41.

Table 41: Information on non-monetised support received (2014-2021)

Activity	Developed country or partner	Status/Remarks
Information matter project. Training on GHG data management in the waste sector	German Federal Ministry for Economic Completed in Cooperation and 2018 Development (BMZ), GIZ	
Reporting for results-based REDD+ actions (RRR+). Hands-on training on the Use of 2006 IPCC guidelines for the AFOLU sector. Technical support to the Forestry Commission during the Technical Assessment of Ghana's FRL under the UNFCCC.	Coalition for Rainforest Nations	Completed
Training on non-annex 1 GHG Inventory software	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	2016, 2017, & 2018, 2019, 2021
UNFCCC GIR CASTT Training Programme on Greenhouse Gas	UNFCCC and the Government of Korea	2016, 2017, 2018
Training on Low Emission Analysis Platform	Stockholm Environment Institute	2016, 2019, 2020
Training on the GACMO model for the construction of the NDC baseline	UNEP-DTU	2017, 2019
Training on Annex 1 Party GHG Review, including methodological, reporting and review guidelines.	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	1 LULUCF expert qualified as a reviewer in 2017
Sustainable GHG Management Project in West Africa: Third-Party Review of National GHG Inventory Review - AFOLU Section. Training on Land uses mapping using the Google Maps engine tool.	Australia, USA, Netherlands, UK, Belgium, New Zealand, UNFCCC, FAO, UNDP, UNDP	Completed in 2017
Training on advanced topics on GHG inventory for a national expert	UNDP Nationally Determined Contribution Support Programme	2019
Collaboration on West Africa GHG Inventory Network	UNDP, Global Support Programme (GSP)	2018
Integrated LED modelling project	United Nations Environment Programme	On-going
Preparation and use of the National GHG Manual and Uncertainty Management Guidance document	UNDP Low Emission Capacity Building Project	Completed in 2017
Training on GHG fresh entrants and experts	CBIT Project	2021
Advanced training of the Modalities, Procedures and Guidelines (MPG) for Article 13	CBIT Project	2021
Training on Advance topics on GHG inventory and mitigation actions	BUR3 Project	2020 and 2021
Training programme for review experts under UNFCCC	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	2019
Joint Global Training Workshop on the Energy Sector for Developing Countries to Prepare for an Effective	United Nations Framework Convention on Climate Change	2019

Enhanced Transparency Framework under the Paris Agreement	(UNFCCC) Secretariat and International Energy Agency	
Training programme for review experts for the technical review of biennial reports and national communications of Parties included in Annex I to the Convention	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	2020
CGE training programme for technical experts undertaking technical analysis of biennial update reports from parties not included in Annex I to the Convention	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	2020
UNFCCC QA Global Sock Take Workshop (14 - 15 October) and FLINT training workshop	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	2019
UNFCCC-GIR-CASTT (Climate Action and Support Transparency Training) Programme	UNFCCC and GIR	2018
23rd Annual IEA-IETA-EPRI Workshop on Greenhouse Gas Emissions Trading	IEA	2023
Emissions Trading in the Paris Era – How it's Done: by Swedish Energy Agency	Sweden Energy Agency	2023
Options for roles and the interplay between Article 6 and voluntary carbon market.	Climate perspectives	2023

6.4 Support received during BUR Preparation

The Global Environment Facility (GEF) funding under the Enabling Activities was Ghana's only direct funding to prepare the BUR4. Following the approval of the BUR2 project proposal, Ghana received funding support of $352,000 through the UN Environment as the implementing agency. The GEF funding enabled Ghana to compile the BUR4. However, the funding was inadequate to cover the full cost of preparing the BUR4. The contributions from other partners through technical assistance contributed to compiling the BUR4. Below is the main technical assistance Ghana received in preparing the BUR4:

- UNEP-DTU ICAT Project uses the GACMO tool to assess mitigation action and effect and uses an in-built MRV template to systematically track and monitor climate measures.
- UNDP NDC Support programme on developing the Ghana NDC tracking tool and energy sector MRV system. Ghana's NDC tracking tool is Excel-based and will be used for NDC accounting established in Article 4.13 of the Paris Agreement.
- CfRN and FAO Training: Quality Control for Collect Earth Database to prepare a land-cover map for Ghana.
- Remote Training on the Building of Sustainable National Greenhouse Gas Inventory Management Systems-Ghana organised by the UNFCCC in collaboration with the US Environmental Protection Agency.
- FAO's Knowledge Transfer/ Capacity Building Programme on Forest Reference Levels for Ghana.

Constraints and gaps and related financial, technical, and capacity needs

7. Constraints and gaps and related financial, technical, and capacity needs

7.1 Financial constraints and gaps

The ability to mobilise finance and capacity support are important drivers for climate action and reporting. Adequate finance and capacity support offers an essential backstop for enabling the implementation of climate action and contributes to strengthening the national arrangement for timely and continuous high-quality biennial update reports. As part of preparing the BUR4, the EPA conducted a national survey to identify major constraints and gaps in implementing climate action, including preparing this report. The survey highlighted the following key financial constraints and gaps:

- Funding for climate change activities, including BUR preparation, is mostly donor-driven and project-based. There are no clear sustainable funding sources for BUR preparation at the national level. Ghana's contribution to the BUR preparation is mainly through in-kind support. The current funding gap for the BURs is a challenge for the continuous preparation of the report and the subsequent consideration stage. In the future, as reporting under the Paris Agreement will get more frequent, elaborate, and structured reviews, it was recommended that the EPA explore sustainable finance for climate reporting to complement the GEF's funding.

- The cost of continuously decentralising data gathering and climate reporting to the facility level can be high for the companies. Even though the approach to involve companies more in the reporting is welcomed, it must be done effectively to minimise the burden on the facilities. One way of getting the companies' buy-in is to build the internal technical capacities of the targeted facilities. With the internal capacity, the facilities can collect data for reporting cost-effectively. In response, the EPA is designing the "facility-level GHG inventory reporting programme" to seek funding to support local companies.

- Lack of transparency on reporting non-financial support for training and technical assistance makes monitoring and reporting non-monetary support difficult. Many institutions receive donor training and technical assistance support without financial disclosure because the funding source is part of the global budget. When such situations arise, reporting becomes difficult because the recipient organisation lacks full access to the funding and accounting information.

- Limited access funding for continuous data generation, collection, archiving, and distribution. Data generation and sharing costs can be prohibitive if no support system is available. Academic institutions or even data providers within the public service cannot undertake research without proper incentives to contribute critical country-specific data to inform climate reporting. The survey recommended that the EPA works with data providers to explore sustainable options for mobilising finance.

7.2 Capacity needs and capacity support received.

During the report consideration stage of the BUR2 and BUR3 under the International Consultation and Analysis (ICA) process, Ghana, together with the Technical Team of Experts (TTE), identified the following capacity-building needs that could facilitate the preparation of subsequent BURs and participation in ICA:

- Collection of activity data on the consumption of F-gases, particularly SF6.
- Collection of activity data and EFs to support the development of a tier 2 method for road transport.
- Support in expanding the current facility-level carbon accounting programme, considering lessons from the public electricity utility's current voluntary carbon accounting programme.
- Development of solid waste and wastewater balances to better understand the flow of solid waste and wastewater from the point of generation to the end site (e.g., solid waste disposal sites in the case of solid waste, or seas, rivers or lakes in wastewater).
- Data collection to improve upon the current expert judgement in allocating manure into various manure management systems.
- Developing concrete category-level plans to collect the necessary uncertainty values for AD, EFs and parameters.
- Aggregating the project-level results of mitigation actions to sectoral and national totals.
- Performing an ex-ante assessment of non-mitigation benefits of mitigation actions.
- Develop country-specific EFs for key categories and improve the accuracy of estimated emissions for key categories.
- Technical capacity to conduct uncertainty analysis for specific sources and sinks, including the capacity of data owners to estimate the uncertainty of the AD that they provide.
- Technical capacity to perform QA/QC activities for the information received from data owners and on the final BUR when reporting on mitigation actions.
- Enhancing the capacity to estimate fugitive emissions from oil and gas.

Table 42 gives the overview of the support needed and the status of implementation of the capacity building needs identified in the technical analysis of Ghana's second and third biennial update reports.

Table 42: Information on capacity building needs and status of implementation of needs identified during the Technical Analysis of the second BUR2

Activity	Objective	Amount Needed ($)	Implementing Entity	Identified by	Priority	Status
Study fugitive emissions in the oil & gas industry.	Make available high-quality activity and emission factors from oil and gas	300,000	EPA, Energy Commission, Petroleum Commission	Ghana	High (GHG inventory KCA)	Not started due to lack of funds.
Develop country-specific emission factors for road transport, livestock, solid and domestic liquid waste, and improvement in data collection systems	Increase confidence in the estimation of GHG emissions data on transportation, livestock, and waste	1,000,000	EPA, Ministry of Transport, DVLA, Energy Commission, Ministry of Food and Agriculture	Ghana	High (GHG inventory KCA)	It did not start because of unsecured funds. CBIT project assessed data systems in transport, energy, waste and agriculture. The government of Australia is supporting selected research institutions in Ghana to develop tier 2 and country-specific factors for livestock emissions.
Collection of AD and EFs to support the development of a tier 2 method for road transport.				Technical Team of Experts and Ghana	High (GHG inventory KCA	
Data collection to improve upon the current expert judgement in the allocation of manure into various manure management systems.				Technical Team of Experts and Ghana	High (GHG inventory KCA	
Development and improvement of non-energy sector mitigation assessment	Estimate mitigation potential in non-energy sectors with increased certainty.	200,000	EPA and relevant sectors	Ghana	Medium	Started ICAT project using the GACMO tool.
Development of solid waste and wastewater balances to better understand the flow of	Identify and collect activity data and improve ways for continuous collection.	200,000	EPA and Ministry of Local Government and Rural Development	Technical Team of Experts and Ghana	High (GHG inventory KCA	The government of Canada is supporting the Ministry of Sanitation in developing a material

solid waste and wastewater from the point of generation to the end site (e.g. solid waste disposal sites in the case of solid waste, or seas, rivers or lakes in wastewater).						flow analysis for selected District assemblies in Ghana.
Improve data collection on wood fuel supply and consumption	Improve the quality of activity data and emission factors for estimating involving the use of traditional solid biomass	350,000	Forestry Commission, Energy and EPA	Ghana	Medium	Not started due to lack of funds. Need a partner to develop a project proposal to seek international funding.
Support expanding the current facility-level carbon accounting programme, considering lessons learned from the public electricity utility's current voluntary carbon accounting programme.	Facilitate regular reporting of emissions and activity from the industry.	120,000	EPA, Ministry of Trade, Associations of Industry, Association of Ghana Industries	Technical Team of Experts and Ghana	High	Received funding from UNDP under NDC-SP to incorporate GHG inventory data into the annual environmental report for the industry. Additional funding is needed to implement the activity industry-wide.
Energy statistics development and Improvement project	Improve the quality of energy statistics, including its metadata and uncertainty estimation.	150,000	Energy Commission, EPA, Ghana Statistical Service	Ghana	High	Not started due to lack of funds.
Collection of AD on the consumption of F-gases, particularly SF6.	Collect relevant industry and ODS activity data through a national survey	130,000	EPA, Ministry of Trade, Ghana Custom Services	Technical Team of Experts and Ghana	High	Some administrative data on SF6 has been collected and used for the GHG inventory.
Aggregating the project-level results of mitigation actions to sectoral and national totals.	Improve the methodology for computing the sectoral and economy-wide mitigation commitment	30,000	EPA	Technical Team of Experts and Ghana	High	Support provided through the ICAT project on using the GACMO model allows for the systematic and transparent aggregation

	from individual mitigation actions.					of the emission reductions of individual mitigation actions.
Performing an ex-ante assessment of non-mitigation benefits of mitigation actions.	Assess the non-GHG benefits of mitigation actions	100,000	EPA	Technical Team of Experts and Ghana	Medium	Under the ICAT project, Ghana is Sustainable Development Methodology for Assessing the environmental, social and economic impacts of policies and actions
Develop country-specific EFs for key categories and improve the accuracy of estimated emissions for key categories.	Increase the accuracy of the emissions estimation for the key categories	1,200,000	EPA and key research institutions in the country	Technical Team of Experts and Ghana	Very high	Not started due to lack of funds. The activity is a priority for Ghana to meet the reporting requirement in the MPGs.
Technical capacity to conduct uncertainty analysis	Operationalise the system for performing uncertainty assessment in the GHG inventory transparently.	50,000	EPA and uncertainty management lead institution	Technical Team of Experts and Ghana	High	A general uncertainty assessment has been implemented in this BUR4. Technical training is needed to develop the capacity of the inventory team.
Capacity to estimate fugitive emissions from the oil and gas industry	Strengthening institutional capacity for estimating estimate fugitive emissions from the oil and gas industry based on the 2006 IPCC Guidelines.	120,000	EPA	Technical Team of Experts and Ghana	Medium	Not started due to lack of funds.

7.3 Technology needs and support received.

7.3.1 Technology needs

Ghana has developed two technology needs assessments (TNA) in 2003 and 2013. Both assessments produced priority mitigation and adaptation technology options for addressing climate change. The 2003 assessment highlighted mitigation technology options in the Energy and Waste sectors. The 2013 TNA focused on adaptation technologies in the Water and Agriculture sectors. Although the 2013 TNA is the most current, it is nearly seven years old and needs to be updated to reflect its current technology needs (Table 43).

Table 43: Climate technology options identified in 2003 TNA.

Priority technology option	2003 TNA	Comments
Biofuels	x	
Industrial energy efficiency improvement	x	Consistent with Ghana's nationally determined contributions
Energy efficiency lighting	x	Aligns with 12 prioritised NAMAs. Ghana's NDCs and the Strategic National Energy Plan.
Solar PVs	x	Aligns with Ghana's SEforALL Action Plan; 12 prioritised NAMAs, Renewable Energy Master Plan, Strategic National Energy Plan and Ghana's updated NDC, Ghana's framework for the international carbon market and non-market mechanism
Natural gas combined cycle and Natural gas distribution system	x	The technology aligns with Ghana's nationally determined contributions, the National Gas Master Plan.
Management technologies and efficiency improvement in the transport sub-sector or BRT	x	The technology aligns with Ghana's NDC, National Transport Policy.
Wind Energy	x	The technology aligns with Ghana's NDC, Renewable Energy Master Plan, Strategic National Energy Plan, and Scaling Up Of Renewable Energy Penetration Investment Plan (SREP-IP).
Solar water heater	x	Renewable energy master plan, strategic national energy plan, Ghana's SEforALL Action Plan, SREP-IP
Small and mini-hydro	x	The technology aligns with the Renewable Energy Master Plan, Strategic National Energy Plan, SEforALL Action Plan, SREP-IP and NDC.
Biomass for power generation (co-generation from sawmill residues)	x	The technology aligns with The Renewable Energy Master Plan, SEforALL Action Plan.
Landfill methane gas capture for power generation	x	The technology aligns with Ghana's NDC and the Renewable Energy Master Plan.
Anaerobic and CH_4 generation technologies for wastewater handling (Biogas technologies)	x	The technology aligns with Ghana's SEforALL Action Plan, 12 prioritised NAMAs, the Renewable Energy Master Plan and Ghana's nationally determined contributions.

Incineration	x	
LPG and improved stoves		Aligns with Ghana's SEforALL Action Plan, Strategic National Energy Plan, LPG Promotion Policy, Renewable Energy Master Plan, National Gas Master Plan, Clean Development Mechanism (CDM), NDC, and ITMOs.
Efficient fridges		Strategic National Energy Plan and the nationally determined contributions.

Similarly, the top technology lists from the 2013 TNA aligned with relevant government policy documents. Among them are the National Climate Change Policy, National Climate Change Adaptation Strategy, National Disaster Management Plan, Nationally Determined Contribution and the Strategic Medium-Term Development Plan for the Ministry of Works and Housing. Table 44 shows adaptation technology options and their supporting policy documents.

Table 44: Climate technology options identified in the 2013 TNA.

Priority technology portfolios	Sector	2013 TNA	Links to policy	Comments
Rainwater collection from ground surfaces	Water	x	x	The technology aligns with the National Water Policy.
Post-construction support for community-managed water systems	Water	x	x	The technology aligns with the National Water Policy.
Improving the resilience of protected wells to flooding	Water	x	x	The technology aligns with the National Water Policy.
Demarcation and protection of buffer zones for water bodies	Water	x	x	The technology aligns with the Riparian Buffer Zone Policy.
Rainwater harvesting from roofs	Water	x	x	The technology aligns with the National Water Policy.
Community-based extension model	Agriculture	x	x	The technology aligns with Ghana's NDC, Planting for Food And Jobs, with the National Climate-Smart Agriculture Action Plan.
Integrated soil nutrient management	Agriculture	x		The technology aligns with the Food and Agriculture Sector Development Policy II and the National Climate-Smart Agriculture Action Plan.
Ecological pest management	Agriculture	x	x	The technology aligns with the National Climate-Smart Agriculture Action Plan and Ghana's NDC.
Seed and grain storage	Agriculture	x	x	Aligns with Ghana's NDC, Planting For Food And Jobs (one district one warehouse programme).

7.3.2 Technology support received

Recently, Ghana adopted the national energy transition and investment plan and the national electric vehicle policy that identified additional mitigation technologies such as (a) low carbon hydrogen, (b) battery storage, (c) battery electric vehicles and (d) renewables drive the transition to net zero emission by 2060. As a result, Ghana is receiving technology support in the following areas:

- **Low Low-carbon hydrogen development** – The Ministry of Energy is interested in collaborating with GIZ to develop Ghana's low-carbon hydrogen road map. The road map will set out the practical steps for developing the market, policy and regulation to guide the hydrogen economy in Ghana.

- **Electric vehicle** – The World Bank and the UK Government, through the UK - Ghana Partnership for Jobs and Economic Transformation (JET), are supporting the development of the electric vehicle market in Ghana. The World Bank's support to the Ministry of Transport focuses on establishing regulatory frameworks.

- **Solar Irrigation** – Under the NDC Action support, the CTCN supports Ghana to upscale solar irrigation technology Options for Smallholder Farmers in Ghana through innovative financing Mechanisms, a conducive policy framework for technology regulation and tailored training modules.

- **Green ACs/Refrigeration** – GIZ is supporting the EPA and Energy Commission to promote the adoption of green (low-GWP emitting refrigerant and energy efficient) ACs and Refrigeration in the country. In this regard, Ghana is implementing the following:

    - ECOFRIDGE initiative, a U4E initiative supported by K-CEP to use innovative financial mechanisms to replace outdated refrigerators.
    - Kigali First Movers Initiative seeks to provide a financing mechanism effectively and sustainably in the cooling sector to support the initiative countries in achieving mitigation efforts that also contribute to their National Determined Contribution
    - Market Transformation through the introduction of green split AC.

7.4 Economic and Social Consequences of Response Measures

7.4.1 Assessment of Consequences Response Measures

The guidelines in Annex III to Decision 2/CP.17 include economic and social consequences of Response Measures (RM). The information in the BUR3 provides the latest update on assessing the consequences of response measures in Ghana. It builds on the information on RM reported in Ghana's Fourth National Communication (NC4) submitted to the UNFCCC in 2019. In the NC4, Ghana has reported information on the progress of studies on the consequences of RM and training programmes in the following areas:

- The EPA partnered with the International Labour Organisation (ILO) to provide the Green Jobs Assessment Model (GJAM).

- Training on the social and employment implications of climate policies and NDC Green Jobs Assessment Model for Ghana.

In the BUR4, Ghana reports on the latest assessment of the Impacts of Response Measures: Ghana Case Study conducted by the European Roundtable Climate Change and Sustainable Transition (ERCST) in collaboration with Ghana's EPA. The study aimed at identifying, measuring, and analysing the impacts of implementing response measures in Ghana. It also helped test, refine, and improve the methodology ERCST has developed in different countries. The study identified global response measures that could have adverse economic and social consequences on some selected sectors in the country. Carbon taxes, subsidies, Carbon Border Adjustment Mechanism (CBAM), organic standards and labelling requirements for agricultural goods and basic materials, and aviation and shipping measures.

The assessment identified several vulnerable sectors in Ghana that are at risk of impacts: palm oil, fishing, oil and gas, manufacture of beverages and food products (Joboba oil), mining and quarrying without oil and gas and gold (Aluminium and Manganese). The next study will continue to assess the impacts of international responses on key economic sectors in Ghana. The assessment will focus on the following areas:

- Response measures: IMO carbon tax
  - Vulnerable sectors in Ghana: oil and gas, mining and quarrying without oil and gas, gold (and aluminium and manganese), and fishing products.

- ICAO/CORSIA carbon tax
  - Vulnerable sectors in Ghana: fishing products, oil and gas, tourism.

- EU CBAM tax
  - Vulnerable sectors in Ghana: oil, aluminium, and manganese.

Annexes

Annexe 1: Non-Annex 1 Reporting Table 1

Inventory Year: 2021

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)		
Categories	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
Total National Emissions and Removals	33,725.19	336.19	28.66	581.51	507.47	0.46
1 - Energy	25,226.84	32.83	1.57	-	-	-
1.A - Fuel Combustion Activities	25,226.84	19.38	1.57	-	-	-
1.A.1 - Energy Industries	6,842.45	1.31	0.17			
1.A.2 - Manufacturing Industries and Construction	1,725.27	0.57	0.09			
1.A.3 - Transport	15,507.69	5.39	0.97			
1.A.4 - Other Sectors	1,151.43	12.11	0.33			
1.A.5 - Non-Specified	-	-	-			
1.B - Fugitive emissions from fuels	0.01	13.45	0.0000	-	-	-
1.B.1 - Solid Fuels	-	-	-			
1.B.2 - Oil and Natural Gas	0.01	13.45	0.0000			
1.B.3 - Other emissions from Energy Production	-	-	-			
1.C - Carbon dioxide Transport and Storage	-	-	-	-	-	-
1.C.1 - Transport of CO2	-					
1.C.2 - Injection and Storage	-					
1.C.3 - Other	-					
2 - Industrial Processes and Product Use	575.49	-	-	581.51	507.47	0.46
2.A - Mineral Industry	496.67	-	-	-	-	-

2.A.1 - Cement production	30.78					
2.A.2 - Lime production	NE					
2.A.3 - Glass Production	-					
2.A.4 - Other Process Uses of Carbonates	0.07					
2.A.5 - Other (please specify)	465.82	-	-			
2.B - Chemical Industry	-	-	-	-	-	-
2.B.1 - Ammonia Production	-					
2.B.2 - Nitric Acid Production			-			
2.B.3 - Adipic Acid Production			-			
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			-			
2.B.5 - Carbide Production	NE	NE				
2.B.6 - Titanium Dioxide Production	-					
2.B.7 - Soda Ash Production	-					
2.B.8 - Petrochemical and Carbon Black Production	-	-				
2.B.9 - Fluorochemical Production				-	-	-
2.B.10 - Other (Please specify)	-	-	-	-	-	-
2.C - Metal Industry	76.75	-	-	-	507.47	-
2.C.1 - Iron and Steel Production	13.25	-				
2.C.2 - Ferroalloys Production	-	-				
2.C.3 - Aluminium production	63.50				507.47	
2.C.4 - Magnesium production	-					-
2.C.5 - Lead Production	-					
2.C.6 - Zinc Production	-					
2.C.7 - Other (please specify)	-	-	-	-	-	-
2.D - Non-Energy Products from Fuels and Solvent Use	2.07	-	-	-	-	-

2.D.1 - Lubricant Use	2.07					
2.D.2 - Paraffin Wax Use	-					
2.D.3 - Solvent Use						
2.D.4 - Other (please specify)	-	-	-			
2.E - Electronics Industry	-	-	-	-	-	-
2.E.1 - Integrated Circuit or Semiconductor				-	-	-
2.E.2 - TFT Flat Panel Display					-	-
2.E.3 - Photovoltaics					-	
2.E.4 - Heat Transfer Fluid					-	
2.E.5 - Other (please specify)	-	-	-	-	-	-
2.F - Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	581.51	-	-
2.F.1 - Refrigeration and Air Conditioning				581.51		
2.F.2 - Foam Blowing Agents				-		
2.F.3 - Fire Protection				-	-	
2.F.4 - Aerosols				-		
2.F.5 - Solvents				-	-	
2.F.6 - Other Applications (please specify)				-	-	
2.G - Other Product Manufacture and Use	-	-	-	-	-	0.46
2.G.1 - Electrical Equipment					-	-
2.G.2 - SF6 and PFCs from Other Product Uses					-	0.46
2.G.3 - N2O from Product Uses			-			
2.G.4 - Other (Please specify)	-	-	-	-	-	-
2.H - Other	-	-	-	-	-	-
2.H.1 - Pulp and Paper Industry	-	-				
2.H.2 - Food and Beverages Industry	-	-				

2.H.3 - Other (please specify)	-	-	-			
3 - Agriculture, Forestry, and Other Land Use	7,905.97	181.78	24.76	-	-	-
3.A - Livestock	-	147.02	3.68	-	-	-
3.A.1 - Enteric Fermentation		139.18				
3.A.2 - Manure Management		7.84	3.68			
3.B - Land	8,421.32	-	-	-	-	-
3.B.1 - Forest land	(3,480.52)					
3.B.2 - Cropland	13,159.18					
3.B.3 - Grassland	(2,088.75)					
3.B.4 - Wetlands	22.98		-			
3.B.5 - Settlements	533.72					
3.B.6 - Other Land	274.71					
3.C - Aggregate sources and non-CO2 emissions sources on land	2.79	34.76	21.08	-	-	-
3.C.1 - Emissions from biomass burning		18.30	1.41			
3.C.2 - Liming	NE					
3.C.3 - Urea application	2.79					
3.C.4 - Direct N2O Emissions from managed soils			18.07			
3.C.5 - Indirect N2O Emissions from managed soils			1.33			
3.C.6 - Indirect N2O Emissions from manure management			0.27			
3.C.7 - Rice cultivations		16.46				
3.C.8 - Other (please specify)		-	-			
3.D - Other	(518.14)	-	-	-	-	-
3.D.1 - Harvested Wood Products	(518.14)					
3.D.2 - Other (please specify)	-	-	-			
4 - Waste	16.89	121.58	2.32	-	-	-

4.A - Solid Waste Disposal	-	55.66	-	-	-	-
4.B - Biological Treatment of Solid Waste	-	1.98	0.15	-	-	-
4.C - Incineration and Open Burning of Waste	16.89	4.85	0.08	-	-	-
4.D - Wastewater Treatment and Discharge	-	59.09	2.10	-	-	-
4.E - Other (please specify)	-	-	-	-	-	-
5 - Other	-	-	-	-	-	-
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	-	-	-	-	-	-
5.B - Other (please specify)	-	-	-	-	-	-
Memo Items (5)						
International Bunkers	CO2	CH4	N20	-	-	-
1.A.3.a.i - International Aviation (International Bunkers)	562.17	0.02	0.02			
1.A.3.d.i - International water-borne navigation (International bunkers)	21.79	0.00	0.00			
1.A.5.c - Multilateral Operations	-	-	-	-	-	-

Annexe 2: Non-Annex 1 Reporting Table 2

Inventory Year: 2021

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)		
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
Total National Emissions and Removals	33,725.19	336.19	24.98	581.51	507.47	0.46
1 - Energy	25,226.84	32.83	1.57	-	-	-
1.A - Fuel Combustion Activities	25,226.84	19.38	1.57	-	-	-
1.B - Fugitive emissions from fuels	0.01	13.45	0.00	-	-	-
1.C - Carbon dioxide Transport and Storage	-	-	-	-	-	-
2 - Industrial Processes and Product Use	575.49	-	-	581.51	507.47	0.46
2.A - Mineral Industry	496.67	-	-	-	-	-
2.B - Chemical Industry	-	-	-	-	-	-
2.C - Metal Industry	76.75	-	-	-	507.47	-
2.D - Non-Energy Products from Fuels and Solvent Use	2.07	-	-	-	-	-
2.E - Electronics Industry	-	-	-	-	-	-
2.F - Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	581.51	-	-
2.G - Other Product Manufacture and Use	-	-	-	-	-	0.46
2.H - Other	-	-	-	-	-	-
3 - Agriculture, Forestry, and Other Land Use	7,905.97	181.78	21.08	-	-	-
3.A - Livestock	-	147.02	-	-	-	-
3.B - Land	8,421.32	-	-	-	-	-
3.C - Aggregate sources and non-CO2 emissions sources on land	2.79	34.76	21.08	-	-	-
3.D - Other	(518.14)	-	-	-	-	-
4 - Waste	16.89	121.58	2.32	-	-	-
4.A - Solid Waste Disposal	-	55.66	-	-	-	-
4.B - Biological Treatment of Solid Waste	-	1.98	0.15	-	-	-
4.C - Incineration and Open Burning of Waste	16.89	4.85	0.08	-	-	-
4.D - Wastewater Treatment and Discharge	-	59.09	2.10	-	-	-
4.E - Other (please specify)	-	-	-	-	-	-
5 - Other	-	-	-	-	-	-
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	-	-	-	-	-	-
5.B - Other (please specify)	-	-	-	-	-	-

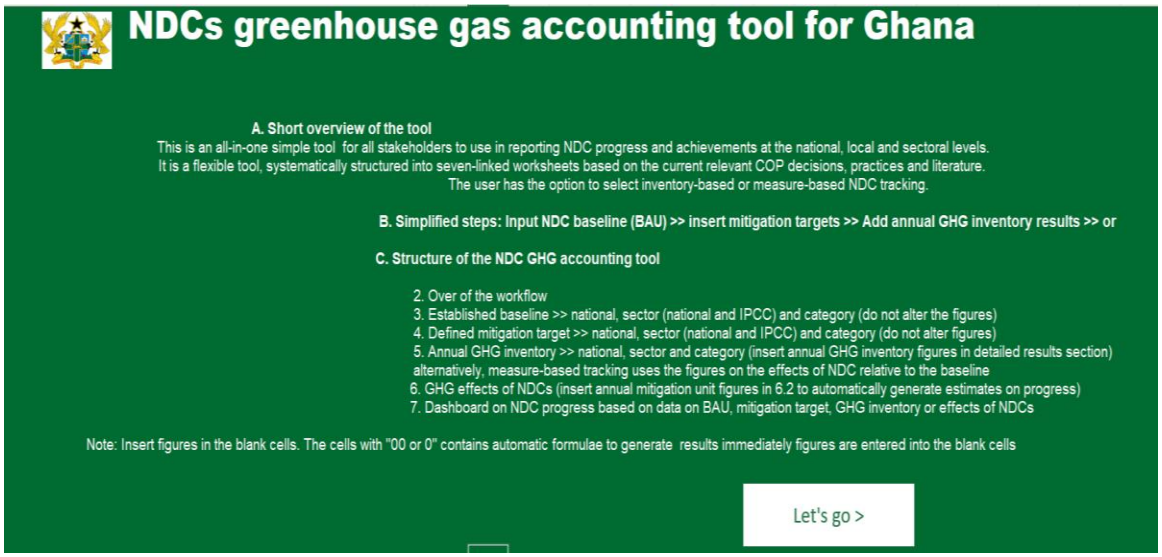
Memo Items (5)						
International Bunkers	583.96	0.0217	0.0163	-	-	-
1.A.3.a.i - International Aviation (International Bunkers)	562.17	0.0197	0.0157			
1.A.3.d.i - International water-borne navigation (International bunkers)	21.79	0.0021	0.0006			
1.A.5.c - Multilateral Operations	-	-	-	-	-	-

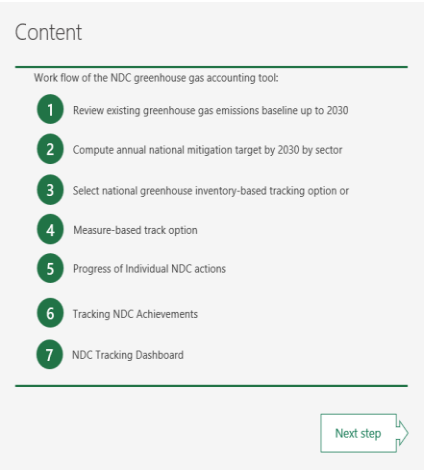
Annexe 3: NDC Indicator Tracking Template

Programme of Actions	Threshold Target by 2030	Sub-units	Indicators	Lead Institutions
Increase small-medium hydro installed capacity up to 150-300MW	300	MW	mini-hydro installed capacity	Ministry of Energy
Attain utility-scale wind power capacity up to 50-150MW	150	MW	Grid-connected wind power installed capacity	Ministry of Energy
Attain utility-scale solar electricity installed capacity up to 150-250 MW	250	MW	Grid-connected solar installed capacity	Ministry of Energy
Scale up the 200,000 solar systems for lightning in residential and non-residential buildings	200,000	500W	Number of installed solar home systems	Ministry of Energy
Establish 55 mini-grids with an average capacity of 40kW.	55	40kW	Number of 40kW mini-grids installed	Ministry of Energy
Increase solar lanterns penetration in rural non-electrified households to 2 million	2,000	1000 lamps	#of LED lamps distributed	Ministry of Energy
Scale-up adoption of LPG in at least 50% of households	134	1000 LPG stoves	#of LPG stoves adopted, % of household using LPG for cooking	Energy Commission
Scale-up access and adoption of 2 million efficient stoves	2,000	1000 efficient stoves	#of efficient stoves distributed	Energy Commission
Fuel switch from heavy fuel oil to natural gas in existing electric power plants	50	100 TJ fuel use/year	Quantity of natural gas per thermal electricity generated	Volta River Authority, IPPs
Improve the efficiency of the thermal power plants by converting the single-cycle power plants to combined cycle	3.3	100 MW increase	Amount of capacity added due to single cycle to combined cycle conversion	Independent Power Producers
Recovery and utilisation of associated gas from Jubilee and Tein oil fields	120	1 MMSCF/day	Amount of gas recovered from oil field	Ghana National Gas Company
Promote Efficient lighting with LED bulbs	20,000	1000 bulbs	#of LED bulbs distributed	Energy Commission
Scale up adoption of Efficient Refrigeration	2,000	1000 refrigerators	# of efficient refrigerators distributed	Energy Commission
Scaling up the installation of power factor correction devices in 1,000 commercial and industrial facilities (capacitor banks).	1,000	1 facility	#of industrial and commercial facilities that have installed capacitors	Energy Commission
Ghana Cocoa REDD+ Programme	270		Avoided deforested area (ha)	Forestry Commission

Ghana Shea Landscape REDD+ Programme		Avoided deforestation 1000 ha		Forestry Commission
Wildfire management in the transition and savannah drylands in Ghana				
National Forest Plantation Development Programme	660	Reforestation of 1000 ha	Areas reforested (ha)	Forestry Commission
Enrichment Planting				
HFC Reduction in the RAC sector (scale-up market share of climate-friendly and energy-efficient air-condition)	70%	Market share of green and energy-efficient air conditioners	% Of market share of green and EE air conditioners	Environmental Protection Agency
Expansion of intracity transportation modes (Bus Rapid Transit)	200	1 km BRT line	Length of BRT km	Ministry of Transport
Expansion of inter and intra city transportation modes (Railway Transit System)	TBD	TBD	TBD	Ministry of Railways
Improve the effectiveness of urban solid waste collection up to 70-90% and the construction of engineered landfills for methane recovery	14	200 t/day plant	Quantity of gas recovered from engineered landfills	Ministry of Sanitation and Water Resources
Increase the current waste-to-compost capacity of 200 t/day to 500 t/day	0.5	1000 t/day plant	Waste-to-compost processing installed capacity	Ministry of Sanitation and Water Resources
Scale-up 200 biogas facilities	1	1000 t/year plant	Quantity of biogas produced	Ministry of Sanitation and Water Resources, Ministry of Environment, Science, Technology and Innovation
Adoption of modified community-based conservation agriculture/climate-smart agriculture in 54 districts	54	Number of districts	Number districts practicing conservation agriculture/CSA	Ministry of Food and Agriculture
Scale-up penetration of climate-smart technologies to increase fisheries and livestock productivity by 10%	10	% Fisheries/Livestock Production	% Increase in fisheries/livestock production	Ministry of Food and Agriculture, Ministry of Fisheries and Aquaculture

Annexe 4: Screenshots of NDC Accounting Tool





National Sectors

Ministry	Abbreviation
Energy	MoE
Transport	MoTR
Trade & Industry	MoTI
Lands and Natural Resources	MLNR
Food and Agriculture	MoFA
Waste	MSWR

IPCC sectors

IPCC	Abbreviation
Energy	EN
IPPU	IPPU
AFOLU	AFOLU
WASTE	WS

Sub-sectors

Category	Sector
Fossil fuel power plants	
Households	
Services/commerce	
Fugitive emissions	MoE
Road Transport	
Railways	
Other transport	MoTR
Manufacturing industry	MoTI
Industrial processes	
Forestry	MLNR
Agric & Fisheries	MoFA
Agriculture	MoFA
Waste	MSWR

Simplified steps

1. Review baseline. Do not change the figures
2. Review targets. Do not change the figures
3. Insert annual GHG inventory figures (option 1) or measure-based option
4. Insert annual mitigation unit figures for each technology
5. Evaluate the overview of the individual NDC progress
6. Check NDC progress track