Republic of Ghana

Ghana's First Biennial Update Report

Ghana Government submission to the United Nations Framework Convention on Climate Change, 2015

Ghana's First Biennial Update Report

June, 2015

Foreword

Our agenda for transformation to propel the country to full middle income country is on course. The transformation is taking place not only to deliver the socio-economic aspirations we want in the medium-term, it is to usher the country into a low carbon climate resilience future. Putting our transformation agenda on low carbon climate resilience pathway is a strategic step we are taking towards securing a sustainable future for our people. It will also unlock additional economic opportunities for the greater benefits to our development.

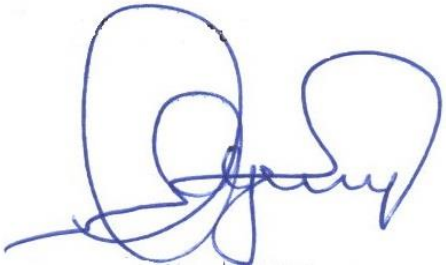
The commencement of implementation of the national climate change policy which is anchored on Ghana Shared Growth and Development Agenda kick starts our journey to low carbon climate resilience society. Although the country will be the immediate beneficiary, the impacts it will have on the global efforts to combat climate change is equally significant. For every inch of step we take in this journey we are mindful that what is stake is not only our actions that matter, but the actions of others together we can make the needed impact on the world.

It is with this hope that Ghana considers the preparation and submission of its first biennial update report another defining opportunity to showcase our resolve to be part of the collective global efforts to mitigate future climate change. Not only are using the BUR to communicate to the international community the practical steps we have taken to reduce GHG emissions in a transparent manner, it also afford us the chance to let our citizen know the positive impacts the policies and measures were embarking are having on sustainable development objectives.

Ghana takes this responsibility seriously and in this respect we have taken concrete steps in several respects. As part of our energy for all policy, we are: delivering green electricity by increasing the share of renewable energy on grid electricity by 10% in 2020; promoting universal access to electricity by 2020, vigorously pursuing demand-side energy efficiency improvements, especially in households etc. Particular mention has be made of our flagship national biogas programme which has quadruple win objectives; sanitation, energy, low carbon emissions and cost savings. We are also proud of the foundation the national forest plantation development programme and REDD+ strategy have laid for us to take off in finding sustainable solution to deforestation.

It is our believe that this BUR will not be seen as only providing a set of numbers to satisfy our obligation under the convention, but it is rather seen as truly about using the numbers to support development decision making and above all provide evidence of the level positive effects our mitigation actions are having on both emission reductions and sustainable development.

The report also contains insightful information and analysis on climate finance and capacity Ghana has received in the last four years. This good piece of information will be useful in mobilizing future climate finance and capacity. The preparation of the BUR has also offered the country another window to consolidate the gains it made in putting in place a credible national MRV architecture for monitoring the impacts of mitigation actions, GHG and support. We trust that as we continue to provide support to the national process of preparing the BUR the national system we have in place will see greater progressive improvements.



Hon. Mahama Ayariga (MP)
Minister, Environment, Science, Technology and Innovation

Preface

This report was compiled by the Ministry of Environment, Science, Technology and Innovation (MESTI) and the Environmental Protection Agency (EPA) to meet Ghana's obligation to prepare and submit Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC) by the end of 2014. Our inability to submit the BUR on time was due to delays in securing the requisite funds to support the preparation ahead of time.

The BUR has been prepared in accordance with the UNFCCC Biennial Update Report guidelines for Parties not included in Annex 1 to the Convention.

The final electronic version of this report will be made available to the general on the website of MESTI (www.mest.gov.gh) and EPA (www.epa.gov.gh).

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Our thanks also goes to:

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- UNDP through the Low Emission Capacity Building Project for provide support to the working groups.
- Member of EPA management who conducted policy and technical review of the BUR.
- All the officials of the MESTI and EPA contributed in several ways in producing this report.

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Acronyms and list of abbreviations

AfDB	Africa Development Bank
AFOLU	Agriculture, Forestry and Other Land Use (AFOLU)
APR	Annual Progress Report
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMZ	Germany Federal Ministry for Economic Cooperation and Development
BUR	Biennial Update Report
CD REDD	Capacity Development for REDD
CDM	Clean Development Mechanism
CERGIS	Centre for Remote Sensing and Geographic Information System
CFL	Compact fluorescent lamp
CfRN	Coalition for Rainforest Nations
CGE	Consultative Group of Experts
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent
CPEIR	Climate Public Expenditure and Institutional Review
DANIDA	Danish International Development Agency
DFID	Department for International Development
DVLA	Driver Vehicle and Licensing Authority
EF	Emission Factors
EFDB	Emission Factor Database
ENRAC	Environment and Natural Resources Advisory Council
EPA	Environmental Protection Agency
EU	European Union
FAO	Food and Agriculture Organization
FAOSTAT	FAO Statistics
FC	Forestry Commission
FIP	Forest Investment Programme
FOAT	Functional Organizational Assessment Tool
FORIG	Forest Research Institute
GCIC	Ghana Climate Innovation Centre
GDP	Gross Domestic Product
GEDAP	Ghana Energy Development and Access Programme
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoG	Government of Ghana
GSGDA	Ghana Shared Growth and Development Agenda
GSS	Ghana Statistical Service
GWh	Gigawatt Hours
IEA	International Energy Agency
IIPAC	Innovative Insurance Products for Adaptation to Climate Change
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Process and Product Use
IT	Information Technology

JICA	Japan International Cooperation Agency
KNUST	Kwame Nkrumah University of Science and Technology
Kt	Kilo Tonnes
M&E	Monitoring and Evaluation
MESTI	Ministry of Environment, Science, Technology and Innovation
MiDA	Millennium Development Authority
MoF	Ministry of Finance
MoFA	Ministry of Food and Agriculture
MOI	Means of Implementation
MRV	Monitoring Reporting Verification
Mt	Million Tonnes
MW	Megawatt
N_2O	Nitrous Oxide
NATU-KNUST	Faculty of Renewable Natural Resources
NCCC	National Climate Change Committee
NCCP	National Climate Change Policy
NDPC	National Development Planning Commission
NIR	National Inventory Report
NLBI	Non Legally Binding Instrument
NORAD	Norwegian Agency for Development Cooperation
NREG	Natural Resources and Environment Governance
ODA	Oversees Development Assistance
ODS	Ozone Depleting Substances
OMCs	Oil Marketing Companies
PFCs	Perfluorocarbons
PoA	Programme of Activities
QA/QC	Quality Assurance/Quality Control
REDD+	Reduction Emission from Deforestation and Forest Degradation Plus
SD	Sustainable Development
TACCC	Transparent, Accurate, Complete, Consistent and Comparable
TNC	Third National Communication
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
V & A	Vulnerability and Adaptation Assessment
VCS	Verified Carbon Standard
VPA	Voluntary Partnership Agreement

ES. Executive Summary

ES.1 National circumstances

ES.1.1: State of Ghana in the context of climate change

Ghana is a unitary democratic republic guided by the 1992 Constitution. Power is segregated among the Executive, Legislature and the Judiciary. In 2012, population was estimated at 25.4million, of which 51.2% were females and 48.8% males. About a quarter of Ghanaians are still poor whilst under a tenth are in extreme poverty. In 2010, Ghana attained Middle Income status, after rebasing the economy. The economy has expanded by nearly 97% with GDP rising from US$1.2 billion in 1960 to US$ 35.9 billion in 2012 (see figure ES1). The economy expansion and growth in population had led to a significant increase in the utilization of energy and other natural resources in industry, transport and households. This has resulted in the rise of GHG emissions, deforestation, high climate risk and environmental degradation that is estimated to cost 9.7% of GDP (World Bank, 2012). Ghana government's medium-term climate change strategy is articulated in the Ghana Shared Growth and Development Agenda (GSGDA) II and the National Climate Change Policy. The two policies are anchored on the transformation agenda in the President's coordinated programme of economic and social development policy for 2014-2020.

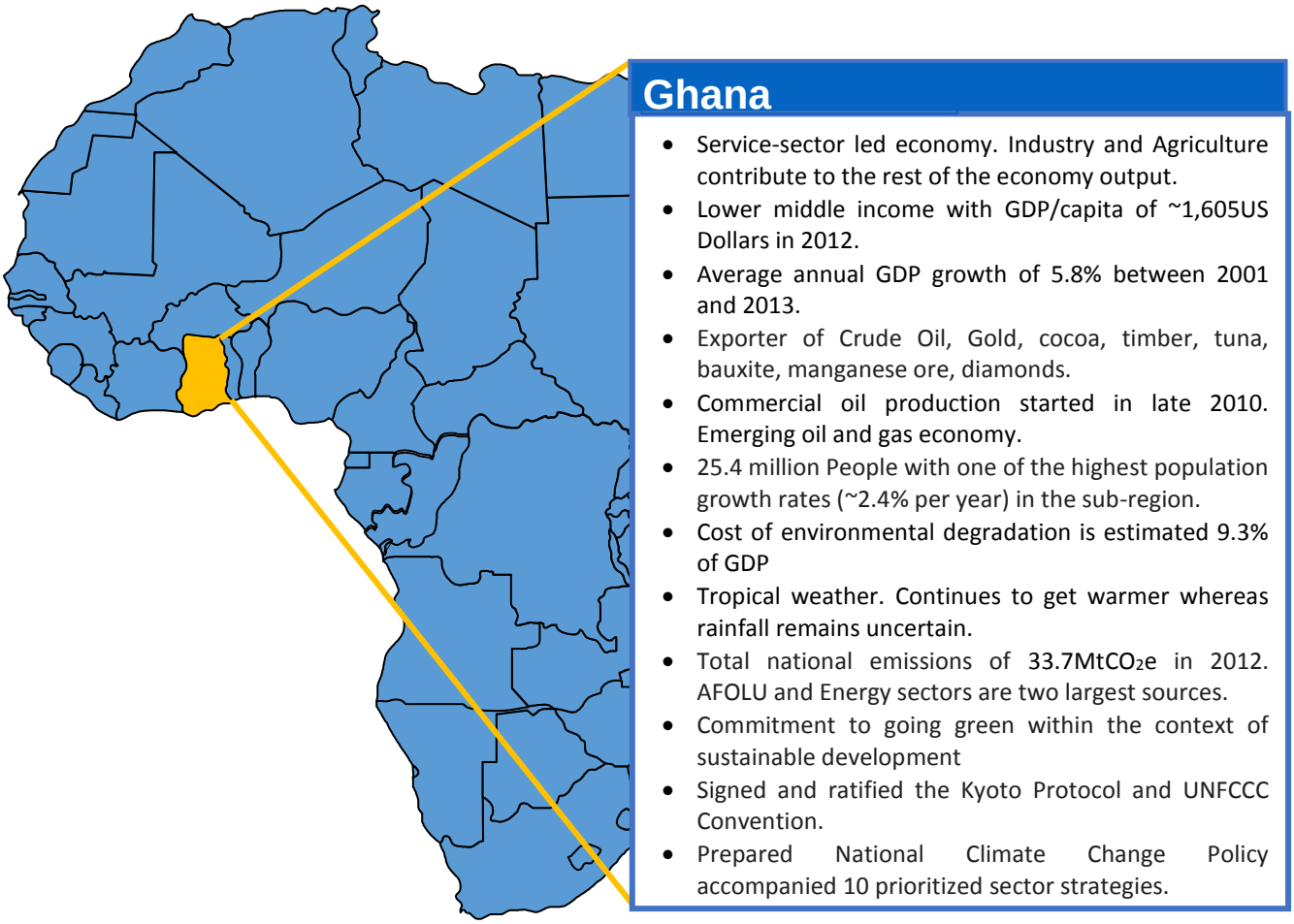

Figure ES 1: Summary of Ghana's National Circumstances in Africa Map

ES.1.2: Climate change Impacts

Ghana faces multiple threats from climate change impacts. Level of climate change impacts is mainly defined by geographic span, incidence of poverty, gender and unique ecological zone conditions. Figure ES2 summarizes the dominant climate change impacts in different ecological locations in the country.

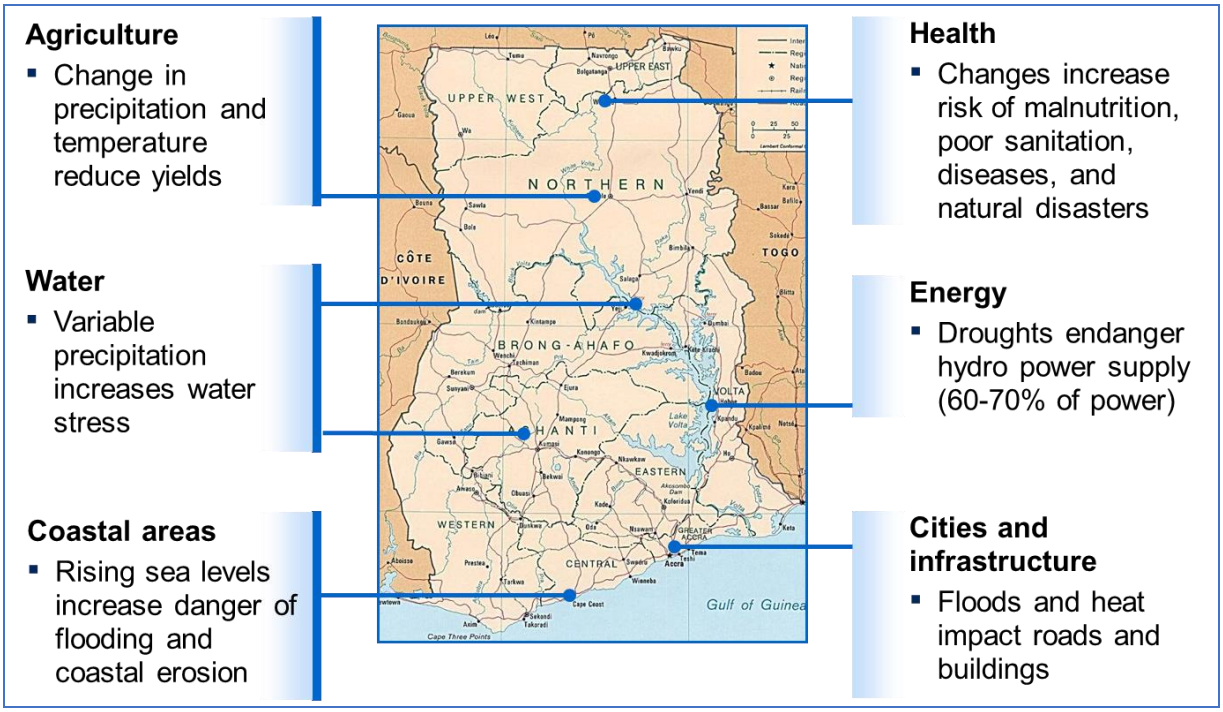

Figure ES 2: Geographic spread of key climate change impacts in Ghana

ES. 2 Institutional Arrangements

Tables ES. 1 to ES. 4 below provides institutional arrangement relevant for climate change in Ghana in the:

Table ES 1: Strategic level climate change institutions

Strategic Level Institution	Environment and Natural Resources Advisory Council
Lead Institution	Ministry of Environment, Science, Technology and Innovation
Institutions involved	Office of Vice-President, Ministries of Environment, Science, Technology and Innovation, Finance, Lands and Natural Resources and, Development Partners.
Description of roles in institutional arrangement	To provide overall policy guidance and determines strategic directions on how climate change integration into broad national development framework should be pursued. Ensure inter-ministry coordination of climate change and facilitate financial and technical resource mobilization to support implementation of climate change activities, provide political authority in order to mobilize and efforts at the sectoral level to combat climate change.
Source of mandate	Cabinet directive through the Office of President

Table ES 2: Planning, budgeting and coordination institutions

Planning, budgeting and coordination institutions	
Institutions involved	National Development Planning Commission – Development and Planning
	Ministry of Finance – Budget coordination
	Ministry of Environment, Science, Technology and Innovation – Sector policy formulation and coordination
Description of roles in institutions	These institutions are responsible for development planning coordination and Monitoring and Evaluation and mainstreaming of climate change; Coordination of budget preparation; and formulation of climate change policies.
Source of mandate	National Development Planning System Act (Act 480) and Executive Instrument (EI 7, 2009)

Table ES 3: Climate change implementation coordination institutions

Climate Change Implementation Coordination	**National Climate Change Committee (NCCC)**
Lead Institution	Ministry of Environment, Science, Technology and Innovation
Institutions involved	Parliament, Ministry of Energy , Ministry of Water Resources, Ministry of Food and Agriculture, Works and Housing, Ministry of Finance, Environmental Protection Agency, Energy Commission, Ministry of Transport, Forestry Commission, Water Resources Commission, Ghana Meteorological Agency, National Disaster Management Organization, Council for Scientific and Industrial Research, Friends of the Earth, Conservation Alliance, Institute for Statistical Social and Economic Affairs, Ministry of Foreign Affairs, Ministry of Lands and Natural Resources, National Development Planning Commission etc
Description of roles of institutions	Evolve harmonized climate change programmes from all sectors especially in the key sectors of finance and economic planning, forestry, agriculture, land and water, health, energy and coastal zones management to ensure coherence and building of synergies among these sectors. Source and utilize funding for the implementation of Climate Change mitigation and adaptation activities, and strengthen financial mechanisms for sustainable implementation; prepare a common Ghanaian position in relation to the on-going Climate Change negotiations. Such a position should as far as possible be consistent and feed adequately into the overall African position, and ultimately the Group of 77 and China but highlighting national areas of difference; Offer strong technical backstopping to the political leadership, Cabinet and Parliament in particular, to share the common African vision on efforts made to combat Climate Change in general and on the African climate platform in particular.
Source of mandate	Administrative directive from MESTI

Table ES 4: Monitoring and reporting Institutions

Monitoring and Reporting Institutions	
NDPC	Monitoring and evaluation of implementation of national development policies and programmes.
MESTI/EPA	Monitoring and evaluation of implementation of national climate change policy. International reporting and review: National Communications; National GHG Inventory; Biennial Update Reports: International Consultation and Analysis.
Ministry of Finance	Tracking and reporting domestic and international climate finance.

ES.3 National GHG Emissions Inventory

ES 3.1 Summary of the National Emission and Removal Related Trends

ES 3.1.1 Greenhouse gas trend and by sectors

Ghana's total GHG emissions stood at 33.66 million tonnes (Mt) CO_2-equivalent (CO_2e) in 2012. When the emissions from Agriculture, Forestry and Other Land Use (AFOLU) sector were excluded, the total emissions amounted to 18.49MtCO_2e for the same year. However, in the 2011, which is the official latest reporting year to UNFCCC, Ghana's total GHG emissions, excluding AFOLU sector, were estimated to be 16.51MtCO_2e. The 2011 emissions were 7.9MtCO_2e higher than 2000 levels and 10.9MtCO_2e above total emissions recorded in 1990 (See table ES.4). When the emissions from AFOLU were added, Ghana's total emissions, the net emissions came to 30.60 MtCO_2e for 2011. Similarly, the total emissions grew by 14.28MtCO_2e over 2000 levels and 16.38MtCO_2e over emissions recorded 1990.

Table ES 4: Total greenhouse gas emissions by sectors

Sectors & Sub-sectors	Emissions MtCO_2e					Percent Change		
	1990	2000	2010	2011	2012	1990-2012	2000-2012	2010-2012
1. All Energy (combustion & fugitive)	**3.50**	**5.54**	**11.27**	**11.63**	**13.51**	**286.08**	**143.65**	**19.79**
(1.A1,A2&A5) Stationery energy combustion	2.03	2.73	6.48	6.22	7.05	247.28	158.10	0.09
(1.A5)Transport	1.47	2.81	4.80	5.41	6.46	339.66	129.85	34.67
(1.B) Fugitive emission	0.000	0.003	0.001	0.001	0.002	284.71	-51.74	139.35
2. Industrial Process & Product Use	**0.81**	**0.77**	**0.24**	**0.44**	**0.47**	-42.47	-39.56	**94.24**
3. AFOLU	**8.61**	**7.72**	**14.67**	**14.08**	**15.17**	**76.28**	**96.65**	**3.46**
3A Livestock	1.72	2.20	2.82	2.80	3.05	77.29	38.66	8.01
3B Land	-3.02	-4.00	1.85	1.31	1.84	-160.73	-145.86	-0.96
3C. Aggregated and Non-CO_2 emissions	9.91	9.52	9.99	9.98	10.29	3.83	8.08	3.00
4. Waste	**1.31**	**2.29**	**4.24**	**4.45**	**4.52**	**245.97**	**97.03**	**6.54**
Total emissions (excluding AFOLU)	**5.61**	**8.61**	**15.75**	**16.51**	**18.49**	**229.31**	**114.81**	**17.36**
Total net emissions (including AFOLU)	**14.22**	**16.32**	**30.42**	**30.60**	**33.66**	**136.69**	**106.22**	**10.66**

The Ghana's total GHG emissions of 33.66 million tonnes of CO_2 equivalent in 2012 represented increases of 10.7%, 106.2% and 136.7 % in in comparison to 2010, 2000 and 1990 respectively. (See figure ES3 and table ES4).

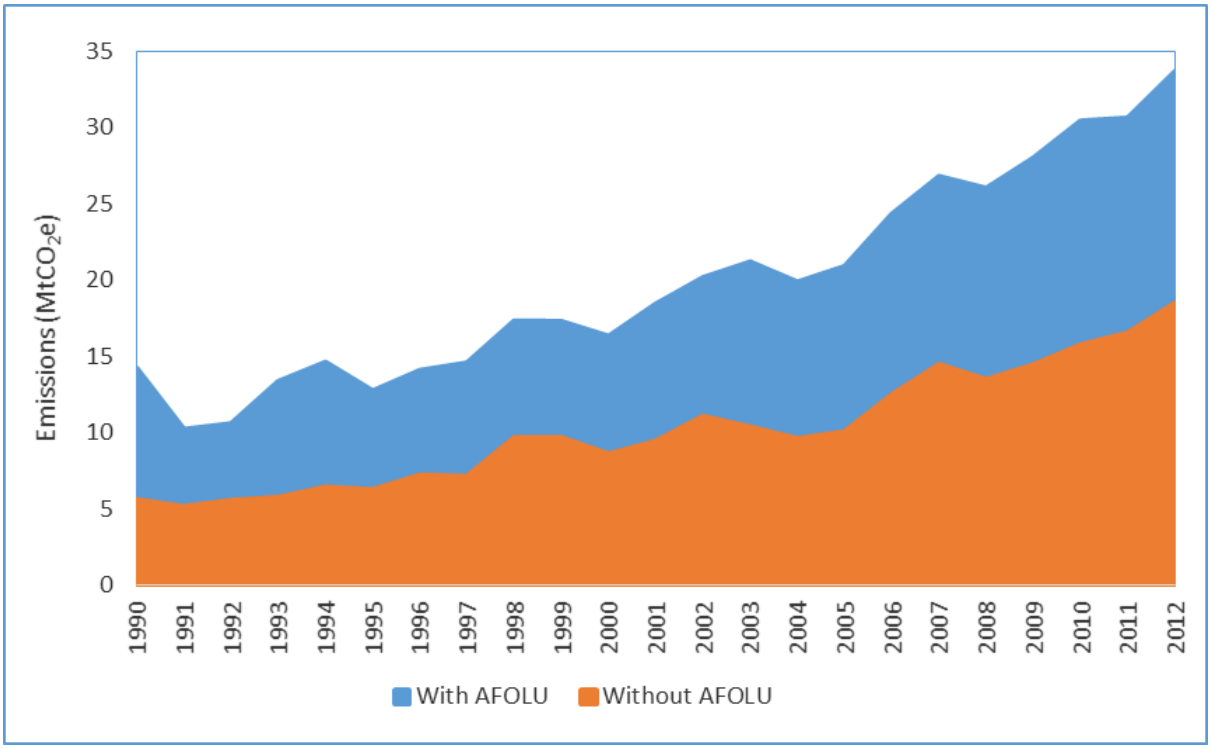

Figure ES 3: National emission trends with and without AFOLU

For the AFOLU sector:

- Emissions from aggregated sources and non-CO_2 emissions sources on land was the largest source of the total net emissions making up 30.6% (10.29MtCO_2e) and grew by 3% between 2010 and 2012.
- Livestock emissions amounted to 3.05MtCO_2e which represented 9.1% of the total net emissions and increased by 8.01% between 2010 and 2012.
- Emissions from land constituted 5.5% (1.8 Mt) of the total net emissions and decreased by 0.96% between 2010 and 2012.

Similarly in the energy sector

- Stationary energy combustion *(1.A1, 1.A2 and 1.A4)* from different point sources contributed to 38.1% of the total emission excluding AFOLU and increased by 8.76% between 2010 and 2012. When are emission from AFOLU are included, stationery emission made up 20.9% of total emissions.
- Emissions from transport made up 34.9% of total national emissions, excluding AFOLU. Transport emissions recorded increases by 34.67 % between 2010 and 2012. With AFOLU emission, transport emissions accounted for 20.9%.
- Fugitive emissions from fossil fuels (0.01% total net emissions, excluding AFOLU) increased by 58.2% between 2010 and 2012.

Emission from IPPU made up 2.5% of the total emissions excluding AFOLU. The IPPU emission increased by 94.2% between 2010 and 2012.

The observed increases in the emission trends corresponded to the on-going structural economic transformation agenda which has led to sustained growth and expansion of the national economy. The expansion in the economy has resulted in notable rise in emissions from road transport, electricity

generation from crude oil-fired thermal plants, increasing demand for biomass use. In addition, emissions from land use change also recorded increases between 1990 and 2012 mainly due to deforestation. However, with the continuous implementation of the government's national reforestation program, emissions from "land" have seen some decreases between 2010 and 2012.

ES 2.1.2 Greenhouse gas emissions by sectors and gases

The AFOLU sector was the largest source of GHG emissions followed by the energy sector in 2012. In the same year, the emission from AFOLU accounted for about 45% of the national total. The rest of the emissions came from the waste and the IPPU sectors. With respect the gases, CO_2 was the most significant, accounting for 44% of total national emissions, followed by N_2O and CH_4, which comprised 30.8% and 24.8% respectively (see figure ES5) because of the importance of the AFOLU sector to the economy. The remaining 0.3% of total national emissions was made up of PFCs (0.11 $MtCO_2e$).

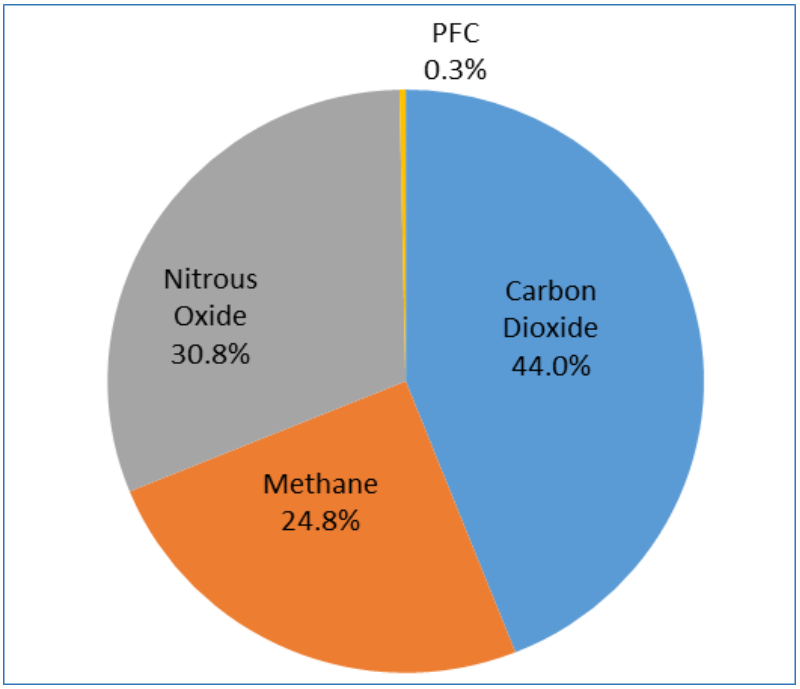

Figure ES. 4. Contribution of gases to the national emissions in 2012

Table ES 5: Trends of national total emissions ($MtCO_2e$)

Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total National Emissions and Removals	14.22	10.22	10.59	13.36	14.62	12.74	14.09	14.58	17.32	17.29	16.32	18.43	20.16	21.19	19.87	20.90	24.31	26.79	26.01	28.00	30.42	30.62	33.66
1 - Energy	**3.50**	**2.98**	**3.23**	**3.38**	**4.10**	**3.86**	**4.70**	**4.45**	**7.31**	**6.99**	**5.54**	**6.21**	**7.87**	**7.57**	**6.75**	**6.93**	**8.91**	**10.59**	**9.39**	**10.28**	**11.28**	**11.65**	**13.51**
1.A - Fuel Combustion Activities	3.50	2.98	3.23	3.38	4.10	3.86	4.70	4.45	7.31	6.98	5.54	6.20	7.87	7.57	6.75	6.93	8.91	10.59	9.39	10.28	11.27	11.63	13.50
1.B - Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
1.C - Carbon dioxide Transport and Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 - Industrial Processes and Product Use	**0.81**	**0.82**	**0.85**	**0.83**	**0.68**	**0.66**	**0.67**	**0.74**	**0.30**	**0.52**	**0.77**	**0.79**	**0.66**	**0.13**	**0.08**	**0.20**	**0.51**	**0.24**	**0.29**	**0.21**	**0.24**	**0.44**	**0.47**
2.A - Mineral Industry	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.05	0.11	0.14	0.16	0.23	0.19	0.21	0.25	0.27
2.C - Metal Industry	0.80	0.80	0.82	0.80	0.65	0.63	0.63	0.69	0.25	0.47	0.71	0.75	0.61	0.07	0.00	0.07	0.35	0.07	0.05	0.01	0.01	0.17	0.18
2.D - Non-Energy Products from Fuels and Solvent Use	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02
3 - Agriculture, Forestry, and Other Land Use	**8.61**	**5.06**	**5.03**	**7.59**	**8.18**	**6.48**	**6.86**	**7.43**	**7.65**	**7.62**	**7.72**	**8.98**	**9.09**	**10.82**	**10.26**	**10.83**	**11.83**	**12.32**	**12.53**	**13.55**	**14.67**	**14.08**	**15.17**
3.A - Livestock	1.72	1.78	1.74	1.76	1.81	1.88	1.92	1.95	2.01	2.06	2.20	2.14	2.18	2.26	2.35	2.37	2.43	2.49	2.55	2.62	2.82	2.80	3.05
3.B - Land	-3.02	-6.60	-6.44	-3.84	-3.23	-5.05	-4.67	-4.09	-3.87	-3.90	-4.00	-2.65	-2.62	-0.99	-0.76	-0.93	-0.06	0.38	0.80	1.20	1.85	1.31	1.84
3.C - Aggregate sources and non-CO2 emissions sources on land	9.91	9.88	9.73	9.68	9.60	9.64	9.61	9.57	9.51	9.46	9.52	9.49	9.53	9.54	8.67	9.39	9.47	9.45	9.17	9.72	9.99	9.98	10.29
4 - Waste	**1.31**	**1.36**	**1.48**	**1.55**	**1.66**	**1.73**	**1.85**	**1.96**	**2.07**	**2.17**	**2.29**	**2.45**	**2.55**	**2.67**	**2.79**	**2.94**	**3.07**	**3.64**	**3.80**	**3.95**	**4.24**	**4.45**	**4.52**
4.A - Solid Waste Disposal	0.09	0.10	0.17	0.19	0.25	0.27	0.33	0.35	0.41	0.44	0.50	0.58	0.63	0.71	0.76	0.82	0.88	0.95	1.03	1.13	1.23	1.31	1.44
4.B - Biological Treatment of Solid Waste	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
4.C - Incineration and Open Burning of Waste	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.03
4.D - Wastewater Treatment and Discharge	1.15	1.20	1.25	1.30	1.35	1.40	1.47	1.54	1.60	1.67	1.74	1.82	1.86	1.92	1.98	2.07	2.14	2.64	2.73	2.79	2.96	3.08	3.01
International Bunkers	**0.04**	**0.07**	**0.11**	**0.05**	**0.11**	**0.07**	**0.18**	**0.18**	**0.26**	**0.29**	**0.34**	**0.20**	**0.23**	**0.23**	**0.27**	**0.30**	**0.49**	**0.45**	**0.48**	**0.55**	**0.58**	**1.73**	**1.20**
1.A.3.a.i - International Aviation (International Bunkers)	0.03	0.06	0.10	0.05	0.10	0.07	0.17	0.18	0.26	0.29	0.34	0.20	0.23	0.22	0.27	0.30	0.29	0.31	0.30	0.31	0.27	0.34	0.35
1.A.3.d.i - International water-borne navigation (International bunkers)	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.21	0.14	0.18	0.24	0.31	1.40	0.85

ES.4 Mitigation Actions and their effects

ES. 4.1 Mitigation opportunities in the sectors

Many of the mitigation actions Ghana has been implementing have significant sustainable development contributions. The actions, which are mainly a combination of a variety of policies and measures, cut across most sectors at different developmental levels. The opportunities in the various sectors are shown in figure ES.5. The mitigation opportunities are shown relative to the emissions from the economic sectors. The mitigation opportunities are with considerable sustainable development benefits that existing the AFOLU, electricity, transport and the waste sectors. In all, twelve key mitigation actions and their effects are reported with their overall expected GHG impacts of 2.22MtCO_2e in 2012 compared with the 33.7MtCO_2etotal emissions. This translated to 6.6% emission reduction impacts. Eight mitigation actions are in the energy and transport sectors whereas four are in the AFOLU sector. In the energy sector, there were eight mitigation that actions cover renewables, energy efficiency and road transport interventions. Their overall GHG impacts amounted to 531.9kt. The rest were AFOLU sector mitigation actions that contributed and 1,688.1kt (see table ES 6).

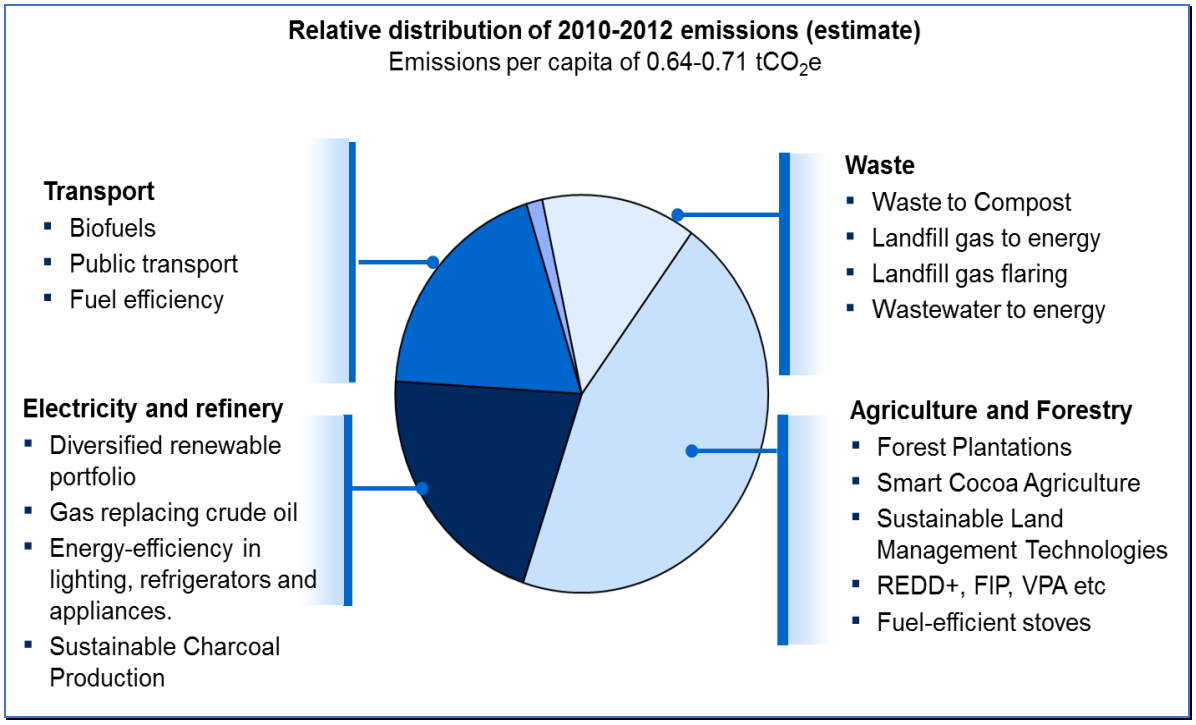

Figure ES 4: Share of GHG emissions and opportunities in key economy sectors

The summary information on mitigation actions, GHG and effects and cost are shown in table ES6.

Table ES 6: Tabulated information on mitigation actions and their effects

Mitigation Actions		GHG Impact (kt)	Co-benefits	Cost[1] ($) in mil	Status
Solar Lantern Replacement Programme		1.29	Avoided US$ 34 million annual kerosene subsidy	2	On-going
Solar Electrification Programme		5.21	Support Rural development	Unknown	On-going
Efficient Lightning – CFL replacement programme		121	Saved 124MW peak hour electricity	15	Completed
Efficient fridge market transformation and rebate programme		3.6	Save energy, money for households, ODS phase out and create downstream jobs	6.1	Completed
Installation of Power Factor Correction Devices (Capacitors)		6	Monthly electricity cost saving to consumer	5.9	On-going
Bus Rapid Transit in Accra		10.2	5% increase in Non-motorized transport	29	On-going
Fuel diversification for thermal electricity generations	Domestic Gas	148.8	Annual US$ 500 million savings from crude oil import and foreign exchange cost	1000	Started
	Nigerian Gas	235.9	94-109 million savings from crude oil cost	500	On-going
National Forest Plantation Programme		44.7	Annual 29,000 jobs, 370 metric ton of staple food, 15,300 (ha) rehabilitated areas	52	On-going
Cocoa REDD+ Programme		1,200	Double cocoa productivity, reduce deforestation	~60	Planned
Forest Investment Programme		440	Reduce deforestation, Promote Biodiversity conservation	50	On-going
Sustainable Land Water Management Project		2.6	Livelihood support	8.75	On-going

[1] *This is gross cost. It does not include subsidy savings for which net cost would have been reported.*

ES.4.2 Summary mitigation actions and effects

ES.4.2.1 Domestic Mitigation Actions and effects

Brief description of domestic mitigation actions are provided in figures ES6 to ES9 below.

Mitigation Actions	Description of Effects
Solar Lantern Replacement Programme	• Distribute 200,000 solar lanterns to rural homes • Cost effective alternative to grid connection • 1.29ktCO_2e/yr. emission reduction. • Avoided US$ 34 million annual subsidy on kerosene • Cost: US$ 2million. Domestic Contributions
Solar Electrification Programme	• Establish 3.54Mw national grid connected utility-scale solar systems. • Installation of 9,536 solar systems in deprived off-grid communities from 2009 to 2014 (~3.41MW). • 5.21ktCO_2e/yr. emission reduction. • Cost: Unknown at time of publication
Efficient lighting -CFL	• Replacing incandescent lighting with higher efficiency bulbs. • Cost effective alternative with longer lifespan. • 121ktCO_2e/yr. emission reductions. • 124MW of peak hour electricity saving. Translated to US$ 3.6million. • Cost: US$15 million. Domestic contributions

Figure ES 5: Mitigation actions in renewable energy and their effects

Mitigation Actions	Description of Effects
Efficient Fridge Market Transformation	• Replacing used and inefficient fridges with efficient fridges. • Save energy, money and environment. Create jobs. • 3.6ktCO_2e/yr. emission reduction. • Phasing out ODS • Save 172.8GWh/annum • Cost: $6.1 million. GEF
Installation of Capacitor Bank	• Install 27 capacitors in commercial public buildings and upscale to 1,047 commercial and industry electricity consumers. • 5.9ktCO_2e/yr. emission reduction. • Monthly maximum demand savings • Cost: $ 5.9 million. Domestic Contributions
BRT Urban Buses	• Construction and operation of BRT on the existing mix traffic situation on the Kasoa – CBD corridor in Accra. • Increased number of NMT trips by 5% on the corridor • 10.2ktCO_2e/yr. emission reduction • Cost: $ 29million. GEF, World Bank, AfDB

Figure ES 7: Mitigation actions in energy efficiency and transport and their effects

Mitigation Actions	Description
Fuel Diversification for electricity generation (Nigeria Gas)	• Replacing natural gas from Nigeria with Light Crude oil for electricity generation. • Lifetime of project expected to save between US$94 million and US$109 million from crude oil cost. • 235.9ktCO2e/yr. emission reduction. • Cost – $500 million
Fuel Diversification for electricity generation (Domestic Gas	• Natural Gas Recovery and Utilization from Jubilee Field that otherwise would have been flared or vented. • 120 million sscf of gas per day for VRA thermal plants • 148.84ktCO_2e/yr. emission reduction. • Annual fuel cost savings US$ 500,000 • Cost – $ 1billion. GoG through Chinese loan.

Figure ES 8: Mitigation actions on fuel diversification for electricity generation and their effects

Mitigation Actions	Description
National Forest Plantation Development	• Restore forest cover to 15,300ha in degraded forestlands every year. • Create an average of 29,000 direct jobs yearly. • Produce 370Mt food annually. • 44.7ktCO$_2$e/yr. emission reduction. • Cost: $52 million. GoG and Private sector
Cocoa REDD+ Programme	• REDD+ result-based payment in Cocoa Landscape • Double yield per ha, average production of 400 kg/ha, and would result in an additional annual income of $650/ha. • 1,200 ktCO2e/yr emission reduction. • Cost: ~$60 million. World Bank
Forest Investment Programme	• Promote Climate-Smart Cocoa Landscapes on 110,000 ha cocoa landscape • Conservation of biodiversity ecological networks and corridors • 440ktCO$_2$e/yr emission reduction • Cost: $ 50million. World Bank, IFC, AFDB
SLWMP	• Landscape approach to sustainable land and watershed management. • Livelihood support • 2.6 ktCO$_2$e/yr. emission reduction • Cost: $8.75million. GEF/World Bank

Figure ES 6: Mitigation actions in the AFOLU sector and their effects

ES. 4.2.2 International Market Mechanism

Clean Development Mechanism (CDM) – Tables ES7 and ES8 contains a list and the status of CDM projects and Programme of Activities (POA) in Ghana.

Table ES 7: List of CDM projects in Ghana

Project	Sector	Status	Registration Date	Reductions (ktCO$_2$e/yr)	Crediting Period
Zoomlion Ghana Limited Ghana Limited: Composting of Municipal Solid Waste in Accra Area	Waste (Compost)	Registered	23rd March, 2012	68	23rd March 12 to 22nd March 2022 (Fixed)
Jubilee Oil Field Associated Gas Recovery and Utilization Project	Oil & Gas (Oil field flaring reduction)	Registered	19th Dec. 2012	2,603	31st Dec 2014 to 30th Dec. 2024 (Fixed)
Project Asona - CCGT – Takoradi - Ghana	EE Supply Side (Single cycle to combined cycle)	Validation		347	
Oblogo 1 Landfill Gas Recovery and Flaring Project	Waste (Landfill gas)	Validation		22	

Table ES 8: List of POA Ghana is participating in under CDM

Title	PoA Boundary	Region	Coordinating Entity	Status	1st period $ktCO_2/yr$	PoA Life time	Years
CPA- GA-001-Ghana		Ghana	Green Development AS	Registered	111.4		7
African Improved Cooking Stoves Programme of Activities	Ghana, Nigeria		Envirofit International	Registered	240.1	13-Dec-11	
African Improved Cooking Stoves Programme of Activities – CPA No. 00001 (Ghana)		Many	Envirofit International	Registered	15.5		7
African Improved Cooking Stoves Programme of Activities – CPA No. 00002 (Ghana)	Ghana	Entire country	Envirofit International	Registered	47.0		10
Standard Bank Renewable Energy Programme–Solar Bundled CPA in SADA zone	Ghana, Kenya, Mauritius	Upper West	Standard Bank	Registered	1.1	22-May-12	10
Standard Bank MSW Composting Programme (Kumasi Composting Plant at Adagya)	Ghana	Ashanti	Standard Bank	Registered	27.9	25-Apr-12	10
CPA-1: Oti Landfill gas capture, flaring and utilization at Kumasi (Ghana)		Ashanti, Ghana	Puresphere Limited	Registered	103.2	20-Mar-12	7
Clean Cook Stoves in Sub-Saharan Africa by Climate Care Limited Cook Clean Ghana Limited —CPA01		Ghana	ClimateCare Limited	Registered	136.7	16-Jun-12	
Decentralized Community Water Purification System installations in Ghana, Africa		Volta, G. Accra, Eastern, Northern, Ashanti, Brong Ahafo	Water Health India Pvt.	At Validation	19.0		

Voluntary Carbon Market – Ghana's Reforestation of Degraded Forest Reserves Program in Ghana is the only forest voluntary market project to earn VCS Validation. The project that aims to reforest 15,000 hectares of degraded forestlands in Asubima Forest Reserve and absorb annually more than 80,000 metric tonnes of carbon dioxide from the atmosphere, has been independently validated by SCS Global Services under the Verified Carbon Standard (VCS). The project will generate carbon credits while simultaneously supporting the commercial harvest of teak timber and planting local tree species.

ES.5Financial Resources, Technology Transfer, Capacity Building, and Technical Support Received and Needed

ES. 5.1 Financial Support Received

The financial flows Ghana received between 2011 and 2014 have been presented in this first BUR. The financial flows have been classified as domestic contributions and external contributions. The domestic contributions ("co-financing" or "own investments") and the external contributions, are from international sources, mainly from Annex 2 Parties, that were received or committed through multilateral, bilateral and GEF channels. Additional information on financial flows from private sector and private foundation has also been provided. Total climate related financial inflows for the period 2011-2014, amounted to US$1,208,746,027 (GhC 2,579,483,625 equivalent) representing 3.7% of GDP (See table ES 10).When the loan from China Development bank is included the total financial inflow came to US$ 2,208,746,027 (equivalent of GhC 4,713,499,843), which was 6.7% share of GDP. Grants are the largest share (69.1%), followed by loans (19.1%), national budget (6.9%) and result-based payment (4.9%). As shown in table ES9, the financial flows through bilateral channel were the largest (49.5%), followed by multilateral channels (39%) and national contributions (5.1), GEF (3.2%). The remaining 3.2% are co-financing (1.7%), private foundations (1.4%) and private sector (0.15).

ES.5.2 Support Received for Preparation of BUR

Table ES 9 contains support received during preparation of the BUR. Apart from the GEF financial support Ghana received, the rest were mainly non-financial technical assistance.

Table ES 9: List of Capacity building received during the BUR preparation

Activity	Capacity Needed	Capacity received	Source of Support
Use of 2006 IPCC guidelines and ALU software for AFOLU GHG Accounting	Data processing and management strategies.	Training on AFOLU data collection and management.	Rainforest Coalition, CD REDD Project,
	Training on ALU and IPCC software	Hands-on training on use of IPCC software for AFOLU.	
	Training on 2006 IPCC Guidelines and software	Training on GHG Inventory	GIZ Information Matters project
			UNFCCC CGE Training
GHG National System improvement	GHG data management and institutional arrangements.	GHG MRV Training	UNEP/GEF, Information Matters project
		Training in GHG MRV Management	
	Strengthening the national system for GHG	Establishment of online climate change data hub	UNEP/GEF, UNDP, Low Emission Capacity Building Project
		Development of a GHG Manual	
		Development QA/QC Plan	
Improvement of GHG	Review of National Inventory	Technical review of energy section	GIZ Information Matters project

Inventory Report	Report	of National Inventory Report	
		Technical review of AFOLU section of the National Inventory Report	Rainforest Coalition, CD REDD Project,
			Sustainable GHG Management in West Africa
		Technical review of entire National Inventory Report	UNFCCC Secretariat
Development of Marginal abatement cost curve	Training on marginal abatement curves	Training on mitigation assessment	UNEP/GEF during preparation of Third National Communication
Improvement in mitigation baseline setting	Training on how to make baseline transparent	Training workshop on baselines	UNEP/GEF during preparation of Third National Communication
			GIZ Information Matters project
Continuous training of GHG experts	Training new technical experts on GHG at the international level	Training of 6 GHG review experts	UNFCCC GHG Review Training Programme
		Training on using Collect Earth to the AFOLU sector	Sustainable GHG Management in, West Africa
Development of mitigation scenarios for the non-energy sector	Training on marginal abatement curves	Training on mitigation assessment	UNEP/GEF during preparation of Third National Communication

Table ES 10: Summary of known climate change financial flows for the period 2011-2014

Overall Analysis		W/China ($)	W/O China ($)	W/China (Gh¢)	W/O China (Gh¢)	Share of GDP[2](2014)	
						W/China	W/O China
	Loans	1,231,090,000	231,090,000	2,627,166,026	493,149,808	3.8%	0.7%
	Grants	836,854,027	836,854,027	1,785,860,066	1,785,860,066	2.6%	2.6%
	National Budgets	82,024,000	82,024,000	175,040,546	175,040,546	0.3%	0.3%
	Results based payment	58,750,000	58,750,000	125,373,453	125,373,453	0.2%	0.2%
	Total	2,208,718,027	1,208,718,027	4,713,440,091	2,579,423,872	6.7%	3.7%

	Parameters of financial flows		Mitigation	Adaptation	MoI[3]	SD[4]	Enabling Activities[5]	Totals (s)	Totals (Gh¢)
	Type of Financial flows	W/China[6]	1,229,500,000					1,229,500,000	2,623,772,941
Loans		W/O China[7]	229,500,000		1,590,000			231,090,000	493,149,808
Grants			621,089,710	40,226,363	174,635,954	50,000	852,000	836,854,027	1,785,860,066
National budgets			80,024,000		2,000,000			82,024,000	175,040,546
Result-based payment			58,750,000					58,750,000	125,373,453
Bilateral	Channels of financial		515,010,000	7,711,048	75,719,505			598,440,553	1,277,081,846
Multilateral			361,906,982	28,026,843	81,815,387	50,000		471,799,212	1,006,827,169
Co-financing			18,000,000		2,000,000			20,000,000	42,680,324

[2]Share of total gross domestic products reported in ending 2014. 2014 GDP reported as GhC 70,000,000

[3] Means of implementation. It has been further classified as Mitigation MoI, Adaptation MoI, and Sustainable Development MoI

[4] Sustainable development financial inflows are cash flows that support mitigation, adaptation, MoI and development activities

[5]Enabling Activities dedicated GEF funds to support facilitation of implementation of Rio convention particularly UNFCCC

[6]Financial inflow included China Development Bank loan for the construction of Ghana Gas Processing Plant at Atuabo in Western Region of Ghana

[7]Financial inflow excluding China Development Bank loan for the construction of Ghana Gas Processing Plant at Atuabo in Western Region of Ghana

GEF			32,422,727	4,418,182	70,000		852,000	37,762,909	80,586,660
National Funds			62,024,000					62,024,000	132,360,222
Global Fund					Unknown			-	-
Private Foundations					16,921,063			16,921,063	36,109,823
Private sector		W/China	1,000,000,000					1,000,000,000	2,134,016,219
		W/O China		70,290	1,700,000			1,770,290	3,777,828
Energy	Recipient sectors	W/China	1,745,939,727					1,745,939,727	3,725,863,694
		W/O China	745,939,727		2,870,000			748,809,727	1,597,972,102
Agriculture			13,250,000	12,689,048				25,939,048	55,354,349
Forestry			140,173,982		21,657,158			161,831,140	345,350,277
Transport			90,000,000					90,000,000	192,061,460
Dev. planning				7,930,214				7,930,214	16,923,205
Environment				11,124,920	19,776,773	50,000	852,000	31,803,693	67,869,597
Health				1,918,182				1,918,182	4,093,431
Interior				5,200,000				5,200,000	11,096,884
Water				1,364,000				1,364,000	2,910,798
Education					16,519,023			16,519,023	35,251,863
Finance					117,403,000			117,403,000	250,539,906
Grand Total		W/China	1,989,363,709	40,226,364	178,225,954	50,000	852,000	2,208,718,027	4,713,440,092
		W/China	989,363,709	40,226,364	178,225,954	50,000	852,000	1,208,718,027	2,579,423,873

ES.5.2 Support Received for Preparation of BUR

The summary information on non-monetized capacity building and technology support received for the period 2011-2014 is shown in Table ES11.

Table ES 11: Summary information on non-monetized capacity building and technology support received for the period 2011-2014

Support Type	Description of Activity	Climate Relevance	Donor	Status
Capacity Building	Information matters project: training on GHG data management, emission baseline and domestic MRV. Third Party Review of National GHG Inventory Review – Energy Section. Opportunity for experience sharing in the preparation of BUR.	Mitigation, GHG Inventory - Energy Sector	BMZ, GIZ	On-going till 2016
	Sustainable GHG Management Project in West Africa: Third Party Review of National GHG Inventory Review – AFOLU Section. Training on land use mapping using Google map engine tool.	Mitigation, GHG Inventory AFOLU sector	Australia, USA, Netherlands, UK, Belgium, New Zealand, UNFCCC, FAO, UNDP, UNDP	On-going till 2017
	Capacity Development for REDD Project: Hands on training on use of 2006 IPCC guidelines and ALU software for AFOLU GHG Accounting. Improvement of GHG Inventory Report- Third Party Review of National GHG Inventory Review – AFOLU Section.	Mitigation, GHG Inventory AFOLU sector	BMU, International Climate Initiative, Coalition for Rainforest Nations.	2012-2014. Possibility of Phase 2
	Training on Non-Annex 1 GHG Inventory software	Mitigation, GHG Inventory Management)	UNFCCC Secretariat	2014
	Training on 2006 IPCC Software		UNFCCC Secretariat	2011-2014
	Training on development of Regional Grid Emission Factors	Mitigation (Baseline assessment)	UNFCCC CDM West Africa Region Collaboration Centre	2014
	Training on development of standard baselines in Waste and Transport sectors			
	Third FAO Regional Workshop on Statistics for Greenhouse Gas Emissions"	Mitigation (GHG Inventory AFOLU)	FAO	2013
	Training on Annex 1 Party GHG Review including methodological, reporting and review guidelines.	Mitigation (GHG Inventory Reviews)	UNFCCC Secretariat	On-going
	CGE Training programmes on National Communications and BUR	Mitigation	UNFCCC	On-going
	Training on long range energy alternatives planning system		Stockholm Environment Institute	2013

ES.6Information on Domestic MRV

Ghana's approach to develop and operationalize its domestic MRV system, focuses on integration into the existing national development M&E superstructure rather than setting up a new layer structures. The domestic MRV system aims at making sure that the existing sector or national development M&E system is able to "monitor:" (a) GHG emissions or reductions attributed to a particular mitigation action (policy, programme, measure or project; (b) climate-related support provided by the Government of Ghana or received from donors or the market in the form of finance, technology transfer and capacity to enable implementation of a certain action or as a result of an action taken in a particular sector of the economy; (c) sustainable development benefits of mitigation actions(See Figure ES10)

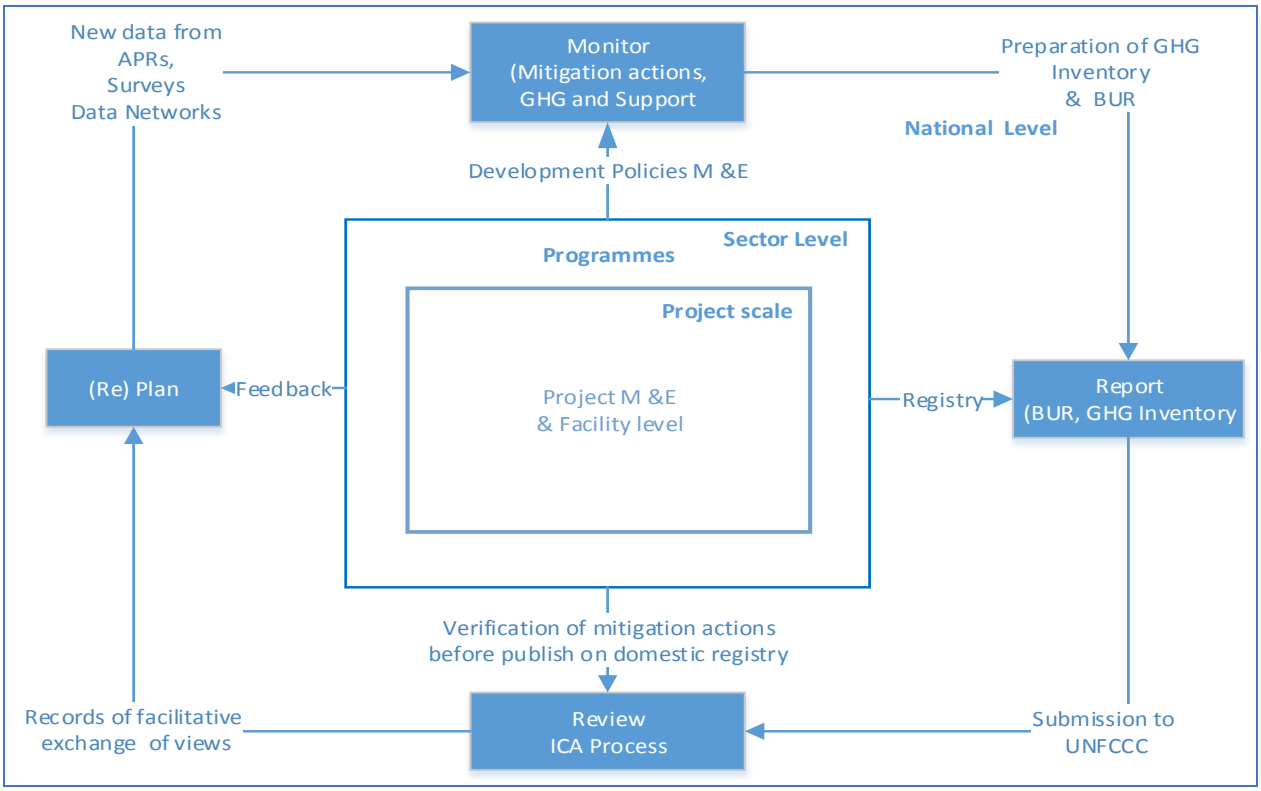

Figure ES 7: Components of domestic MRV system

Currently, Ghana is at the planning and staging phase in the developing in the development and setting up of the domestic MRV (see ES 11). So far, the major institutions and their roles in the MRV structure have been mapped out. What is left to be done by the December, is to focus on the operationalization of the institutional setup and the system for continuous data collection and sharing on major mitigation actions and support flowing into the country. It is expected that by the end 2015, a proto type of MRV system with its IT support infrastructure will be put to operation.

The roadmap for the development of the domestic MRV system is shown in figure ES 11

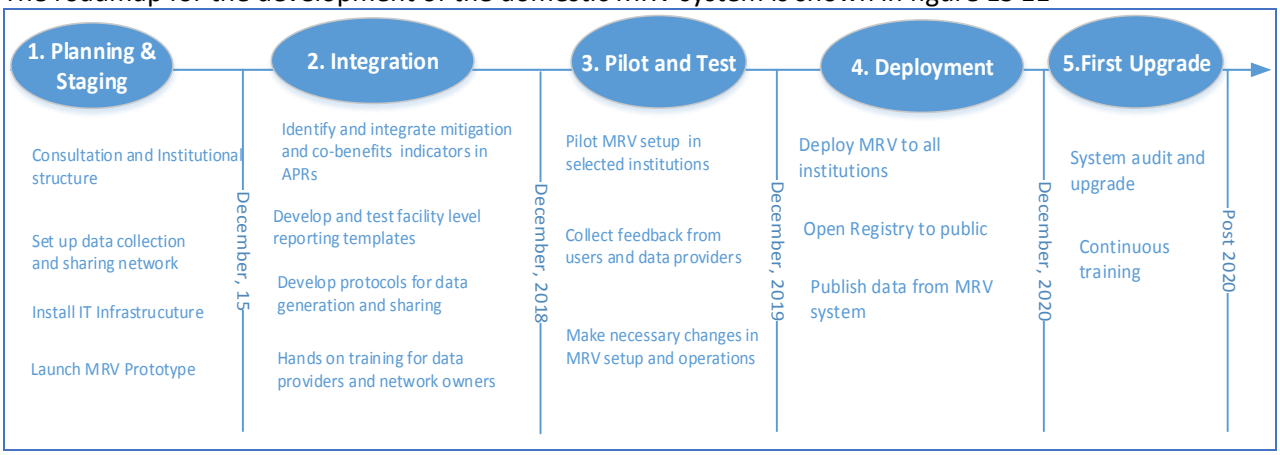

Figure ES 8: Domestic MRV development roadmap

1. National Circumstances and Institutional Arrangements

1.1 Ghana at a glance

Country	Republic of Ghana
Government	Unitary democratic state governed under the 1992 Constitution. Power is shared among the Executive, Legislature and the Judiciary. Local Government system with a decentralized system of administration.
Location	Land area of 239,460km^2 with 560km^2 coastline. Located in West Africa and lies close to the equator between latitude 11.50N and 4.50S and longitude 3.50W and 1.30E
Population	25.37million in 2012 people with 52.5% urban population. Quarter of Ghanaians are still poor whilst under a tenth of the population are in extreme poverty
Economy	Lower middle-income status with a per capita income of $1,602. Service-sector led economy, industry and Agriculture
Major Exports	Crude Oil, Gold, cocoa, timber, tuna, bauxite, manganese ore, diamonds
Climate	Tropical weather with two rainy seasons in South and single season in the North. Ghana's climate continued to get warmer whereas rainfall remains uncertain and unpredictable. The projected rate of warming is more rapid in the northern inlands than the coastal regions.
GHG Emissions Footprint	National total GHG emission of 33.66 MtCO_2e as of 2012 AFOLU is the largest source of emission followed by the energy sector

1.2 Geography

Ghana, with a total land area of 239,460km^2 is located in West Africa on the Guinea Coast and lies close to the equator between latitude 11.50N and 4.50S and longitude 3.50W and 1.30E. The country has six distinct ecological zones namely; Sudan Savannah Zone, Guinea Savannah Zone, Transition Zone, Semi-deciduous Forest zone, Rain Forest Zone and the Coastal Savannah Zone. About 58% of the total land area of Ghana is used for agriculture, out of which 55% is under cultivation (MoFA, 2014). Ghana's climate is tropical and strongly influenced by the West Africa Monsoon winds. The climate is generally warm with variable temperatures masked by seasons and elevation. Ghana's population has almost quadrupled, from 6.7million in 1960 to 25.37million in 2012 with nearly 52.5% living in urban areas. The improvements in the wellbeing of Ghanaians in the last couple of decade are manifested in the positive progress in the country's human development index and Gini inequality index.

1.3 Macro Economy

Ghana has a service-sector led economy that still depend on natural resources such as gold, diamond, manganese, bauxite, cocoa and recently oil and gas. Ghana's major export commodities are crude oil, cocoa, minerals, timber and electricity. The size of the Ghanaian economy has expanded from USD1.2 billion in 1960 to USD 35.9 billion in 2012 in real terms (Ministry of Finance, 2012). Ghana attained lower middle-income country status in November 2010 after rebasing its economy. With the revised GDP estimates, GDP/capita has increased from USD1, 067 in 2000 to USD 1,652 in 2012. About a quarter of Ghanaians are poor whilst under a tenth of the population is in extreme poverty (GSS, 2014). Between the periods 1991-2013, the general poverty level reduced from 51.7% to 24.2%. The incidence of extreme poverty reduced by 8.1% from the 2005/06 extreme poverty incidence of 16.5%. Extreme poverty is also a rural phenomenon, with as many as over 1.8 million persons living in extreme poverty in rural areas (GSS, 2010). Extreme poverty is particularly high in rural Savannah at 27.3% and this locality accounts for nearly three-fifths of those living in extreme poverty in Ghana. Ghana's socio-economic transformation agenda has been set out in the President's coordinated programme of economic and social development policy for 2014-2020.

1.4 Natural Resource Dependency

1.4.1 Water resources

In Ghana, 5% of the land area is freshwater and covers Volta, South Western and Coastal basins with 54 billion m^3 of total annual run-offs. Total annual underground recharge is estimated at 157.7mm-195mm. Renewable internal freshwater resources are estimated at 30.3 billion m^3 (World Bank, 2012) and an annual withdrawal of 0.982 billion m^3 mainly used in agriculture, hydroelectric generation and domestic use.

1.4.2 Land resources

Ghana's forest has declined from 8.2million hectares in the 1960s to less than 1.6million hectares. The decline in the forest cover is mainly due to human-induced deforestation estimated at, 2% per annum (MLNR, 2012) resulting from agricultural expansion, mining, illegal timber and wood fuel harvesting. Many forest reserves are heavily encroached and degraded, and the off-reserve stocks are being depleted. Agricultural land accounts for 58% of the total land area of Ghana, out of which 55% is under cultivation (MoFA, 2014). The remaining 30% are forestland and other lands. Agriculture is predominantly (nearly 90%) on a smallholder basis, which relies on rainfall with little mechanized, farming. While crop production has increased by 45% for the period 2000-2012, cultivated areas only increased 10% in the same period. This means the yield per ha of crop production has shot particularly due to the promotion of good farming practices including application of fertilizers. Cassava (49.8%) is the largest food crop followed by yam (22.7%), plantain (12.2% maize (6.7%) and others (8.6%). The livestock population has risen from 26.4 million in 2003 to 57.9 million in 2012.

1.4.3 Energy resources

Ghana is endowed with a variety of energy resources including biomass, hydrocarbons, hydropower, solar and wind. It also has the capacity to produce modern bio-fuels. As at 2012, the total primary energy supply of 11.77Mtoe exceeded final energy consumption by 31% (8.16Mtoe). Final energy consumption has shifted from being biomass-dominant in 2000 to greater reliance on petroleum products (49%) in 2012. Table 1 shows the trend of energy indicators for the period 2001-2012.

Table 1: Distribution of changes in energy indicators

Indicators	1990	2000	2006	2010	2012	Change 1990-2012 (%)	Change 2010-2012 (%)
Population (million)	14.43	18.91	21.88	24.23	25.87	79.3	6.8
GDP (Constant 2006 USD billion)*	5.51	8.39	20.33	16.95#	16.78#	204.5	-1
TPES (Mtoe)**	5.29	7.74	9.06	9.32	11.77	122.49	26.29
Final Consumption (Mtoe)***	4.31	5.41	6.01	6.46	8.16	89.33	26.32
Total Electricity Generated (GWh) ***	5,721	7,223	8,430	10,167	12,024	110	18
*of which is Hydroelectric (GWh)****	*5,721*	*6,609*	*5,619*	*6,996*	*8,071*	41	15
*of which is Oil Products (GWh)****	*0*	*614*	*2,811*	*3,171*	*3,953*	0	25
Total Electricity Consumed*** (GWh)	4,462	6,067	7,362	8,317	9,258	107	11
GDP per capita* (Current USD thousand)	0.4	0.26	0.93	1.33	1.6	300	20.3

TPES per capita (toe)	0.37	0.41	0.41	0.38	0.45	21.62	18.42
Final Consumption per capita (toe)	0.30	0.29	0.27	0.26	0.31	3.33	19.2
GHG emissions per capita (tCO_2e)	0.39	0.45	0.57	0.64	0.71	82.05	10.9
GHG emissions per GDP unit (kg CO_2e /2005 USD)	1.02	1.03	1.09	1.06	1.00	-1.9	–6.2
Energy Intensity (toe/2005 GDP)	0.96	0.92	0.45	0.55	0.70	-26.9	27.7

* Source: World Bank, National Account (2014), ** Source: International Energy Agency, *** Source: National Energy Statistics. This also takes in account electricity export to neighboring countries and total hours of electricity load shedding #: Decline in GDP was the result of revision in GDP figures by Ghana Statistical Service

1.5 Key development policies relevant to climate change

Ghana's socio-economic transformation agenda has been set out in the President's coordinated programme of economic and social development policy for 2014-2020. The country's medium-term development framework is the operational vehicle transformation agenda and focuses on the following priorities; (a) social development; (b) economic development; (c) infrastructure development;(d) natural resources management and; (e) Transparent, Accountable and Responsive Governance. The strategic priority interventions in the transformation agenda that relate to climate change are anchored on the natural resource management pillar. Therefore the broad medium-term vision is articulated in the Ghana Shared Growth and Development Agenda (GSGDA).

Ghana has also launched its National Climate Change Policy (NCCP), which aims at ensuring a climate resilient and climate compatible economy while achieving sustainable development through equitable low carbon economic growth. The three objectives of the Policy are as follows: (a) effective adaptation, (b) social development and (c) mitigation. Progress towards the objectives rests on seven systemic pillars. These are, governance and coordination, capacity building, science, technology and innovation; finance, international cooperation, information, communication and education; monitoring and reporting. In addition to the NCCP, there are number of key policies and legislations that are relevant to climate change (see table 2).

Table 2: Relevant climate change related national policies, legislation and measures

Policy Focus	Legislations/ Measures/Instruments	Relationships with Climate Change
National policy on public private partnership		Help to mobilize public and private finance to support infrastructure and service delivery. PPP in waste management and energy infrastructure are early example of project level financing using PPP
National budget guidelines	Local Government Act. (Act 462), Financial administration Act 654	Guide MMDAs in the budgeting for climate change activities in their annual budgets. CPEIR has been undertaken to identify public sector expenditure items.
Environmental fiscal reform program	15% environmental tax on plastics with exemption on Pharmaceutical and agricultural sectors	Mobilize funds at the national level to support proper plastic waste disposal
Decentralized planning system	National Development Planning Systems Act (Act 480)	Relevant to mainstreaming of climate change into national, sector and district medium term development plans
National climate change policy	Executive Instrument (EI 7), 2009	Framework for addressing climate change. Complement efforts of NDPC to facilitate mainstreaming of climate change
National Environment Policy		Framework for addressing Environment. Complement effort of NDPC to facilitate mainstreaming of environment.
Environmental Assessment	Environmental Assessment Regulations,1999 (L1 1652)	Addressing climate change issues at the project level through permitting and licensing.

	Strategic Environment Assessment	Strategic level mainstreaming of environment into development policies, programmes and plans.
Akoben programme	Environmental Protection Agency Act, 1994 (Act 490)	Environmental performance and public disclosure rating system for industry, mining and oil marketing companies.
Local government policy	Functional Organizational Assessment Tool (FOAT)	M & E system that evaluates the performance of MMDAs in relation to compliance with Government policies, rules, regulations and procedures in carrying out their mandated functions. Climate change indicators are part of the assessments.
Energy policy	Renewable Energy Act (Act 832), Feed-in-tariff scheme, Renewable energy fund	Provide framework of renewable energy promotion.
	National Energy Fund	Funding for energy research and seed capital development of renewable systems
	Energy Efficiency Standards and Labeling Regulations, 2005 (LI1815). Energy Efficiency Standards And Labeling (Household Refrigerating Appliances) Regulations, 2009 (LI 1958)	Obligation to display a label, which indicates the energy efficiency rating of the product before the first retail sale. It is an offence under LI. 1815 to import, display for sale or sell air conditioners and CFL in Ghana unless they meet the minimum performance standards and are properly labeled.
	Energy Efficiency Regulations, 2008 (LI 1932)	Prohibition of Manufacture, Sale or Importation of Incandescent Filament Lamp, Used Refrigerator, Used Refrigerator-Freezer, Used Freezer and Used Air-Conditioner
	Automatic utility and petroleum price formula	Phasing of subsidies on utility and petroleum products
National Transport Policy	10-year over-aged vehicle importation tax	Disincentive for importing over-aged vehicles.
	Annual road worthy certification for all vehicles	Yearly physical inspection of vehicles before road worthy certification is issued.
	Motor Emission Standards	Proposed standards for mobile and stationery engine emissions and fuel economy.
National Forest and Wildlife Policy	Stumpage Fees	Surcharge on timber. Promote sustainable timber harvesting.
	Annual allowable cuts	Cut off threshold of volumes of timber harvested every year
	Banning on chain saw operations	
	Timber certification	Implementation of timber Certification through the Voluntary Partnership Agreement with the EU
National Environmental Sanitation Policy	MMDAs bye-laws	
	Environmental Assessment Regulations, 1999 (L1 1652)	Promotion of cleaner production
	Environmental Protection Agency Act 1994 (Act 490)	
Industrial Waste Management Policy	Ministry of Trade and Industry	Promotion of cleaner production
National Action Plan on DRR	Ghana Meteorological Agency Act, Act 682, 2004.	Weather forecasting, early warning, provision of metrological services
National urban Development Policy		Framework to support sustainable city development.

1.6 Institutional arrangements relevant to climate change

The institutional arrangements for planning and implementation of climate change in Ghana has been divided into five interrelated coordinated structures (see figure 1). The structure reflects the roles various institutions are playing in the planning and implementation of climate change in the country as envisaged in the NCCP.

Strategic level institutions - One of the critical success factors for climate change mainstreaming in Ghana is to have the highest possible political buy-in vested in the strategic level institutions by law. The strategic level institutions (see figure 1) have the political mandate to define the vision and policy directions national development. They perform this function by setting out development priority areas and allocation of national resources. In Ghana, the decision to commit to "low carbon climate resilient development" emerged from the government's 2020 transformation agenda. This is vision that all government development agencies, development partners and private sector are to work towards achieving it.

Planning, budgeting and overall coordination institutions - The NDPC, Ministry of Finance and MESTI perform the planning, budgeting and coordination functions at different stages and levels of the climate change mainstreaming process. The NDOC coordinates and regulates the decentralized national development planning system in accordance with 480. The central development framework coordinated by the NDPC is useful for the formulation and integration of climate change into national development. The MOF plays central fiduciary management role in national development planning. Their fiduciary functions relates to budget coordination and fiscal policy setting within the economic development framework. Insofar as, climate change is anchored on the medium term national development priorities, the budget guidelines that will be issued by MOF to the MDAs and MMDAs would justify budget allocations for climate change public investments. MESTI plays the leading role in the overall coordination of the implementation of the national climate change policy, which has three pillars on effective adaptation social development and low carbon development. As the lead institution, MESTI is responsible for coordination and harmonization of climate change activities among the sectors and much as possible ensures alignment to the medium term development plan. This is done through the National Climate Change Committee, which is a multi-stakeholder committee of Ministries, Department and Agencies (MDAs), Donors, Parliament of Ghana, CSOs, research institutions and representatives of the private sector.

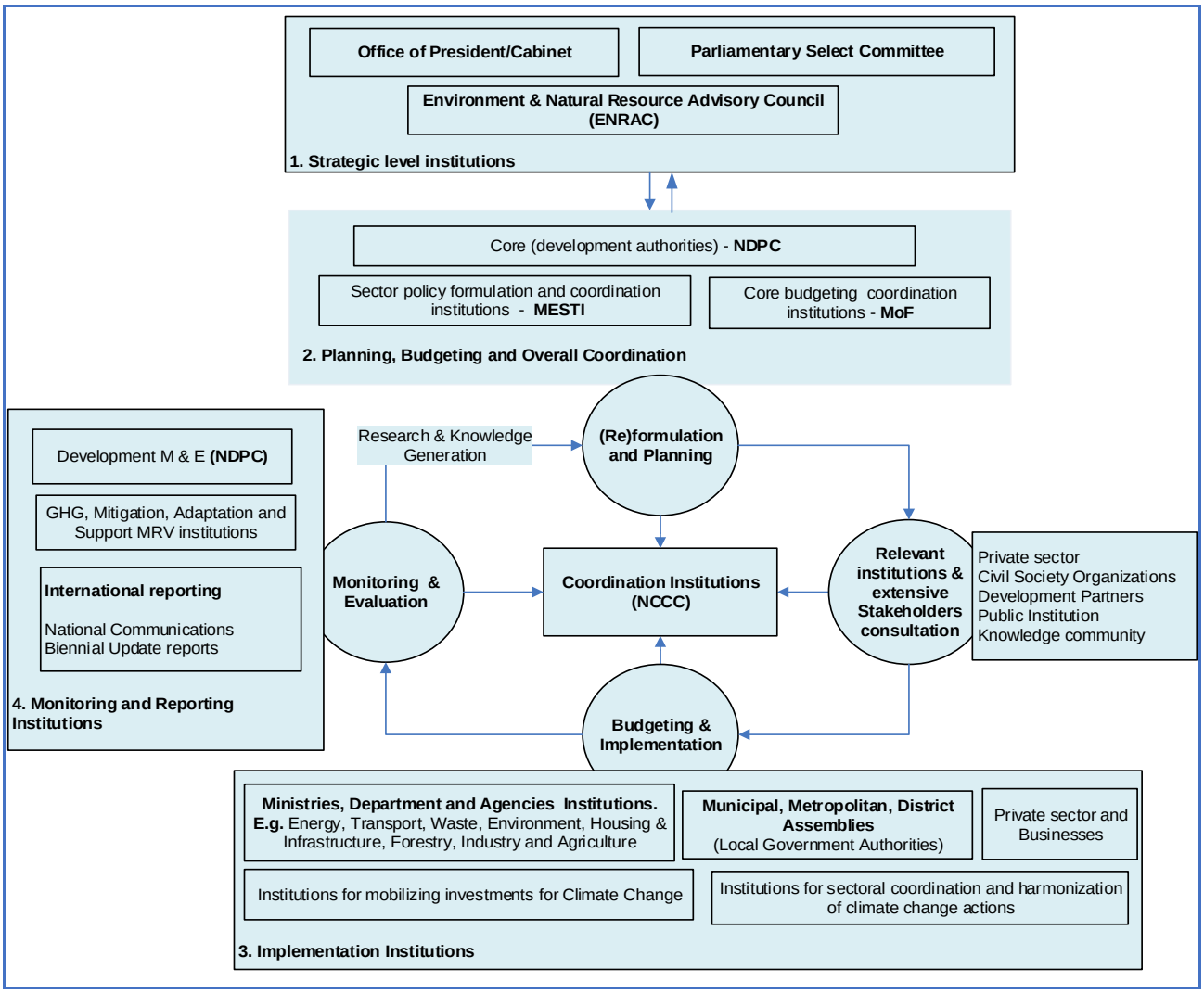

Figure 1: Institutional Arrangement for coordination and implementation of climate change in Ghana

Monitoring and reporting institutions – MOF, NDPC, MESTI and EPA have some form of monitoring and reporting and function to play at different levels. Whereas the NDPC has overall M&E mandate over the implementation of the medium development plan, MOF also track public sector expenditure including climate change investment through the GIFMIS platform. Within environment sector, MESTI has responsibility of monitoring the progress of implementation of the NCCP and the EPA is responsible for leading the preparation of the international climate change reports. The EPA mandate make its central to the domestic MRV architecture.

1.6.1 Institutional arrangement for continuous preparation of Biennial Update Reports

The national architecture Ghana has put in place for the regular preparation and reporting of national communication to UNFCCC had evolved from ad-hoc working groups towards attaining permanent decentralized institutional representations. The institutional arrangements for national communications and Biennial Update Reports are intertwined (see figure 2) and integrated into the superstructure for coordination of planning and implementation of climate change. Linkages have been established with the monitoring and evaluation structures, research and knowledge generation structures (see figure 2).

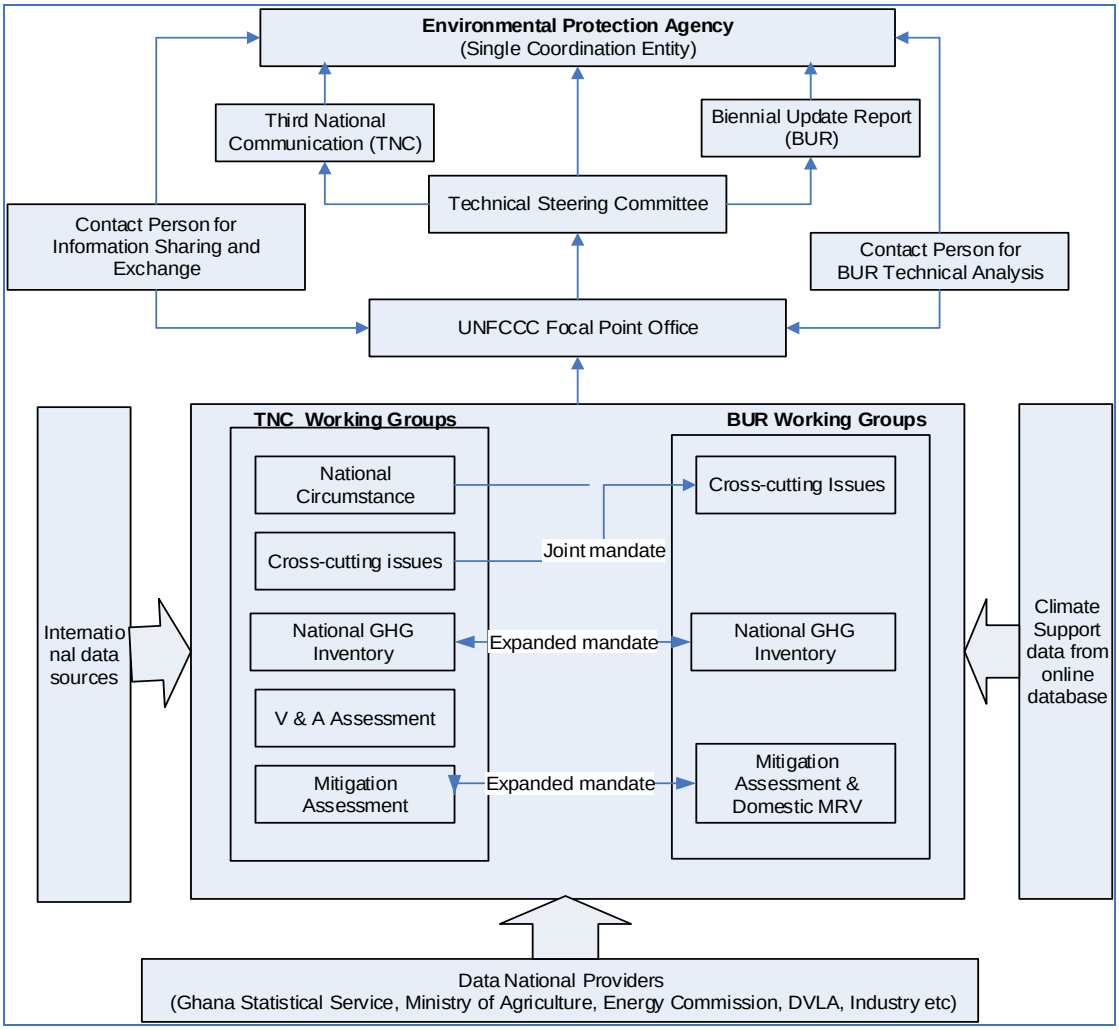

Figure 2: Institutional arrangement for preparation of BUR

2. National GHG Inventory

2.1 Overview of the inventory

Summary of the greenhouse inventory results has been provided for the period 1990-2012 although decisions 1/CP.16 stipulates 2011 as the latest year for reporting. Detailed description of the results, methodology and processes used for the preparation of the national inventory is contained in the 2014 National Inventory Report (NIR). The NIR and associated tables are submitted to the UNFCCC to fulfill Ghana's obligations, in part, under the enhanced national communication reporting (Article 12, paragraph 1(a), of the Convention, decisions 1/CP.16 para 60(a-b) and to comply with reporting requirements in the preparation of its first biennial update report (BUR) consistent with decision 1/CP.16 para 60(c). Although this is the second time Ghana prepared a NIR, it is the first NIR submitted to the UNFCCC under "BUR" reporting mechanism.

The GHG emission estimates were compiled based on the methodologies contained in the Intergovernmental Panel on Climate Change (IPCC) 2006 IPCC Guidelines for National GHG Inventories (IPCC 2006). The use of the 2006 IPCC guidelines was to ensure that the GHG emission estimates were as much as practicable transparent, complete, consistent and accurate (TCCCA) through time and comparable with those inventories produced in other countries with similar national circumstances. For this reason Ghana did not use the 1996 GL and GPG as referred to in the BUR guidelines. The inventory estimate covers direct anthropogenic GHG emissions by sources and removals by sinks and included carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and Perfluorocarbons (PFCs).The emissions/removals from the following four economic sectors have been estimated; (1) Energy, (2) Industrial processes and product use (IPPU), (3) Agriculture, Forestry and Other Land Use and (AFOLU) and (4) Waste.

2.2 Brief description of the national system for sustainable inventory preparation

Ghana has a national inventory system that is capable of supporting the continuous preparation of robust national GHG inventories on a sustainable basis. For the national system to function efficiently, a number of reforms have been introduced, since 2006, as part of the long-term improvement strategies. The reforms have brought about greater improvements in the way and manner the national system operates. Figure 3 shows the main elements introduced in the national system.

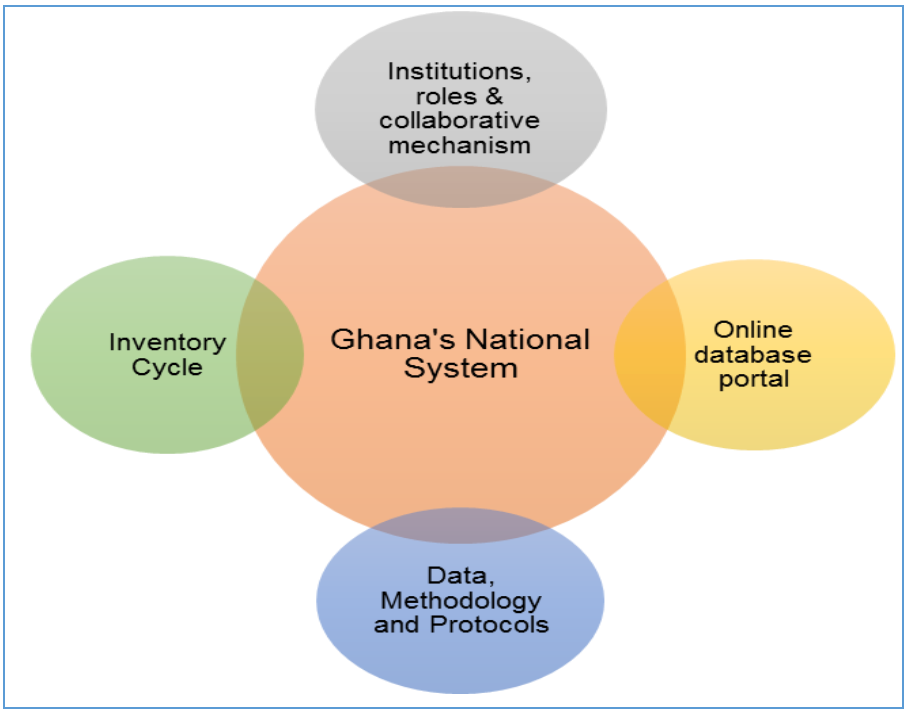

Figure 3: Elements of the GHG Inventory National System

2.2.1 Description of institutional arrangement

The revised institutional arrangements involve nearly thirty experts from sixteen different public and private institutions. The roles and, responsibilities of each institution and their reporting lines are arranged to reflect the levels of interlinkages contained in the respective memorandum of understanding. The EPA was established by Act 490, 1994 and is designated as the national entity for the preparation of Ghana's national GHG inventory. The EPA functions as the "single national entity". As the "single national entity" the EPA collaborates with the inventory stakeholders to undertake management of activity data and emissions factors, compilation of emission estimates from the sectors, quality control/quality assurance, improvement planning, and preparation of the reports. The MESTI is responsible for the official approval and endorsement of NIR and onward submission to UNFCCC. Within the EPA, the UNFCCC Focal Point and Climate Change unit is the national inventory entity and is directly responsible for the management of the entire inventory process. The unit ensures that the delivery of the inventory is timely, of good quality and above all meets international standards (see figure 4).

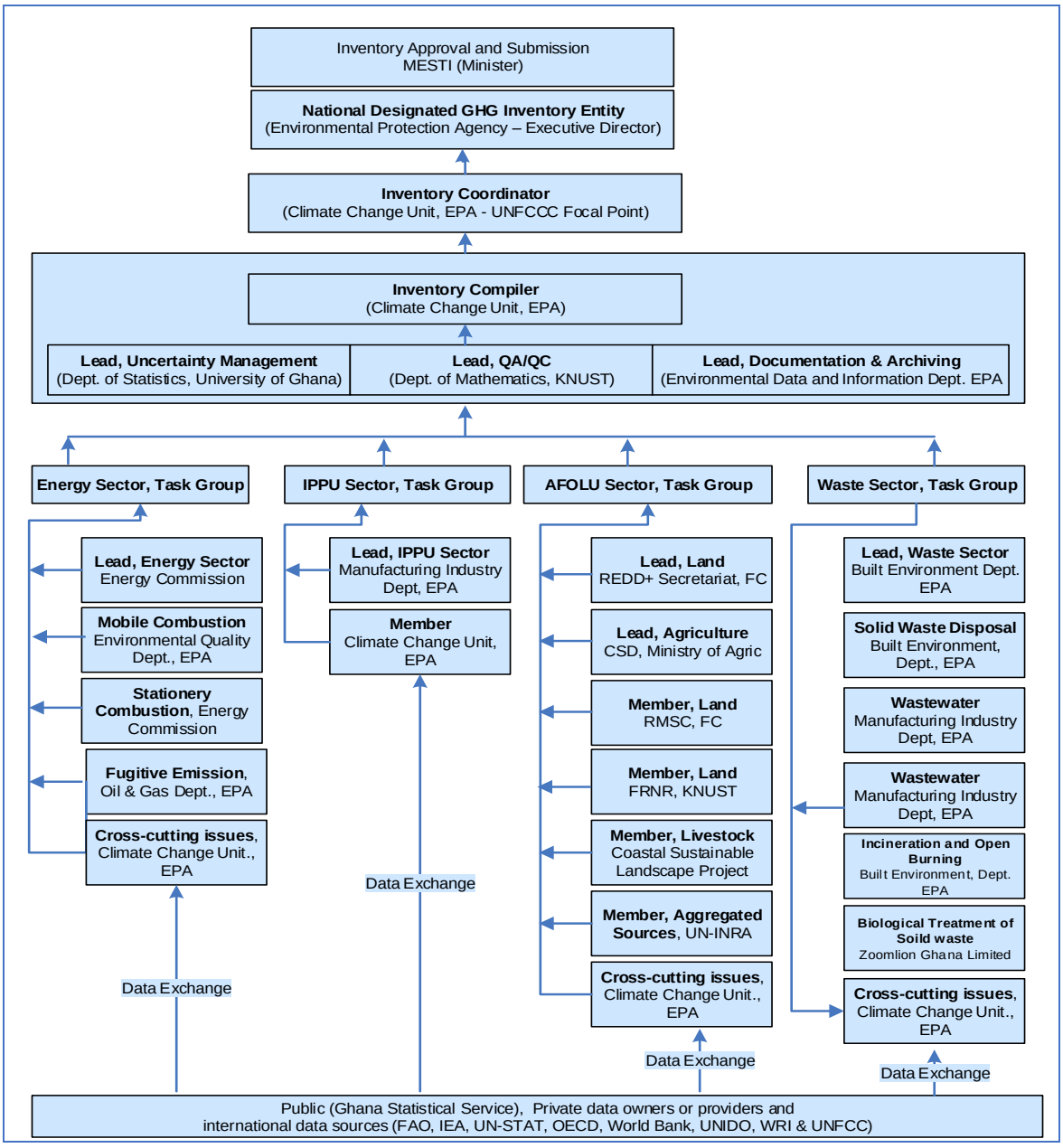

Figure 4: Functional institutional arrangements for the preparation of the national GHG inventory

The inventory compilers also serving in the capacity as the generalist, the uncertainty management lead, QA/QC lead and the documentation and archiving lead are responsible for cross-cutting issues both at national and sector levels. The 4 working groups were responsible for completing the inventory for the 4 sectors, namely; Energy, IPPU, AFOLU and Waste. Each working group has a lead and membership drawn from public and non-governmental organizations. In addition, there are a number of institutions that supply data to the inventory compilers. In order to ensure that there is no double counting, the inventory coordinator ensure that there is enough coordination among the working groups.

2.2.2 Means of data acquisition and I.T set-up behind data management system

The lead inventory sector institution is responsible for the identification and sourcing of all datasets at the national and international levels in collaboration with the inventory compiler. As much as possible, the sector lead institutions, identify all the data needs and the institutions where the data will be sourced. After initial contacts with the data owners/providers, the sector lead directly requests the data from the source with administrative help from the EPA. When the EPA receives a request from the sector lead, a data request is made to the top management of the relevant institution indicating what form of data is required, covering years, data format and main use of the data in the inventory through an official letter. The EPA data request letters, especially those to industrial plants, usually make reference to the relevant provisions of the EPA law which authorizes the EPA to request and be given such information as it may require in the exercise of its functions. The collected data goes through several steps of administrative procedures. Initial technical and quality evaluation of the data is done before transmission to the working teams. All data are documented and stored in the online database for archiving and retrieval system.

The online database system that hosts all GHG inventory data and related information is shown in figure 5. The database is meant to help streamlining documentation and archiving of all GHG data, reports and publications. The database contains (a) all inputs data from each sector, (b) datasheet for each sector, (c) emission estimates from the IPCC software for all sectors from 1990-2012, (d) IPCC 2006 software database, (f) completed QA/QC templates for sectors, and (g) all reports, documentations. The IT infrastructure of the database (server, backend database resources) is managed by the IT team of EPA. The general public and the GHG inventory team have access to the online database through this Internet Protocol address 197.253.69.38 or www.epa.gov.gh/tnc. The inventory data, individual results sheets and the database files are transmitted to the administrator of the online database for archiving and publication on the Internet.

2.2.3 Strategies for long term improvement in the National Inventory System

The reforms in the national system that have started will continue in the coming years to ensure that it operates efficiently on sustainable basis. The following specific actions will be undertaken:

Strengthening data handling and management- Facilitate continuous update of country-specific activity data through regular exchanges of data from the primary data providers using the online database. In this regard, selected persons from Energy Commission (responsible for publication of annual energy statistics), Ministry of Food and Agriculture (responsible for publication of Agriculture Facts and Figures), Driver Vehicle Licensing Authority (responsible for Vehicle annual inspection) Forestry Commission etc will be given limited right of access to the online database to upload new datasets where necessary. Discussions will be held on ways to effectively incorporate GHG data collection into “facility level” environmental reporting managed by the EPA. The facility environmental reporting can be done through (a) Annual Reports; (b) Environmental Management Plans; and (c) Environmental Performance Rating and Public Disclosure (EPRPD -“Akoben”).

Continuous training: Organize regular tailor made training programmes for national experts, public data providers, and private data owners, potential users of the GHG results and new experts who join the inventory process. If possible, additional experts would be nominated to the UNFCCC roster of experts to allow them undertake training. Apart from the fact that the training will help to build capacity and awareness, it will also give opportunity to the experts from Ghana to learn-on-the-job based on the experience from the review of GHG inventories from Annex I Parties.

Greater mainstreaming: Identify the challenges associated with the existing institutional arrangements and where possible put in place new measures to ensure greater participation of other relevant bodies. Continue with the discussions on harmonizing the national statistics reporting to international agencies (especially FAO, IEA, World Bank).

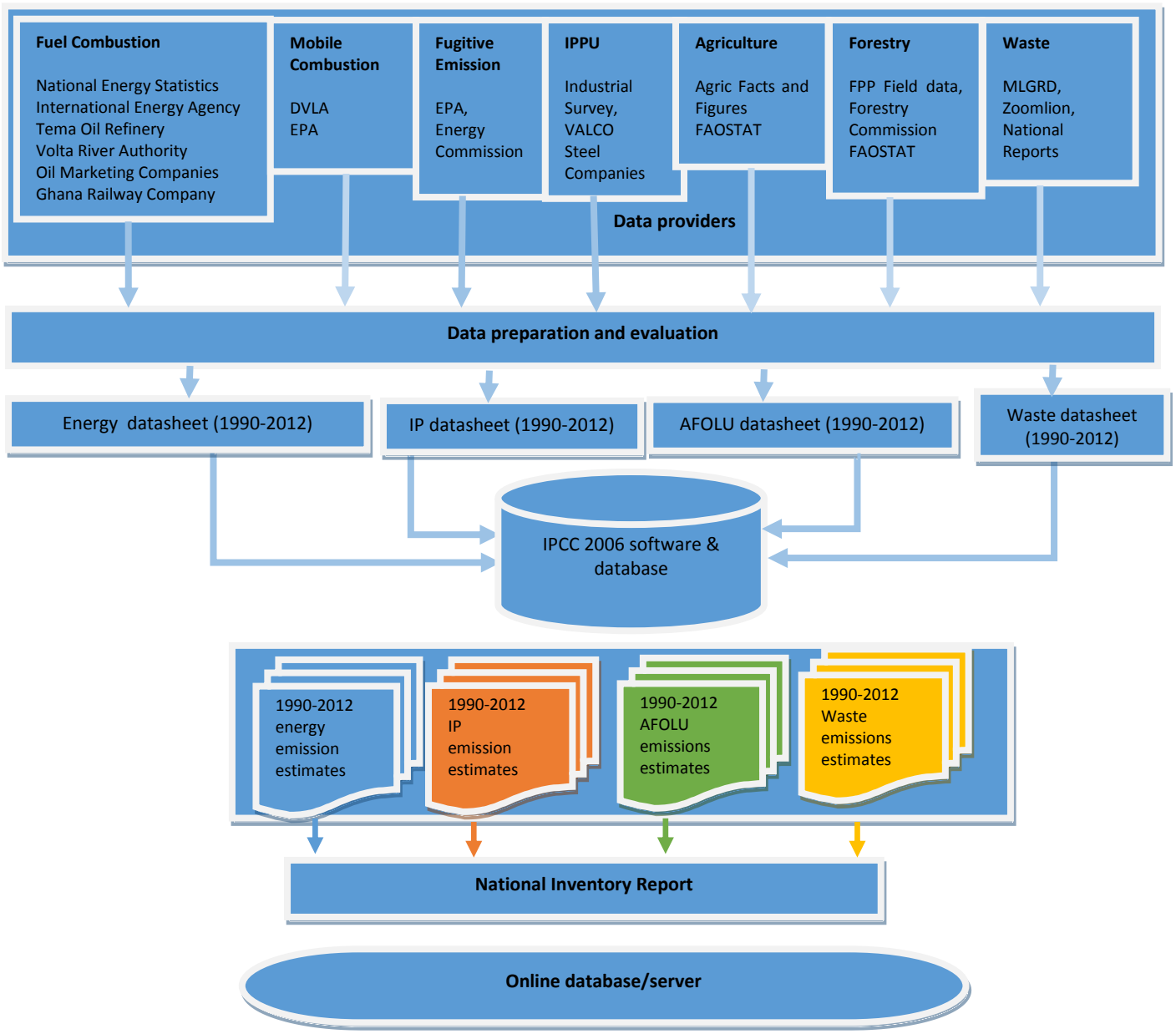

Figure 5: Inventory Data Structure and relationships among them

2.3 Brief description of methodology and data sources

The emissions inventory has been conducted from a series of steps using a range of data from diverse sources. The emissions were not directly measured but were estimated through the application of methodologies that link emissions to data on observable economic activities in the country. The estimation of the GHG emissions and sinks used a combination of: (a) country-specific methods and data; (b) IPCC methodologies and; (c) Emission Factors (EFs). These methods are consistent with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) and are to the extent possible, in line with international practice. Generally, Tier 1 IPCC methodology was applied, however there were selected categories such as Transport (1.A3), Land (3B), IPPU (2C) and Solid Waste Disposal (4a) for which higher tier (tier 2) methodology was used. The methodology has seen some improvements over the previous years. This was because of: (a) the continuous use of new and additional country-specific activity data and (b) the shift from the Revised 1996 IPCC guidelines to the 2006 guidelines. Emission factors were obtained from: facility-level plants; country-specific or regional and international studies and IPCC Emission Factor Database. Default emissions factors from the IPCC EFDB were commonly used, however, in cases where country or region specific emission factors existed, priority was given to it. An overview of the methods and emission factors applied for the calculations of the emissions is presented in table 3.

Table 3: Mapping of methods and emission factors

GHG Source and Sink Categories		CO_2		CH_4		N_2O		PFC-CF_4		PFC-C_2F_6		HFCs	
		Meth	EF	Meth	EF	Meth	EF	Meth	EF	Meth	EF	Meth	EF
1.	Energy	T1, T2	D, CS	D, T1	D, CS	D, T1	D, CS						
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 Construction	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 Emission from Energy Production			NO	NO								
2	Industrial Process	D, PS	D, PS	NE	NE	NE	NE	T2	PS	T2	PS	NE	NE
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	T2	PS		

2.D	Non-Energy Products from Fuels and Solvent Use	T1	D										
2E	Electronics Industry	NO	NO	NO	NO	NO	NO						
2.F	Product Uses as Substitutes for Ozone Depleting Substances											NE	NE
3	Agriculture, Forestry, and Other Land Use	T1,T2	D, CS	T1	D	T1	D						
3.A	Livestock			T1	D								
3.B	Land	T2	CS										
3C	Aggregate sources and non-CO_2 emissions sources on land	T1	D	T1	D	TI	D						
4	Waste	T1	D	T1	D	T1	D						
4.A	Solid waste disposal			D	D	D	D						
4.B	Biological Treatment of Solid Waste			TI	D	T1	D						
4.C	Incineration and Open Burning of Waste	T1	D	TI	D	T1	D						
4.D	Wastewater Treatment and Discharge			T1	D	T1	D						

Key: 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

The inventory was prepared using data from combination of sources from national and international institutions. During data collection, priority was given to data that have been generated in the country. In cases where the required data was not available in the country, the data from international organizations such as FAO, IEA, World Bank, etc. were obtained. Table 4 provides an overview of the data used in the inventory.

Table 4: Description of sources of activity data

Sector		Data Type	Data Source	Principal Data Providers
1. Energy Sector				
1.A1	Energy Industry	Fuel types, Fuel consumption, supply Crude oil and petroleum products production, Imports and exports	National Energy Statistics Refinery Product Balance National Energy Plan IEA Database	Energy Commission, National Petroleum Authority, Tema Oil Refinery, Ministry of Energy and Petroleum, Thermal Electricity Generation Utility Companies (VRA, Sunon Asogli, Takoradi International Company TICO and other independent power producers etc, and the IEA
1.A2	Manufacturing Industry and Construction	Fuel types, fuel consumption, supply, Feedstock, Fuels for Non-energy Use	National Energy Statistics Industry survey data, 2013 National Industry Census, 2003	Energy Commission, Manufacturing Industry Department of the Environmental Protection Agency, Manufacturing and Construction Industries, Ghana Statistical Service.
1.A3	Transport	Fuel Types, fuel Consumption by Vehicles, Aviation, Rail and Navigation, Number of Registered vehicles, Vehicle Types	Vehicle registration Database, Petroleum Product Sales Data, Railway Fuel Consumption data, Water Transport Fuel Consumption Data	Energy Commission, Environmental Quality Department of Environmental Protection Agency, Driver Vehicle Licensing Authority, Oil Marketing Companies (particularly, Shell Ghana Limited, Total Ghana Limited), Ministry of Transport, Ghana Railway Company, Volta Lake Transport Company, Ghana Bunkering Services
1.A4	Other Sectors	Fuel consumption per fuel type	National Energy Statistics National Energy Plan, National Census Report, Ghana Living Standard Survey Report	Energy Commission Ghana Statistical Service
1.B	Fugitive emissions from fuels	Gas flared, Gas produced, Gas injected and Gas consumed on site, Refinery input (crude oil)	Oil Exploration and Production Data Oil refinery data in the Energy Statistics	Ghana National Petroleum corporation Oil Exploration and Production, Companies Environmental Protection Agency Tema Oil Refinery
2. Industrial Process and Product Use				
2.A	Mineral Industry	Industrial production and Plant specific emission factors	Environmental Reports EPRPD Database Industry Survey Industrial data from	Volta Aluminum Company Limited Tema steel works, Aluworks Environmental Protection Agency
2.C	Metal Industry			
2.D	Non-Energy Products from	Amount of non-energy use of		

	Fuels and Solvent Use	diesel and kerosene	facilities.	
3. Agriculture, Forestry and Other Land Use				
3.A1 and 3.A2	Enteric Fermentation & Manure Management	Animal population, Fractions of manure, management practices	Agriculture Facts and Figures FAOSTAT Expert Judgment	Ministry of Food and Agriculture – Statistics Research and Information Directorate, UN Food and Agriculture Organization, AFOLU Team
3.B1	Forest land	Land use maps, land use change map, land use change matrix	Forest Preservation Program, 2012	Forestry Commission, Ghana
		biomass estimates for 5 IPCC pools (AGB, BGB, deadwood, herb, litter and soil)		
		Climate zones, soil stratifications and ecological zone maps	IPCC database	IPCC
		Industrial round wood	RMSC, FAOSTAT	Forestry Commission, Ghana FAO
		Wood fuel production	Energy Statistics	Energy Commission
		Areas affected by fire	Expert Judgment	AFOLU Team
3.B2	Cropland	Land use maps, Land use change map, Land use change matrix	Forest Preservation Program, 2012	Forestry Commission, Ghana
		biomass estimate for 5 IPCC pools (AGB, BGB, deadwood, herb, litter and soil)		
		Climate zones, soil classification and ecological zone maps	IPCC database	IPCC
3.B3	Grassland	Land use maps, Land use change map, Land use change matrix	Forest Preservation Program, 2012	Forestry Commission, Ghana
		biomass estimate for 5 IPCC pools (AGB, BGB, deadwood, herb, litter and soil)		
		Climate zones, soil classification and ecological zone maps	IPCC database	IPCC
3.C1	Biomass burning	Areas affected by fire in cropland, forestland and grassland	Expert Judgment	AFOLU Team
		Mass fuel available for burning	Forest Preservation Program, 2012	Forestry Commission, Ghana
3.C3	Urea application	Annual Urea consumption figures	Agriculture facts and figures	Ministry of Food and Agriculture – Statistics Research and Information Directorate,
3.C4	Direct N_2O emissions from managed soils	Annual generic NPK consumption	Agriculture Facts and Figures	Ministry of Food and Agriculture – Statistics Research and Information Directorate,
3.C5	Indirect N_2O emissions from	Annual crop production in		

	managed soils	tonnes per annum		
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 – Statistics Research and Information Directorate,
		Fractions of manure management practices	Expert Judgment	AFOLU Team
3.C7	Rice cultivation	Annual rice production areas	Agriculture facts and figures	Ministry of Food and Agriculture – Statistics Research and Information Directorate
		Proportions of annual rice production area under rain fed, irrigated and upland systems	National Rice Development strategy	Ministry of Food and Agriculture
4. Waste				
4A	Solid Waste Disposal	Waste Generation, Population Figures, Composition, amounts of waste deposited, means of disposals and their various percentages	Published national reports, Ghana Statistical Services, Sanitation Directorate of MLGRD, World Bank Country Database, Private Waste Management Companies and Civil Engineering Department, KNUST, EPA	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, etc.), and NGOs Academia (Civil Engineering Department, KNUST), Second National Communication Report from EPA.
4B	Biological Treatment of Solid Waste	Fraction of waste composted, number of compost plants	Private Waste Management	Private Waste Management Companies (Zoomlion Ghana Limited) and NGOs. Expert judgment by the Waste Team
4C	4C.1 Waste Incineration	Amount and types 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 and Ghana Health Service Facts and Figures, and Expert Judgment by the Waste Team
	4C.2 Open Burning of Solid Waste	Population, proportion of population burning waste, duration of burning in number of days per year, 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
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,	Ghana Statistical Services, 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

		GDP/capita		Waste Team
	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 Outputs data collected during national survey, EMPs Expert Judgment by Waste Team

2.4 Emissions and Removals and Trends

2.4.1 Aggregated national emission trends

Ghana's total GHG emissions were 33.66 million tonnes (Mt) carbon dioxide-equivalent (CO_2e) in 2012. This represented an increase of 10.7% on total emissions recorded in 2010, and an increase of 106.2% and 136.7% above 2000 and 1990 levels respectively. The net national GHG emissions in 2012 was 18.49 $MtCO_2e$ when emissions and removals from the Agriculture, Forestry and Other Land Use sector were excluded (see figure 6).The mandatory summary tables are provided in annex 1. Annex 2 contains time series table of the total national emissions (1990-2012).

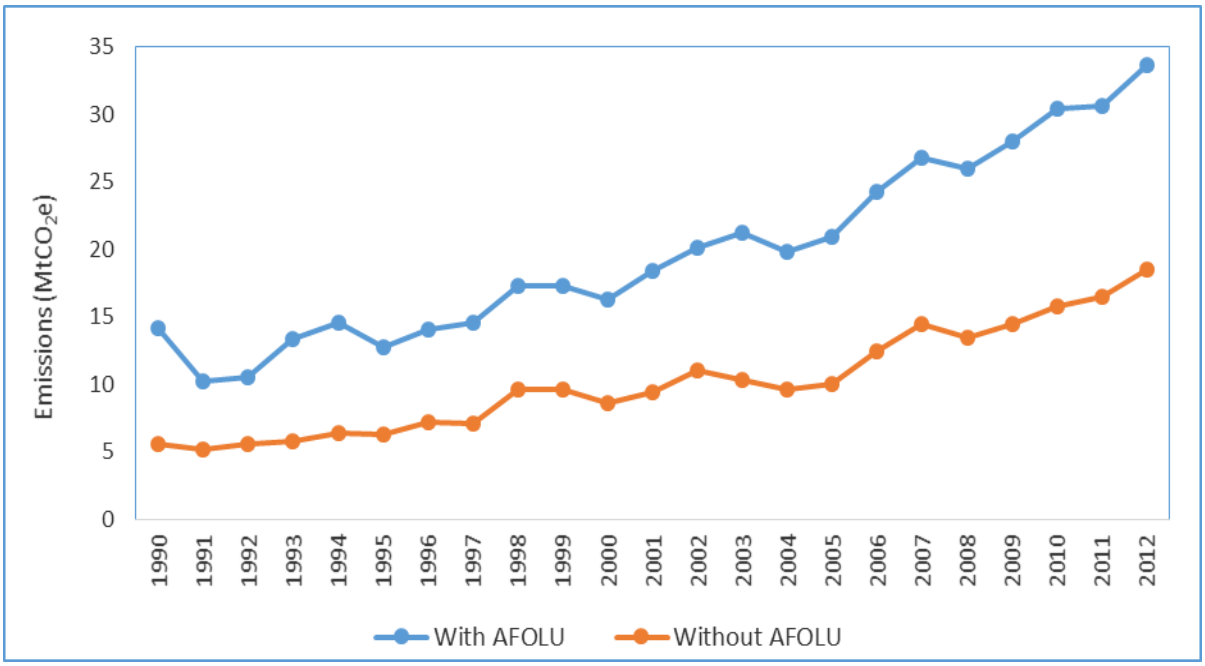

Figure 6: National emission trends with and without AFOLU

The observed increases in the emission trends corresponded to the on-going structural economic transformation agenda which has led to sustained growth and expansion of the national economy. The expansion in the economy has resulted in notable rise in emissions from road transport, electricity generation from crude oil-fired thermal plants, increasing demand for biomass use. In addition, emissions from land use change also recorded increases between 1990 and 2012 mainly due to deforestation. However, with the continuous implementation of government's national reforestation program, emissions from "land" have seen some decreases between 2010 and 2012 (see table 5).

Table 5: Total greenhouse gas emissions by sectors

Sectors & Sub-sectors	Emissions $MtCO_2e$					Percent Change		
	1990	2000	2010	2011	2012	1990-2012	2000-2012	2010-2012
1. All Energy (combustion & fugitive)	**3.50**	**5.54**	**11.27**	**11.63**	**13.51**	**286.08**	**143.65**	**19.79**
(1.A1,A2&A5) Stationery energy combustion	2.03	2.73	6.48	6.22	7.05	247.28	158.10	0.09
(1.A5)Transport	1.47	2.81	4.80	5.41	6.46	339.66	129.85	34.67
(1.B) Fugitive emission	0.000	0.003	0.001	0.001	0.002	284.71	-51.74	139.35
2. Industrial Process & Product Use	**0.81**	**0.77**	**0.24**	**0.44**	**0.47**	-42.47	-39.56	**94.24**
3. AFOLU	**8.61**	**7.72**	**14.67**	**14.08**	**15.17**	**76.28**	**96.65**	**3.46**
3A Livestock	1.72	2.20	2.82	2.80	3.05	77.29	38.66	8.01
3B Land	-3.02	-4.00	1.85	1.31	1.84	-160.73	-145.86	-0.96
3C. Aggregated and Non-CO_2 emissions	9.91	9.52	9.99	9.98	10.29	3.83	8.08	3.00
4. Waste	**1.31**	**2.29**	**4.24**	**4.45**	**4.52**	245.97	**97.03**	**6.54**
Total emissions (excluding AFOLU)	**5.61**	**8.61**	**15.75**	**16.51**	18.49	**229.31**	**114.81**	**17.36**
Total net emissions (including AFOLU)	**14.22**	**16.32**	**30.42**	**30.60**	**33.66**	**139.69**	**106.22**	**10.66**

The AFOLU sector was the largest source of emissions followed by the energy sector in 2012 constituting 45.1% (15.17 $MtCO_2e$) of total net emissions. The rest of the emissions came from the waste sector and the industrial process and product use. In the same year, CO_2 was the most important of GHG (including AFOLU) with a large share of 44% of the total national emissions, followed by N_2O and CH_4, which comprised 30.8% and 24.8% respectively (see figure 7). The remaining 0.3% of the total national emissions was made up of PFCs (0.11 $MtCO_2e$).

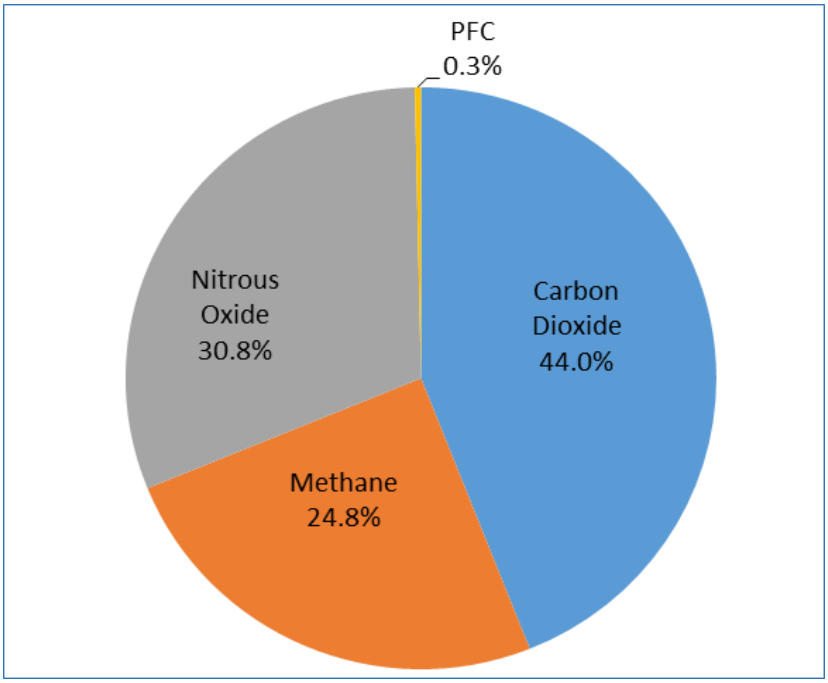

Figure 7: Contributions of gases to the national emissions in 2012

However, in terms of gases, the energy sector was the main source of CO_2 emissions in 2012, which represented 85% of the total anthropogenic CO_2 emissions (see table 10). This was followed by AFOLU (12.6%), IPPU (2.3%) and waste (0.03%). On the other hand, for CH_4 emissions, the share of the sectors were as follows: waste sector (48.1%), AFOLU (44.2%) and energy (7.7%). For N_2O emissions, 92.7%, 2.62% and 4.7% of the total emissions were from the AFOLU, waste and energy sectors respectively (see table 6 and 7).

Table 6: Distribution of emissions contribution by sectors in 2012

Sector and sub-sectors	CO_2 [%]		CH_4 [%]		N_2O [%]	
	W/O AFOLU	With AFOLU	W/O AFOLU	With AFOLU	W/O AFOLU	With AFOLU
1. All Energy (combustion & fugitive)	97.2	85.03	13.72	7.7	35.7	2.62
Stationery energy combustion	50.0		94.4			
Transport	50.0		5.5			
Fugitive emission*	0	0	0	0	0	0
2. Industrial Process & Product Use	2.7	2.39	0.0	0.0	0.0	0.00
3. AFOLU		12.6		44.2		92.7
Livestock				57.5		9.58
Land		*98.7*		0		0
Aggregated and non-CO_2 emissions		*1.26*		42.5		90.4
4. Waste	0.03	0.03	86.3	48.1	64.3	4.72
Total net emissions (w/ AFOLU)		100		100		100
Total emissions (w/o AFOLU)	100		100		100	

*Fugitive emissions are marginal and below zero percent

Table 7: Net national emissions by sectors in 2012 including AFOLU

Sectors and Sub-sectors	Emissions					Share of Total Emissions	
	Mt	$MtCO_2e$					
	CO_2	CH_4	N_2O	PFC	Total	%	%
1. All Energy (combustion & fugitive)	12.59	0.64	0.27	0.00	13.51	73%	40.1%
Stationery energy combustion	6.29	0.60	0.15	0.0	7.0	38%	
Transport	6.30	0.04	0.12	0.0	6.5	35%	
Fugitive emission	0.00	0.00	6.4E-06	0.0	0.002	0%	
2. Industrial Process & Product Use	0.35	0.00	0	0.11	0.47	3%	1.4%
4. Waste	0.00	4.02	0.49	0.0	4.5	24%	13.4%
3. AFOLU	1.86	3.70	9.62	0.00	15.17	100%	45.1%
Livestock	0.00	2.13	0.9	0.0	3.0	20%	
Land	1.84	0.00	0.0	0.0	1.8	12%	
Aggregated and Non-CO_2 emissions	0.02	1.57	8.7	0.0	10.3	68%	
Total net emissions (including AFOLU)	14.81	8.36	10.38	0.11	33.66		100%
Total emissions (excluding AFOLU)	12.95	4.66	0.76	0.11	18.49	100%	

Within the energy sector, emissions from stationery energy combustion (mainly from power plants, industrial point-sources and household consumption of biomass) made up 52.2% of the total emissions, which is followed by emissions from mobile combustion (transport) accounting for 47.8%. The remaining 0.01% came from fugitive emission sources in the oil and gas industry.

2.4.2 Description of emissions and removals by gases

2.4.2.1 Carbon dioxide emissions

In 2012, Carbon dioxide emissions amounted to 14.8 Mt accounting for 48% of the total GHG emissions. When emissions from AFOLU were excluded, CO_2 made up 42% share of the total GHG emissions. They increased by 100.7% from -0.11Mt in 1990 to 14.8Mt in 2012 (see figure 8). The increase was observed in all the sectors except the Waste sector where CO_2 emissions declined. The AFOLU sector recorded the highest increase in CO_2 emissions (261.8%). Emissions increased from a net sink of -3.1 Mt in 1990 to 1.86 Mt in 2012 (see figure 21). The substantial rise of CO_2 emissions in the AFOLU sector corresponded to the increasing intensity of land use change in forestland, croplands and grasslands. Conversions that took place on grassland and cropland contributed to most of the CO_2 emissions on land for the period 1990-2012. Similarly CO_2 emissions from forestland saw a rise to 68% for the same period.

For the energy sector, CO_2 emissions accounted for the largest share of gases. They accounted for 93% of the total GHG emissions of which transport and electricity generation were the main sources. Between 1990 and 2012, CO_2 emissions rose by 79.3%; 2.6 Mt in 1990 to 12.59 Mt in 2012 (see figure 8). The increases in CO_2 emissions were mainly due to the increasing emissions contributions from the transport and energy industries categories. The rise in the CO_2 emissions could be seen as a result of the following factors (a) increasing traffic congestion in the urban centres (b) increasing thermal electricity in the generation mix (c) increasing use of stand-by generators in commercial activities during load shedding periods, by the utility companies and (d) kerosene use in both domestic (non-electrified rural areas) and commercial (part of urban centers) lighting.

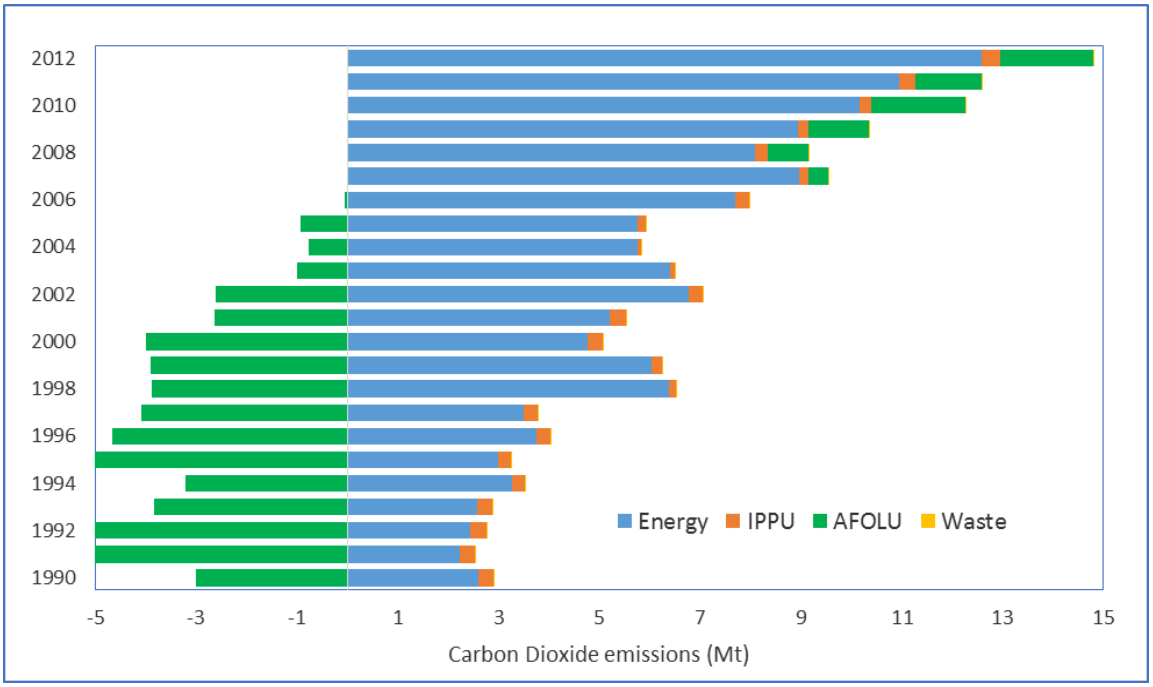

Figure 8: Chart showing trend of rising net CO_2 emissions from 1990 to 2012

2.4.2.2 Methane emissions

The total methane emissions were estimated at 8.4 $MtCO_2e$, which represented 24.8% of total GHG emissions in 2012. Methane emissions from the waste sector were the largest source contributing 48.1% followed by AFOLU (44.2%) and Energy (7.7%). Although there were overall increases in the methane emissions trend, for the period 1990-2012, not all the individual sectors recorded increases (see figure 9). While the methane emissions in the waste sector saw 75.9% rise for the same period, that of AFOLU (-29.9%) and Energy (-12.7%) sectors recorded decreases. In the AFOLU sector, enteric fermentation in livestock and biomass burning were the main sources of methane emissions. The rise in the number livestock and frequent burning of biomass through land clearing, contributed to the emissions in the sector. In the waste sector, methane was the most important gas. It constituted 89.1% of total emissions from the waste sector in 2012. Wastewater treatment and discharge was the dominant source of methane (63.3%) followed by solid waste disposal (35.8%). The rising methane emissions from wastewater treatment were due to the growing proportions of domestic liquids waste, which are not adequately treated before it is discharged into environment. The way some of the liquid waste are discharged in the environment may not lead to methane emissions because of the presence of aerobic condition in the final treatment. This had strong correlation with the rising urban population in Ghana.

The growing urbanization in the country put significant pressure on sewage infrastructure, which is practically incapable of meeting the load capacity. Furthermore the CH_4 emissions increases also corresponded with the amounts of solid waste collected and disposed throughout for the period 1990-2012.The increased trend in the amount of waste collected and disposed of underscores the policy shift, over the years, in the decentralization of solid waste service provision from central government to local governments and current involvement of the private sector. Historically, in the early 1990s, there was a policy shift towards private sector-led development, which led to contracting out and franchising the solid waste collection services to the private sector in Accra and Tema. The shift helped to increase the amount of waste collected and deposited for treatment at landfill sites. Although the policy that allowed private sector participation yielded some level of efficiency in waste collection and disposal, not much has been done to improve management of waste disposal sites. In addition, the existing policy does not offer clarity on landfill gas management.

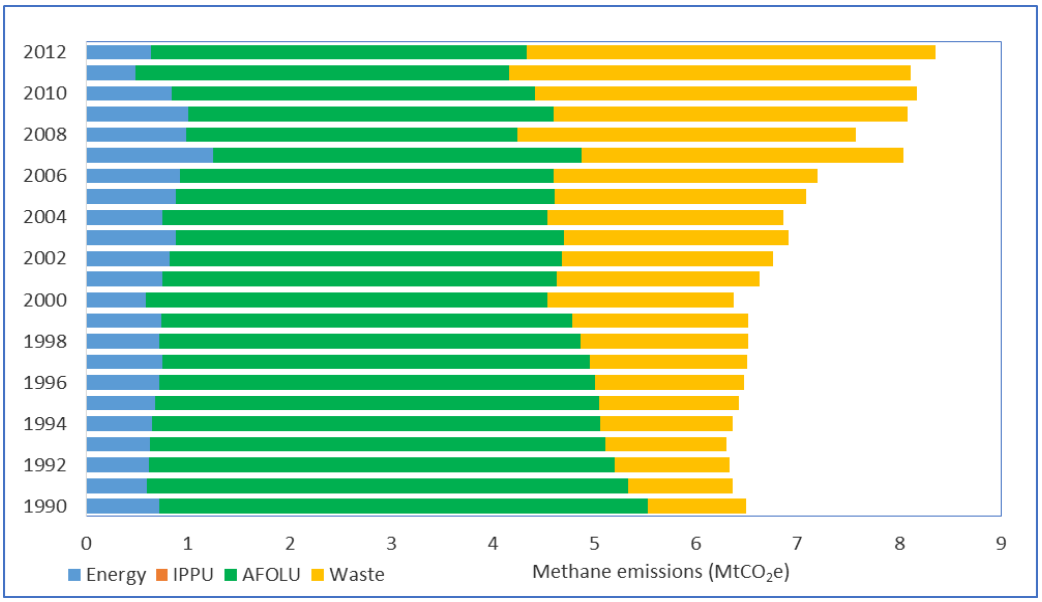

Figure 9: Chart showing rising trend of CH_4 emissions from 1990 to 2012

2.4.2.3 Nitrous Oxide emissions

Nitrous oxide emissions were the second most important source of GHG emissions in the country. It was estimated at 10.38 $MtCO_2e$, which represented 30.8% of the total GHG emissions in 2012. For the period 1990-2012, N_2O emission grew by 29.5% essentially resulting from biomass burning and application of artificial nitrogen-based fertilizer in the AFOLU sector (see figure 10). The AFOLU sector was the largest source of nitrous oxide emissions followed by the waste sector through incineration and open burning.

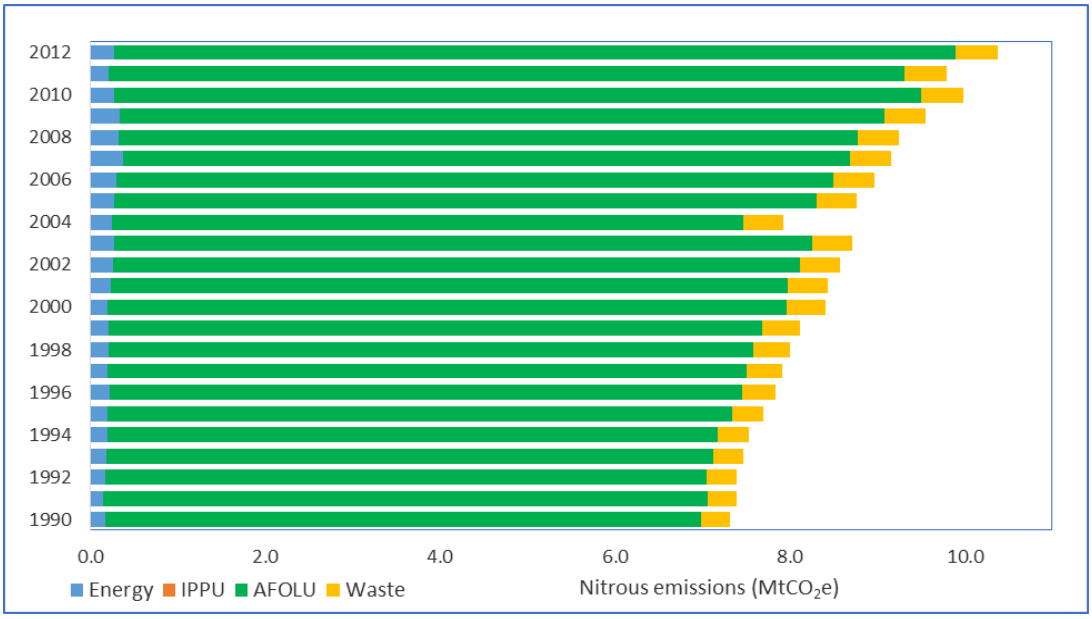

Figure 10: Chart showing rising trend of N_2O emissions from 1990 to 2012

2.4.2.4 PFC emissions

PFCs emissions were the least important source of GHG emissions in the country. It was estimated as 0.11$MtCO_2e$ which represented 0.4% of the total GHG emissions in 2012. Aluminum production in the IPPU sector was the only source of PFC emissions. The emissions showed a consistent decrease from 0.52$MtCO_2e$ in 1990 to 0.11$MtCO_2e$ in 2012 (see figure 11). The general decline in the PFCs emissions coincided with the periods when the Volta Aluminum Company Limited recorded lower productivity.

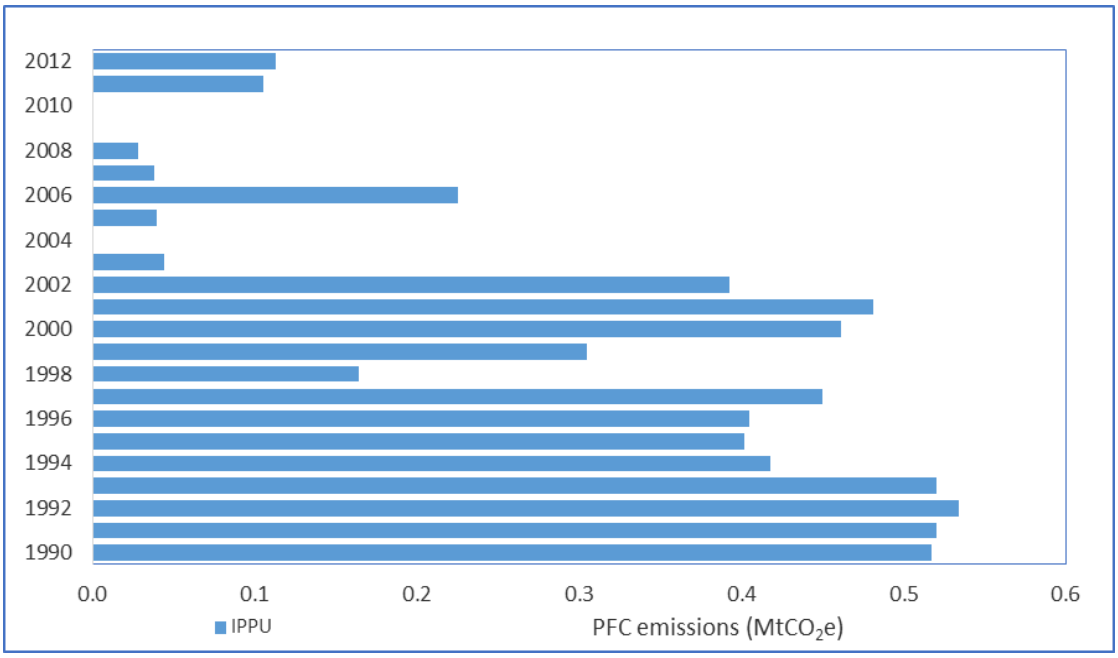

Figure 11: Chart showing of decreasing PFC emissions from 1990 to 2012

2.4.3 Description of emissions and removals by sectors

In 2012, the total emissions of 15.2 $MtCO_2e$ from the AFOLU sector constituted the largest source of GHG emissions in Ghana, accounting for 45% of the total national emissions. The 15.2 $MtCO_2e$ emissions in 2012 represented 96.5% above the share of the total emissions in 2000. Emissions from aggregated sources and non-emissions from land contributed the largest share of 67.8% and 30.6% of the total AFOLU and nation's emissions respectively. The Energy sector was the second largest source of emissions making up 40.1% of the national total emissions. This share was 6.3% lower than that of 2000. A majority of the emissions in the sector were mainly from stationery fuel combustion (52%) and transport (48%) sources. The remaining 16.2% of the national total emissions were from the waste (14.6%) and IPPU (1.5%) sectors.

Over the period 1990-2012, total emissions from most of the sectors showed increasing trends except emissions from IPPU sector which showed a slight decline (see figure 12). In terms of changes in trends, emissions from IPPU sector recorded the highest increase of 135% from 2010 to 2012. For the energy sector, similar increases were observed, but it was not as sharp as that of the IPPU sector. The emissions increased from 3.5 $MtCO_2e$ in 1990 to 13.5 $MtCO_2e$ in 2010, and further increased by 19.5% in 2012. Similarly, the waste sector emissions rose by 71% and 7.1% from 1990 and 2010 to 2012 respectively. The AFOLU sector also recorded a 32.7% increase in emissions between 1990 and 2012 and 5.3% from 2010 to 2012.

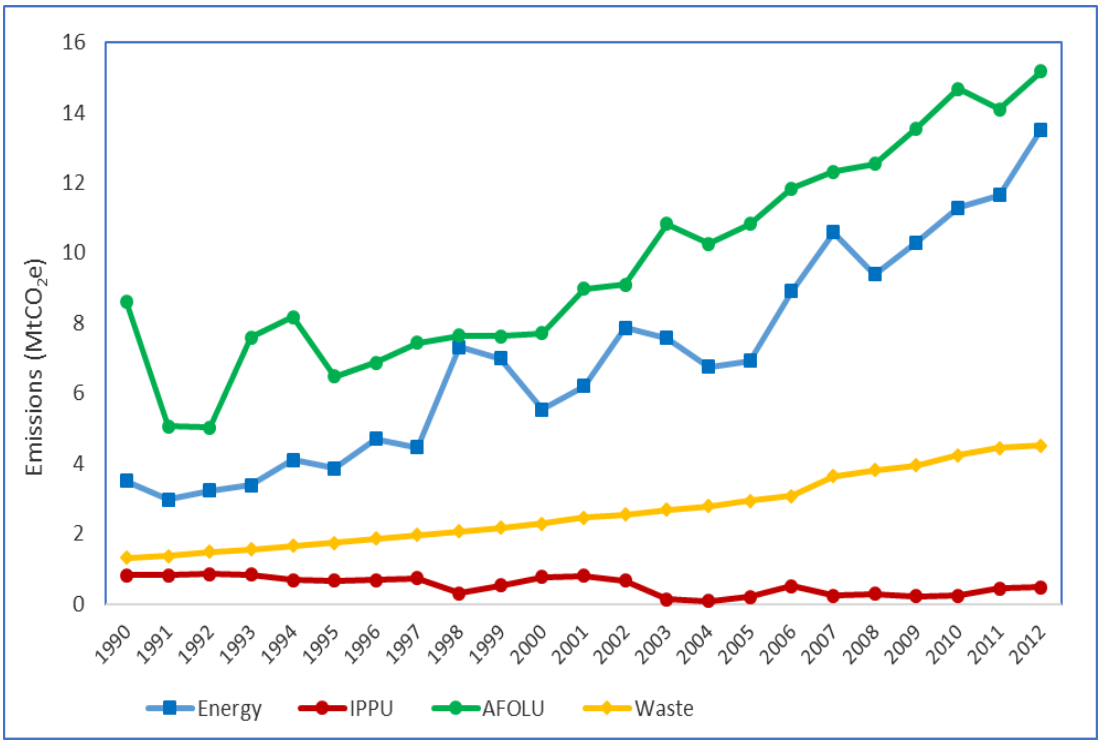

Figure 12: Trends of total emissions by sectors

The key drivers of the emission trends in the various sectors are as follows:

- Energy Sector: The largest sectoral increase in GHG emissions over the 1990 to 2012 period, of 52% (7 $MtCO_2e$), was from the stationary energy sector driven partly by increasing energy demand due to the rising number of electrified households, expanding commercial/industrial activities and household incomes. The main driver for the increase in transport emissions is continuing growth in the number of passenger vehicles and the expanding domestic aviation industry.

- Industrial processes: The decrease in emissions since 1990 was primarily driven by the declining operational capacity of the only Aluminum Plant in Ghana (VALCO).

- Waste: The increase in the net emissions from waste are due to growing populations, changing lifestyles and operational and management challenges at most landfill sites. In most of the landfills methane is not captured.

- AFOLU – The increasing trend in emissions from AFOLU since 1990 has been mainly driven by the emissions from forestland converted to cropland and grassland, biomass burning through wildfires, increases in animal populations, crop production, fertilizer use, and associated emissions. These factors contributed to the AFOLU sector becoming source in 2007.

2.5 Identification of key categories

The key categories were identified using the level assessment and trend approaches. The level assessment approach was used to identify key categories from 1990 to 2012 whereas trend assessment was used to identify key categories for 2012 using 1990 as the base year. The total emissions from the key categories amounted to 17.57 $MtCO_2e$ in the year 2012, which represented 57% of Ghana's total GHG emissions (without AFOLU). On the other hand, when AFOLU emissions were included, total emissions from the key categories were 26.13 $MtCO_2e$ in 2012, which was 84.7% of the total national emissions. With the inclusion of the AFOLU sector emissions in the analysis, "land converted to cropland" and "forest land remaining forest land" were identified as the most significant of the key categories (i.e. contributing more than 45% of the emissions) in 2012 (see tables 8 and 9). When the AFOLU sector emissions were excluded from the analysis, the most, significant key categories in 2012 were, road transport (liquid fuels), wastewater treatment and discharge and public electricity generation (liquid fuel).

Table 8: Identified key categories using level assessment in 2012

IPCC Code	IPCC Categories	Gas	Cumulative Total
3.B.2.b	Land Converted to Cropland	CO_2	0.2
3.B.1.a	Forest land Remaining Forest land	CO_2	0.5
3.B.1.b	Land Converted to Forest land	CO_2	0.6
3.B.3.b	Land Converted to Grassland	CO_2	0.7
1.A.3.b	Road Transport	CO_2	0.8
3.C.4	Direct N_2O Emissions from managed soils	N_2O	0.8
4.D	Wastewater Treatment and Discharge	CH_4	0.8
1.A.1	Energy Industries - Liquid Fuels	CO_2	0.8
3.A.1	Enteric Fermentation	CH_4	0.9
3.C.1	Emissions from biomass burning	N_2O	0.9
1.A.4	Other Sectors - Liquid Fuels	CO_2	0.9
4.A	Solid Waste Disposal	CH_4	0.9
3.C.1	Emissions from biomass burning	CH_4	0.9
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	0.9
3.C.5	Indirect N_2O Emissions from managed soils	N_2O	1.0

Table 9: Identified key categories using trend assessment for the period 1990-2012

IPCC Code	IPCC Categories	Gas	Cumulative Total
3.B.1.a	Forest land Remaining Forest land	CO_2	0.4
3.B.1.b	Land Converted to Forest land	CO_2	0.7
3.C.1	Emissions from biomass burning	N_2O	0.7
3.C.1	Emissions from biomass burning	CH_4	0.8
3.B.3.b	Land Converted to Grassland	CO_2	0.8
1.A.3.b	Road Transport	CO_2	0.9
1.A.1	Energy Industries - Liquid Fuels	CO_2	0.9
3.B.2.b	Land Converted to Cropland	CO_2	0.9
4.A	Solid Waste Disposal	CH_4	0.9
2.C.3	Aluminum production	PFCs	0.9
1.A.4	Other Sectors – Biomass	CH_4	0.9
1.A.1	Energy Industries - Gaseous Fuels	CO_2	0.9
3.C.4	Direct N_2O Emissions from managed soils	N_2O	1.0

In terms of trend assessment, CO_2 emissions from "forestland remaining forestland" and "land conversions to forestland" were the key categories. This was followed by N_2O and CH_4 emissions from biomass burning (see table 13). More details on the description of the key categories are provided under each sector.

2.6 Information on Quality Assurance/Quality Control (QA/QC) Procedures

2.6.1 Description of Roles and Responsibilities

The sector leads were given responsibilities of ensuring that adequate QA/QC procedures were performed in the inventory, its supporting documents and spreadsheets. The EPA also doubled as the back stopper of QA/QC and focused on the following: (a) creating a checklist of QA/QC procedures, based on "EPA's Procedures template for Quality Assurance/Quality Control and Uncertainty Analysis" for the team members to follow, (b) collecting and reviewing checklists for completeness, and following up when necessary to ensure that the required QA/QC procedures were observed, (c) delivering all documentations to the online database manager, and (d) facilitating all technical reviews at the national and international levels.

2.6.2 Implementation of QC Procedures

The tier 1 QC procedures Ghana implemented in the inventory are listed in table 10:

Table 10: Summary of the QC procedures implemented in the Inventory

QA procedures	Description of tasks	Responsibility(ies)
Internal consistency	Ensured that the total GHG emissions equal the sum of the individual emission from the sectors and categories.	Inventory compiler
	Ensured that the total GHG emissions equal the sum of the emissions by gas.	
	Compare data in tables to calculation spreadsheets and to the text in order to ensure that all reported the same estimates.	
	Ensure that parameters used in multiple categories (e.g., population) are consistent across categories.	
	Ensure that the emissions data is reported in a manner consistent with the calculation tables in the Non-Annex 1 National Communications Reporting Guidelines	
	Ensure that the selection and application of the estimation methods were consistent with IPCC guidelines.	
Documentations	Create back-ups of all documentations in hard and soft copies and uploaded files in a central storage facility online	Inventory compilers
	Moved all files and documentations to an "online GHG database"	Online database manager
	Review, approve and harmonize sector files to ensure consistency in filing.	Inventory compilers

2.6.3 External Review QA Procedures

International third party review

External reviews by experts offer the opportunity to uncover technical issues related to the application of methodologies, selection of activity data, development and selection of emission factors. Based on their knowledge and experience in areas related to the inventory. The listed experts and/or organizations indicated in table 10, below were sent draft copies of the inventory for review three months before publication. The review package that were sent to the third party reviewers included (a) data inputs, (b) inventory datasheets and results and (c) inventory report.

Table 11: List of Experts for External Review of National Greenhouse Gas Inventory

Reviewer	Affiliation/Organization	Sector or Category	Comments
Zoltan Somogyi	EU - Hungary	AFOLU	Review was done as part of the CD-REDD Project through Rainforest Coalition with support the Germany Government.
John Watterson & Ross Hunter	Ricardo-AEA	Energy Sector	Review was done as part of the Information Matters Project through GIZ with support the Germany Government
Dominique Revet	UNFCCC	Draft inventory report	Request from Ghana for informal review of draft NIR
Sabin Guendehou	Benin (Coordinator , Sustainable Greenhouse Gas Management Project in West Africa)	AFOLU	Review was done as part of the Sustainable Greenhouse Gas Management Project in West Africa through UNFCC with support from Australian Government

Domestic third party review

In addition, all the sector inventory results were also subjected to "internal disclosure and assessment" by the relevant Ministries, Department and Agencies (MDAs). The "internal disclosure assessment" was done through four "reality check" meetings that were held at the various MDAs to collect inputs on (a) policy implications of the sector estimates (b) practical steps that are needed to be taken to facilitate further mainstreaming of inventory in the sector and (c) how to strengthen the linkages with research. Furthermore internal technical and policy review was done by selected management members at MESTI and EPA under the overall coordination of the Executive Director, EPA. Out of the 15 people who did review, 5 of them focused on the reviewing the NIR.

They are (a) Mr. Ebenezer Sampong (Deputy Executive Director, Technical –EPA); Mr. John Pwamang (Deputy Executive Director, Field Operations -EPA), Mr. Peter Dery (Deputy Director, Climate Change and Sustainable Development Unit, MESTI), Mr. K.Y. Oppong-Boadi (UNFCCC Focal Point, EPA) and Mr. Joseph Baffoe (Climate Change Unit, EPA). Another set of 5 people focused on the review of the BUR. They were (a) Lambert Fabulon (Director Compliance and Enforcement, EPA), Mr. Antwi Boasiako Amoah (Climate Change unit, EPA), Daniel Benefor (Climate Change unit, EPA) and Dr. George Essegbey (STEPRI-CSIR).

2.7 General Uncertainty Assessment

The process of estimating GHG emissions has inherent uncertainties. The way the activity data and emission factors are generated, either through physical measurements or modeling, carries certain levels of uncertainty. Datasets that are produced through such processes introduce their inherent uncertainties into the GHG accounting. Managing these uncertainties, and reducing them over time, is recognized by the IPCC Good Practice reports (IPCC 2000, 2003) as an important element of inventory preparation and development. Ghana has conducted a tier 1 uncertainty analysis across the sectors in line with the IPCC Good Practice reports (2000, 2003). However, because most of the activity data were mainly from secondary sources that hardly reported uncertainty ranges in their metadata, qualitative approach backed by expert's judgment was used to assign the uncertainty ranges based on the sources of data in a consistent and transparent manner. In addition, the uncertainty ranges associated with the IPCC emission factors were also used. Using the IPCC recommended minimum uncertainty range of 5% plus/minus for facility level activity data, the uncertainty ranges were assigned to each activity based on

the source. The spread of uncertainty ranges was assumed to increase according to the level of verifiability and reliability of the source of data. Table 12 shows the uncertainty range based on input activity data.

Table 12: Range of uncertainty range input for activity data

Activity data source	Uncertainty Range		Comments
	Plus	Minus	
Facility level measurement	5%	5%	Applied to Volta Aluminum Plant (VALCO)
Peer reviewed literature	5%	5%	
Research results	5%	5%	
Enumeration	4%	2%	Driver Vehicle and Licensing Authority data type
Industry archive	6.5%	6%	(Ghana railway company type)
International sources	6%	5.50%	(FAO, IEA, WB, etc)
National reports			Including strategies, action plans etc.
Annual reports	5%	5.5%	
Project reports	5%	5.5%	
Energy Statistics	6%	5.5%	
National Census	5%	5%	
Ghana Living Standard Survey	5%	5.5%	
Expert judgment	15%	12%	
Personal Communication	10%	10%	

At an aggregate level, using IPCC good practice tier 1 methods, the overall uncertainty surrounding the inventory estimate for 2012 was estimated at ±2.1%.

2.8 General assessment of the completeness

Assessments of completeness for each sector have been provided under the sector-specific description section. The general overview of completeness is as follows:

Geographic coverage

The geographic coverage is complete. The inventory covered the entire territorial boundary of the Republic of Ghana. Thus none of the 10 administrative regions in Ghana was left uncovered by the inventory.

Sectors (sources and sinks)

All sources or removals of direct GHG gases, outlined in the 2006 IPCC Guidelines, were covered in the inventory except the following activities which were considered insignificant in the country or where data were non-existent:

- 1A.2a – Iron and steel
- 1A.2b – Non-ferrous metals
- 1A.2i – Mining (excluding fuel) and quarry
- 1B.2a.iii.5 – Distribution of oil products
- 2F – Product use as substitute to ozone depleting substances
- 3B.4 – Wetlands
- 3B.5 – Settlements
- 3B.6 – Other lands
- 3D.i – Harvested wood products

Gases

Majority of the direct gases have been covered under this inventory. These direct gases included CO_2, CH_4, N_2O and PFCs (CF_4 and C_2F_6). HFCs have not been considered in this inventory due to data unavailability.

Notation keys

NE (not estimated):
There were categories reported as NE because of lack of requisite data. Although some of the activities could be significant sources such as mining and iron steel, it was report because of either the available data were not disaggregated enough or the serious time series gaps that could be filled. The sources are:

- 1A.2a – Iron and steel
- 1A.2b – Non-ferrous metals
- 1A.2i – Mining (excluding fuel) and quarry
- 1B.2a.iii.5 – Distribution of oil products
- 2F – Product use as substitute to ozone depleting substances
- 3B.4 – Wetlands
- 3B.5 – Settlements
- 3B.6 – Other lands
- 3D.i – Harvested wood products

NO (not occurring)
The highest number of source categories marked with NO is found in the industrial processes sector, as most of these do not occur in the country.

Reporting activities in informal sectors

The emission inventory do not include activities that are not captured in the official data reported the stated institution. For example, unreported fuel use, household animals that are not captured in the livestock census, unaccounted timber etc.

2.9 Planned Improvements

During the inventory certain areas were identified for future improvements to ensure building greater confidence in the inventory estimate by reducing uncertainties to the extent possible. Table 13, 19 and 20 contain the list of identified planned improvement activities and the necessary next steps that must be taken.

Table 13: Description of planned improvement areas for energy sector

Category	Identification of planned improvement areas	Prioritization of improvement activities	Responsibility and next steps	Expected time to resolve
1.A4b other sector commercial/institutional	Survey on source-specific commercial/institutional generators: fuel consumption, installed capacity, population etc	KC	Energy commission and EPA	Next inventory
1.A1b – Electricity generation	Develop or request IPPs to report on their plant-specific emissions and emission factors	KC	EPA & Energy Commission	Next inventory
1.A2a	Allocate fuel share to iron and steel industry (support activities)	Non-KC	Energy team	Next inventory
All Categories	Conduct survey to update and review existing sectoral fuel consumption share		Energy Statistic Team. Energy Commission	Medium-long term improvement in the reporting in Energy Statistics
1.A3b – Road Transport	Survey to update the existing 2005 data on of fuels allocation to the various vehicle classes.	KC	DVLA, EPA and Energy Commission	Medium to long term bearing in mind on-going project on roadmap emission and fuel economy standards by 2020.
	Survey to improve the technology-based classification of the vehicle on based EU standards (in addition focus on separating functional catalytic device).			
	Survey to establish fuel economy baseline for different classes of fairly new vehicles (120,000 to 50,000km)		DVLA, EPA and Energy Commission, private garages	
	Separate portions of the total fleet is that use for freight transport from passenger transport		Energy Team	Next inventory
1.A3a – Civil aviation	Collect additional ATK consumption, LTO of domestic airlines data from OMCs , Civil Aviation Authority, and the Airlines	Non-KC	Energy Team	Next two inventories
	Additional data collection with the aim producing tier 2 estimates – data on domestic air traffic movement (LTO),	Non-KC	Energy Team	next inventory
1.A3c Railways	Reconcile the Ghana Railway Company's and IEA diesel consumption for rail	Non-KC	Energy Team	next

	transport to ensure consistency and transparency.			inventory
	Collect additional data from Ghana Railway Company on the following: (a) number of train in service, (b) annual distances or destinations covered and (c) technologies of the trains	Non-KC	Energy Team	next inventory
Bunkering fuels	Collect additional specific data on ATK and diesel for bunkering services	-	Energy Team	Next inventory

Table 14: Description of planned improvement areas for AFOLU sector

Improvement tasks	Responsibility & Collaborators	Priority	Next Step	Target	Assumptions
Develop all-embracing new land representations schemes with definitions(include possibility of delineating tree crops from annual crop areas)	FC, EPA, UNU-INRA, Rudan, CERGIS, Geomatics-KNUST, FAO, NATU-KNUST, Cocoa Board	High	Explore possibility of making a link with the FPP process as follow-up. EPA can only facilitate.	Next Inventory	Funding is secured on time
Reprocess land use maps and LUC matrices	FC, AFOLU Team	High	AFOLU technical team from the collaborating institutions will proceed with these activities following the initial action		
Overlay land cover maps with map of eco-zones, climate, soil and recalculate land use change maps		High			
Integrate maps on perennial crops (mainly cocoa and rubber) in land use maps and recalculate		High			
Reconsider the dealing with wetlands and eliminate some ways of change between categories.		High			
Reconsider factors that express speed of land use change in the 1970ies and 1980ies		High			
Cross-check area estimates from LUC matrices with data available at the plantation unit		High			
Include the annual fire hotspots and overlay on the land use maps to	FC	High	Link with AGRYMET, UNEP data on fire	Next Inventory	FC to initial contact with AGRYMET supported by EPA

assign disturbances to land use subcategories and manure management.					
Work on biomass inventory	FC and FORIG	High			
Include the biomass density estimates for plantations	FC and FORIG	High	EPA to follow-up with FC and FORIG	Next Inventory	Contact FORIG
Remove outliers from biomass plot estimation (dead wood estimates)	FC and FORIG	High			Contact FC for updates
Quality check deadwood calculations in inventory data	FC and FORIG	High			Contact FC
Explore possibility of surveying of non-forest trees, in settlements and communities(Measure AGB and fuel wood collections in settlements and integrate these values in the inventory)	FC and FORIG and EPA	Medium	Float call for proposal for the selection of the vendors	Next Inventory	Fund secured by EPA
Explore possibility of including trees in annual croplands	FC & MoFA	Medium	include in the discussions of the AFOLU collaborating team	Next Inventory	part of the activity 1
Explore possibility of reducing uncertainty associated with time series data (infilling of data gaps)	AFOLU Team	Medium	EPA to coordinate revision of existing estimates	Next Inventory	Funding is secured on time
a. biomass changes in different land representations including different pools					
b. Fuel production/supply					
d. Pools					
Account for the burning of crop residues beyond the burning of fields	MoFA	Low	MoFA to lead AFOLU team in the identification, collection and inclusion of data in to the inventory	Next Inventory	Funding for NC4 and BUR2 will cover this activity
Account for multiple cropping rice	MoFA and AFOLU Team	Low			
Include harvested wood products	FC	Low			
Include crop residues from plantain	MoFA and EPA	Low			
Clarify the fertilizer use in rice	MoFA and EPA	Low			

Table 15: Description of planned improvement areas for Waste sector

Improvement tasks	Responsibility &Collaborators	Priority	Next Step	Target	Assumption
Collect additional data on solid waste generation rate and waste classification	Built Environment Department, EPA, Civil Engineering Department, KNUST, MLGRD, AMA, KMA, STMA, TMA	Medium	Contact relevant institutions to include data need into yearly surveys and research	Next inventory	Funding is secured on time
Revise solid waste generation rates and waste stream fractions with new datasets	Waste inventory team	High	EPA to coordinate revision of existing estimates		
Separate solid disposal further to managed, unmanaged and uncategorized	Waste inventory team	Medium	EPA to coordinate		Availability of new solid waste dataset
Revise fraction of solid waste biologically treated through composting	Built Environment Department, EPA and Zoomlion Ghana Limited	Medium	EPA and Zoomlion to take lead		
Revision of the fraction of solid waste incinerated and openly burnt	Built Environment Department, EPA	Medium	EPA to contact Ghana Health Service and Ghana Education Service to include in their survey		
Update existing survey data on industrial and domestic waste	Manufacturing Industry Department, EPA	High	EPA to initiative review of industrial survey		Funding is secured on time

Table 16: Description of planned improvement areas for IPPU sector

Item	Description
Data improvements	Conduct industrial survey in country to identify all possible sources according to the IPCC guidelines for both formal and informal sources and ensure data is collected and sources maintained for future inventories.
	Identify, track and monitor any potential new source that would be important for emissions for inclusion in inventories according to the IPCC guidelines
	Identify additional data collection sources for lime production. Particular attention will be given to collecting enough data to fill in time series gaps.
	Collect comprehensive data on ODS substitute gas (HFCs) especially in the refrigeration and air-conditioning sectors
	Collect data from 1990 to 2004 and include the data from a second plant established in country, as the latest guidance from the IPCC on the use of facility-level data in national inventories will be relied upon.
Methodological improvements	Improvement in estimates on non-energy use and feedstock to ensure internal consistency.
	Analyze data reported for dolomite use by the cement industry and limestone use as fluxes in the steel recycling plants, which would be useful to improve the emission estimates for the

	Limestone and Dolomite Use source category. In implementing improvements and integration of data from the plant, the latest guidance from the IPCC on the use of facility-level data in national inventories will be relied upon. Additionally, future improvements include revisiting the methodology ensure the use of tier 2 method for all years to improve emission calculations.
	Analyze data reported particularly for all three steel plants that would be useful to improve the emission estimates for the Iron and Steel Production source category. This will be done to ensure time series consistency, as the facility-level reporting data from the facilities may not be available for all Inventory years as required for this inventory. The latest guidance from the IPCC on the use of facility-level data in national inventories will be taken into account.

3. Information on mitigation actions and their effects

3.1 Tabulation of mitigation actions their effects

Many of the mitigation actions Ghana is implementing have significant sustainable development impacts. The actions, which are mainly a combination of a variety of policy measures, cut across most sectors at different development levels. The selected major mitigation actions that Ghana is embarking on in the energy sector are highlighted in table 17.

Table 17: Highlights of energy sector mitigation actions

Sector	Development focus	Related policy or measure	Specific Interventions	Remarks
Energy (National Energy Policy)	Renewable energy	Renewable Policy (10% share of 5000MW installed capacity by 2020 target), 50% LPG Penetration by 2020 2million improved cook stoves in households and commercial sectors	Renewable Energy Act, Act 832	Legislative Framework
			Renewable Energy Fund	Proposed means for financing FIT
			Feed-in Tariff Scheme	Gazette Tariff
			Solar PV Electrification Programme	On-going. Multiple funding sources
			Solar Lantern Replacement Programme	On-going domestic Action
			Household Rooftop Solar system programme	Funded from Renewable Energy fund and special electricity level
			Sustainable energy for all actions plan	China-Ghana South-South Corporation on Renewable Energy Technology
			National LPG Programme	Proposed under SEA4ALL
			National Biogas Programme	
	Energy Efficiency	Improvement in EE by 20% in 2020	Energy Efficiency Standards and Labeling Regulations, 2005 (LI1815), Energy Efficiency Standards And Labeling (Household Refrigerating Appliances) Regulations, 2009(LI 1958) Energy Efficiency Regulations, 2008 (LI 1932)	Installation of capacitors in commercial/industry Households CFL light exchange programme Promoting appliance Energy and Transformation of Refrigeration Appliance Market

In addition, information on mitigation and effects in the energy, transport and the AFOLU sectors are provided in table 18 and 19. The information that has been presented in tabular format covers (a) background and scope of the mitigation actions; (b) status of implementation and progress indicators and (c) GHG impacts and co-benefits. Detailed information on each of the mitigation actions that have been provided in tables 18 and 19 are provided in Annex 3. The detailed information that is provided in Annex 3 covers description of methodology, assumptions and uncertainty.

Table 18: Energy and transport mitigation actions and their effects

Mitigation Action	Policy/Instrument Aligned	Primary Objectives	Coverage					Progress Indicators	Steps taken and Envisaged	Estimated emissions reductions ($ktCO_2e/yr$)	Co-benefits
			Scale	Gas	Status	Implementing Entity	Type Instrument				
Financial support for climate mitigation technology uptake	Venture Capital Fund	Establish Ghana Climate Innovation Centre	National (private sector)	CO_2	Planned	Ashesi University, SNV and UNU, World Bank (Donor Implementing agency	Economic	Capital investment in clean technologies ($) No of entrepreneurs trained and coached	Mobilize US$ 17.2 from donors Setting up of innovation Centre Recruitment of entities	661.7	Assist 304,000 to increase resilience to climate change 10,720 cumulative jobs
Financial support for grid-scale and off-grid renewable systems	Renewable energy policy, Feed-in-tariff instrument, renewable energy fund through electricity level	Incentives to promotion wind and solar installation in homes and the national grid. Increase renewable energy to 10% of 5000MW by 2020	National Residential sector	CO_2	On-going	Ministry of Power and Energy Commission	Economic	Share of generation mix (%); Off-grid RE capacity (MW) RE Investments ($)	Renewable energy law enacted, FIT gazette Renewable energy fund being established 200,000 households Rooftop solar by 2015	Not estimated at this scale	Energy security Downstream jobs Reduce GHG emissions Green electricity
Households Solar Lantern Distribution Programme	Renewable energy policy, Feed-in-tariff instrument, renewable energy fund through electricity level	Distribute 200,000 solar lanterns by 2018 at 70% subsidized price to off-grid communities	Off-grid non-electrified communities.	CO_2	On-going	Ministry of Power	Economic	No of solar lantern at time distribution, No. Kerosene stove retrieved.	Communities identified, 21,000 solar lantern distributed Awareness in selected communities	1.29	Avoided US$ 34 million annual subsidy on kerosene. Reduce Indoor pollution risk of 30,000 women and children

Solar PV Electrification Programme	Renewable energy policy, Feed-in-tariff instrument, renewable energy fund through electricity level	Establish 3.54Mw national grid connected utility-scale solar systems in selected institutions and VRA installations.	National grid scale	CO_2	On-going	Ministry of Power	Economic	Grid-scale Solar capacity (MW) Electricity availability on national grid (MWh)	Installation of 9,536 solar systems in deprived off-grid communities from 2009 to 2014 and other individual standalone installations, which translates into 3.41MW.	5.21	Energy security Downstream jobs Reduce GHG emissions Green electricity
Fuel diversification for thermal electricity generating	National Energy Policy and VRA'S Power Generation Strategic Plan	Availability of Nigerian Natural Gas for thermal electricity generation through West Africa Gas Pipeline to replace Light-crude oil fired plant	National – electricity sub-sector	CO_2, CH_4,and N_20	On-going	Volta River Authority (VRA) and Sunon Asogli	Economic	Delivery contract quantities of natural gas from Nigeria (Mscf) Annual electricity generation from natural gas-fired plants (GWh)	Establishment of West Africa Gas Pipeline Company Joint Gas partnership distribution agreement Construction natural gas distribution pipeline network	235.9	Fuel cost savings over the lifetime of the project are expected to be between US$94 million and US$109 million Energy security
		Indigenous Natural Gas Recovery and Utilization of 120 million scf/day from Jubilee Field that Otherwise be Flared or Vented at Atuabo for electricity generation and LPG production	National – electricity sub-sector	CO_2, CH_4,and N_20	On-going	Ghana Gas Company Limited and Volta River Authority (VRA)	Economic	Indigenous delivered from Atuabo to VRA (Mscf) Annual electricity generation from natural gas-fired plants (GWh)	Establishment of Gas Infrastructure plant at Atuabo, Western Region of Ghana On-shore pipeline for distribution completed LPG production and distribution to homes	148.84	Annual Fuel cost savings US$ 500,000 Meet 75% of LPG needs Energy security
Energy Efficiency measures in residential, commercial	Energy Efficiency Standards and Labeling Regulations,	Improve energy efficiency by 20% by 2030. Peak savings of 124 MW	Residential, commercial and industrial sectors	CO_2	On-going, some completed	Energy Commission, Ministry of Energy and Petroleum	Regulatory and Awareness	Energy saving from EE (MW) Progress of implementatio	Promoting appliance Energy and Transformation of Refrigeration Appliance Market	3.6	Reduce household electricity demands and expenditure

and industrial sectors	2005 (LI1815), Energy Efficiency Standards And Labeling (Household Refrigerating Appliances) Regulations, 2009(LI 1958) Energy Efficiency Regulations, 2008 (LI 1932) National Energy Policy	or 172.8GWh/annum.						n measures			100 direct jobs E-waste management Phasing out of ODS
									Households CFL light exchange programme	121	124 MW of peak hour electricity saving. This translated to US$ 3.6million Delayed investment in power generation expansion Net income savings for households
									Installation of capacitors in commercial/industry	5.9	Reduction in electricity demands and expenditure
Diversification of urban transport	National Transport Policy, Environmental Protection Agency Act, Proposed Motor Emission Standards	Construction and operation of a new bus rapid transit system (BRT) for urban transport of passengers including replacement, extensions or expansions of existing mix traffic situation on the Kasoa – Central Business District (CBD) corridor in Accra.	Urban transport - Accra	CO_2, CH_4,and N_20	On-going	Ministry of Transport	Economic	Passenger travel on BRT Bus (%) Capital investment ($)	Construction of BRT lanes Purchase 400 Euro 3 Buses BRT regulation body	10.02	Increased public transportation by 10% Decrease GHG by 20%

Table 19: AFOLU mitigation actions and their effects

Mitigation Action	Policy/Instrument Aligned	Primary Objectives	Coverage					Progress Indicators	Steps taken and Envisaged	Estimated emissions reductions ($ktCO_2e/yr$)	Co-benefits
			Scale	Gas	Status	Implement Entity	Type Instrument				
National Forest Plantation Development Programme (NFPDP)	National Forest and Wildlife Policy National Forest Plantation Development Fund	Restore the forest cover of 15,300ha of degraded forest lands every year	National On and off Forest reserve lands)	CO_2	On-going	Ministry of Lands and Natural Resources, Forestry Commission and private sector	Economic	Area planted and maintained (ha), Annual Investment cost ($) Jobs created (No)	Set up Plantation development fund Contract with private sector Land demarcations	44.7	Average 29,000 direct job yearly, 370Mt food annually
Forest Investment Programme	National Forest and Wildlife Policy National REDD+ Strategy	Promote Climate-Smart Cocoa Landscapes in 110,000 ha cocoa landscape Promote Climate-Smart Agriculture (food crops) Promote Watershed Services – Reduce GHG emissions from deforestation and forest degradation, while reducing poverty and conserving biodiversity	High Forest Transition, and Savanna Zones - (Brong Ahafo and Western Regions)	CO_2	On-going	Ministry of Lands and Natural and Forestry Commission	Economic	Programme delivery indicators (%), Area of land of which carbon stock are enhanced (ha) Investment ($) Food production (Mt)	Project 1: Enhancing Natural Forest and Agroforests Landscapes	Not estimated	Conservation of biodiversity ecological networks and corridors Livelihood and development benefits to forest populations Increase yields and income to contribute to food security
									Project 2: Engaging Local Communities in REDD+/Enhancing Carbon Stocks	200	
									Project 3: Engaging Private Sector in REDD+	440	

Cocoa Forest REDD+ Programme	National Forest and Wildlife Policy National REDD+ Strategy	Reduce emissions across the High forest zones that are driven by cocoa farming and other key drivers in Cocoa Landscape covering 5.9million ha. (4.3million ha off-reserve area and 1.6 million ha on -reserve	Sub-national - High Forest Zone	CO_2	Planned	Ghana Cocoa Board and Forestry Commission	Economic	Cocoa landscape affected by project (ha) Livelihood affected (No) Investments ($)	Project idea Note approved by World Bank National forest reference level being developed National REDS+ ready strategy in place MRV system yet to be fully deployed	1,200	Farmer Livelihoods – 10 year time frame, if the program enabled 20,000 farmers per year to double their yields and then maintain the yield increase over time, then it would result in more than US$ 4.3 billion in additional revenue
Sustainable Land and Water Management Project	Food and Agriculture development	Comprehensive landscape approach to sustainable land and watershed management at the community level	Sub-national – landscape approach in Upper Ghana's savanna	CO_2	On-going	MESTI EPA Forestry Commission	Project-based action	Land area where sustainable land and water management practices have been adopted as a result of the project (ha)	Additional financing from World Bank for up scaling. Upscale to include additional communities	2.6	Enhancement of livelihood sources, Job creation

3.2 International Market mechanism

3.2.1 Clean Development Mechanism (CDM)

Ghana has two registered CDM projects in the waste and oil and gas sector. The two projects have total volume of 2,672.1kCERs per year. Additional two CDM projects are at the validation stage and have 368.9kCER. In addition, there are a number of CDM PoAs Ghana is participating. The tables 20 and 21 provide overview of CDM projects and PoAs in Ghana.

Table 20: Standalone CDM project in Ghana

Project	Sector	Status	Registration Date	Amount Reduction ($ktCO_2e/yr$)	Crediting Period
Zoomlion Ghana Limited Composting of Municipal Solid Waste in Accra Area	Waste (Compost)	Registered	23rd March, 2012	68	23rd March 12 to 22nd March 2022 (Fixed)
Jubilee Oil Field Associated Gas Recovery and Utilization Project	Oil & Gas (Oil field flaring reduction)	Registered	19th Dec. 2012	2,603	31st Dec 2014 to 30th Dec. 2024 (Fixed)
Project Asona - CCGT – Takoradi – Ghana	EE Supply Side (Single cycle to combined cycle)	Validation		347	
Oblogo 1 Landfill Gas Recovery and Flaring Project	Waste (Landfill gas)	Validation		22	

Table 21: List of CDM Programme of Activities Ghana is participating

Title	PoA Boundary	Region	Coordinating Entity	Status	1st period $ktCO_2/yr$	PoA Life time	Years
CPA- GA-001-Ghana		Ghana	Green Development AS	Registered	111.4		7
African Improved Cooking Stoves Programme of Activities	Ghana, Nigeria		Envirofit International	Registered	240.1	13-Dec-11	
African Improved Cooking Stoves Programme of Activities – CPA No. 00001 (Ghana)		Many	Envirofit International	Registered	15.5		7
African Improved Cooking Stoves Programme of Activities – CPA No. 00002 (Ghana)	Ghana	Entire country	Envirofit International	Registered	47.0		10
Standard Bank Renewable Energy Programme–Solar Bundled CPA in SADA zone	Ghana, Kenya, mauritius	Upper West	Standard Bank	Registered	1.1	22-May-12	10
Standard Bank MSW Composting Programme (Kumasi Composting Plant at Adagya)	Ghana	Ashanti	Standard Bank	Registered	27.9	25-Apr-12	10
CPA-1: Oti Landfill gas		Ashanti,	Puresphere	Registered	103.2	20-	7

capture, flaring and utilization at Kumasi (Ghana)		Ghana	Limited			Mar-12	
Clean Cook Stoves in Sub-Saharan Africa by ClimateCare Limited Cook Clean Ghana Limited — CPA01		Ghana	ClimateCare Limited	Registered	136.7	16-Jun-12	
Decentralized Community Water Purification System installations in Ghana, Africa		Volta, G. Accra, Eastern, Northeren, Ashanti, Brong Ahafo	Water Health India Pvt	At Validation	19.0		

3.2.2 Voluntary Market (VCS)

"Form" Ghana's reforestation of Degraded Forest Reserves

"Form Ghana's" reforestation of Degraded Forest Reserves programme in Ghana is the forest voluntary market project to earn VCS Validation. The project that aims to reforest 15,000 hectares of degraded lands in Asubima Forest Reserve and absorb annually more than 80,000 metric tonnes of carbon dioxide from the atmosphere has been independently validated by SCS Global Services (SCS) under the Verified Carbon Standard (VCS). The project will generate carbon credits while simultaneously supporting the commercial harvest of teak timber and planting local tree species.

4. Financial Resources, Technology Transfer, Capacity Building, and Technical Support Received and Needed

Ghana continues to mobilize requisite resources from several sources to help meet the additional cost the economy incurs in combating climate change. The resources Ghana has committed to raise include financial, technical assistance and technology transfer within the country and at the sub-regional and international levels. The information on the financial and non-financial resources that were mobilized for the period 2011-2014 is provided in the subsequent sections. The information has been presented according to financial and non-financial resources through the four dominant channels – multilateral, bilateral (Annex 2 Party contributions), GEF and national contributions. Ghana also recognizes that its ability to transparently track and account for the financial and non-financial flows received from development partners will not only serve the purpose of reporting to the UNFCCC but strengthen its development cooperation. Above all, the information highlights additional resources that the country still need to effectively respond to climate change.

4.1 Information on Support Received

4.1.1 Financial Support Received

The climate change financial flows that Ghana received between 2011 and 2014 provided in this first biennial update report. The financial flows have been classified first as domestic contributions and external contributions. The domestic contributions are financial resources which the Government of Ghana invested in direct climate change programmes as “co-financing” or “own investments” while the external contributions are international resources, mainly from Annex 2 Parties”, that were received or committed through multilateral, bilateral and GEF channels. Additional information on financial flows from the private sector and private foundation have been provided. Financial flow is classified as a multilateral if it comes from more than one donor country/entity and it is channeled through one implementing agency and classified as bilateral when it comes from one donor country and conditions of the funding is negotiated and determined by the recipient and donor countries. Financial flows from the private sector and private foundations are mobilized directly between entities within a given country and entities in the private sector or philanthropic organizations.

The support has further been clustered according to financial flows towards mitigation, adaptation and means of implementation (finance, capacity building, technical assistance and technology transfer) activities. The classifications of the mitigation, adaptation and means of implementation of financial flows were defined according to the set of activities the funding was used to support. Similar configurations have been made for the recipient sectors and institutions. Data on financial inflows were collected through national survey and information published on the web pages of donor and recipient institutions. Projects without adequate information and those worth less than $30,000 have been excluded. Financial inflows are reported in Ghana Cedi (Gh₵) and US Dollar (US$) dominations. Non-US dollar denominated flows have been converted to US$ using an average exchange rate of 0.4686 for each year and in the period 2011-2014, projects that started before 2011 and are still active have been included. Those projects that started and ended before 2011 have been excluded from the list. For projects are that still active, only committed funds has been reported. Actual disbursement amounts may differ. Actual disbursed funds have been reported for completed projects. All the results are presented without the China loans except when it is otherwise stated. Financial flows are considered and reported as non-ODA

4.1.1.1 Summary of financial flows

Total climate related financial inflows for the period 2011-2014 were US$1,208,746,027 (equivalent of GhC 2,579,483,625) representing 3.7% of GDP (see table 22).When the loan from China Development bank is included the total financial inflow was US$ 2,208,746,027 (equivalent of GhC 4,713,499,843), which was 6.7% share of GDP. Grants were the largest share (69.2%), followed by loans (19.1%), national budget (6.9%) and result-based payment (4.9%). As shown in table 22, the financial flows through bilateral channels were the largest (49.5%), followed by multilaterals channels (39%), national contributions (5.1%), GEF (3.1%). The remaining 3.2% were co-financing (1.7%), private foundations (1.4%) and private sector (0.15).

Table 22: Summary of financial flows for the period 2011-2014

Overall Analysis		W/China ($)	W/O China ($)	W/China (GhC)	W/O China (GhC)	Share of GDP[8](2014)	
						W/China	W/O China
	Loans	1,231,090,000	231,090,000	2,627,166,026	493,149,808	3.8%	0.7%
	Grants	836,854,027	836,854,027	1,785,860,066	1,785,860,066	2.6%	2.6%
	National Budgets	82,024,000	82,024,000	175,040,546	175,040,546	0.3%	0.3%
	Results based payment	58,750,000	58,750,000	125,373,453	125,373,453	0.2%	0.2%
	Total	2,208,718,027	1,208,718,027	4,713,440,091	2,579,423,872	6.7%	3.7%

	Parameters of financial flows		**Mitigation**	**Adaptation**	**MoI[9]**	**SD[10]**	**Enabling Activities[11]**	**Totals (s)**	**Totals (Ghc)**
	Type of Financial flows	W/China[12]	1,229,500,000					1,229,500,000	2,623,772,941
Loans		W/O China[13]	229,500,000		1,590,000			231,090,000	493,149,808
Grants			621,089,710	40,226,363	174,635,954	50,000	852,000	836,854,027	1,785,860,066

[8]Share of total gross domestic products reported in ending 2014. 2014 GDP reported as GhC 70,000,000
[9] Means of implementation. It has been further classified as Mitigation MoI, Adaptation MoI, and Sustainable Development MoI
[10] Sustainable development financial inflows are cash flows that support mitigation, adaptation, MoI and development activities
[11]Enabling Activities dedicated GEF funds to support facilitation of implementation of Rio convention particularly UNFCCC
[12]Financial inflows included China Development Bank loan for the construction of Ghana Gas Processing Plant at Atuabo in Western Region of Ghana
[13]Financial inflows excluding China Development Bank loan for the construction of Ghana Gas Processing Plant at Atuabo in Western Region of Ghana

National budgets			80,024,000		2,000,000			82,024,000	175,040,546
Result-based payment			58,750,000					58,750,000	125,373,453
Bilateral	Channels of financial flows		515,010,000	7,711,048	75,719,505			598,440,553	1,277,081,846
Multilateral			361,906,982	28,026,843	81,815,387	50,000		471,799,212	1,006,827,169
Co-financing			18,000,000		2,000,000			20,000,000	42,680,324
GEF			32,422,727	4,418,182	70,000		852,000	37,762,909	80,586,660
National Funds			62,024,000					62,024,000	132,360,222
Global Fund					Unknown			-	-
Private Foundations					16,921,063			16,921,063	36,109,823
Private sector		W/China	1,000,000,000					1,000,000,000	2,134,016,219
		W/O China		70,290	1,700,000			1,770,290	3,777,828
Energy	Recipient sectors	W/China	1,745,939,727					1,745,939,727	3,725,863,694
		W/O China	745,939,727		2,870,000			748,809,727	1,597,972,102
Agriculture			13,250,000	12,689,048				25,939,048	55,354,349
Forestry			140,173,982		21,657,158			161,831,140	345,350,277
Transport			90,000,000					90,000,000	192,061,460
Dev. planning				7,930,214				7,930,214	16,923,205
Environment				11,124,920	19,776,773	50,000	852,000	31,803,693	67,869,597
Health				1,918,182				1,918,182	4,093,431
Interior				5,200,000				5,200,000	11,096,884
Water				1,364,000				1,364,000	2,910,798
Education					16,519,023			16,519,023	35,251,863
Finance					117,403,000			117,403,000	250,539,906
Grand Totals		W/China	1,989,363,709	40,226,364	178,225,954	50,000	852,000	2,208,718,027	4,713,440,092
		W/China	989,363,709	40,226,364	178,225,954	50,000	852,000	1,208,718,027	2,579,423,873

4.1.1.2 Summary Bilateral financial flows

Table 23: Summary of bilateral financial flows

Parameters		Mitigation	Adaptation	MoI	Totals (US$)	Totals (GhC))
Total		**515,010,000**	**7,711,048**	**75,719,505**	**598,440,553**	**1,277,081,846**
Grants	**Type financial flows**	515,010,000	7,711,048	75,719,505	598,440,553	1,277,081,846
Agriculture	**Recipient Sectors**	6,827,048			6,827,048	14,569,031
Education				41,000	41,000	87,495
Energy		511,110,000		150,000	511,260,000	1,091,037,132
Finance				17,664,746	17,664,746	37,696,854
Forestry		3,900,000		11,524,759	15,424,759	32,916,686
Water			884,000		884,000	1,886,470
Environment				17,664,746	17,664,746	37,696,854
Active	**Status**	514,310,000	3,901,170	19,297,377	537,508,547	1,147,051,958
Pipeline		400,000			400,000	853,606
Complete		300,000	3,809,878	56,422,128	60,532,006	129,176,283
Government	**Recipients Institutions**	509,600,000	7,711,048	55,297,246	572,608,294	1,221,955,387
Ministries			3,901,170	46,797,246	50,698,416	108,191,243
Implementing Agencies		509,600,000	3,809,878	8,500,000	521,909,878	1,113,764,144
International NGOs		1,910,000	0	2,997,281	4,907,281	10,472,217
Academia		0	0	17,424,978	17,424,978	37,185,186
Research National				177,478	177,478	378,741
Universities				17,247,500	17,247,500	36,806,445
Private		3,500,000			3,500,000	7,469,057

Table 24: Analysis of bilateral financial flows

Description	Climate relevance	Type of Means of Implementation (MoI)	Recipient	Start Date	End Date	Institution (Country)	Implementing Agency	Amount (US$)	Type	Status
Ghana Energy Development and Access Project GEDAP (formerly) Development of Renewable Energy and Energy Efficiency	Mitigation		Electricity Company of Ghana	2007	2017	Switzerland	WB	11,000,000	Grant	Active
Natural Resource and Environmental Governance Program (NREG)	Mitigation MoI	Finance	Ministry of Finance	2008	2012	Dutch Embassy, Netherlands		28,739,000	Grant	Complete
				2008	2012	DFID, United Kingdom		6,440,000	Grant	Complete
Ghana Natural Resource and Environmental Governance – DPO				2010	2011	Dutch Embassy, Netherlands		11,160,000	Grant	Complete
Non-legally Binding Instruments on all types of forest in Ghana (UNFF/NLBI)	Mitigation		Forestry Commission	2008	2011	BMZ, Germany	GIZ	400,000	Grant	Pipeline
Forest Preservation Programme	Mitigation MoI	Technical Assistance	Forestry Commission	2012	2014	Japan	JICA	8,500,000	Grant	Complete
Ghana Climate Innovation Centre (GCIC)	Sustainable Dev. MoI	Finance	Ashesi Uni., SNV, EY, UNU-INRA	2014	2019	DANIDA, Denmark	WB	17,206,500	Grant	Active
Millennium Development Challenge Account Compact 2 – Ghana Power Pact	Mitigation		E Electricity Company of Ghana	2014	2019	United States	MiDA	498,200,000	Grant	Active
Innovative Insurance Products for Adaptation to Climate Change (IIPAC)	Adaptation		Ghana Insurance Association	2009	2014	Germany	GIZ	2,925,878	Grant	Complete
Climate Change Adaptation in Northern Ghana	Adaptation		Water Resources Commission	2009	2012	Denmark	DANIDA	884,000	Grant	Complete
Ghana Climate Change and Environmental Governance	Mitigation MoI	Technical Assistance	MESTI	2012	2013	DFID, United Kingdom	DFID	362,246	Grant	Complete
Coastal Sustainable Landscapes Project	Mitigation		USDA/USAID	2013	2016	United States	USAID	3,500,000	Grant	Active
Does shifting Carbon Use Efficiency determine the growth rates of intact and disturbed tropical forests? Gathering new evidence	Mitigation MoI	Finance	CSIR-FORIG	2011	2014	Natural Environment Research Council, United		177,478	Grant	Complete

from African forests						Kingdom				
PEER Science Project	Adaptation MoI	Capacity Building	UFCCC	2012	2014	USAID, United States	USAID	41,000	Grant	Complete
Adaptation of Agro-Ecological Systems to Climate Change	Adaptation		MoFA	2012	2017	BMU, Germany	GIZ	3,901,170	Grant	Active
Mapping forest landscape restoration in Ghana	Mitigation MoI	Finance	IUCN-Ghana	2010	2012	Germany	GIZ	110,533	Grant	Complete
pro poor REDD+ initiative in Ghana	Mitigation MoI	Finance	IUCN-Ghana	2009	2012	Denmark	DANIDA	570,871	Grant	Complete
Scaling up voices for influencing post-2012 climate regime	Mitigation MoI	Finance	IUCN-Ghana	2010	2011	Norway	NORAD	75,000	Grant	Complete
Energy, Poverty and Gender in Agro Processing (EPGAP)	Mitigation		SNV	2014	2015	Netherlands	SNV	600,000	Grant	Active
Developing Sustainable Energy Value Chains in Fish Smoking Markets in Ghana	Mitigation		SNV	2014	2015	Netherlands	SNV	650,000	Grant	Active
Integrated Clean Cookstoves and Biomass Fuel Market Assessment Project	Mitigation		SNV	2014	2015	Netherlands	Sustainable Energy Solutions for Africa	180,000	Grant	Active
Solar Lantern Saving scheme for Ghana	Mitigation		SNV	2014	2015	Netherlands	Sustainable Energy Solutions for Africa	180,000	Grant	Active
Switching from Fuel wood to LPG	Mitigation		SNV	2013	2013	Netherlands	SNV	150,000	Grant	Complete
Energy, Poverty and Gender (EnPoGen)	Mitigation		SNV	2013	2013	Netherlands	SNV	150,000	Grant	Complete
Renewable Energy Capacity Building	Mitigation MoI	Finance	SNV	2013	2013	Netherlands	SNV	150,000	Grant	Complete
Facilitating countries and communities in the design of pro-poor REDD+ Benefit Sharing Schemes	Mitigation MoI	Finance	IUCN-Ghana	2013	2015	Germany		795,839	Grant	Active
Towards Pro-Poor REDD+ Initiative in Ghana II	Mitigation MoI	Finance	IUCN-Ghana	2014	2017	Denmark		636,088	Grant	Active
Advancing REDD+: mobilizing private investment for community-based, carbon-intensive landscape restoration	Mitigation MoI	Finance	IUCN-Ghana	2013	2015	Norway		658,949	Grant	Active
Green Facility	Mitigation MoI	Finance	MESTI	2011	2014	Denmark	UNEP DTU Partnership	96000	Grant	Complete

4.1.1.3 Summary Multilateral financial flows

Table 25: Summary of Multilateral financial flows

Parameters		Mitigation	Adaptation	MoI	SD	Totals (US$)	Totals (GhC)
Totals		**361,906,982**	**28,026,843**	**81,815,387**	**50,000**	**471,799,212**	1,006,827,170
Loans	Type financial flows	229,500,000		1,590,000		231,090,000	493,149,808
Grants		73,656,982	28,026,843	80,225,387	50,000	181,959,212	388,303,910
Result-based payment		58,750,000				58,750,000	125,373,453
Agriculture	Recipient Sectors		3,362,000			3,362,000	7,174,563
Dev. Planning			7,930,214			7,930,214	16,923,206
Education				78,023		78,023	166,503
Energy		179,377,000		2,720,000		182,097,000	388,597,951
Finance				67,364,000		67,364,000	143,755,869
Forestry		117,529,982		9,611,336		127,141,318	271,321,635
Interior			5,200,000			5,200,000	11,096,884
Transport		65,000,000				65,000,000	138,711,054
Water			480,000			480,000	1,024,328
Environment			11,054,629	2,042,027	50,000	13,146,656	28,055,177
Government	Recipients Institutions	**360,487,858**	**16,254,629**	**80,726,027**	**50,000**	**457,518,514**	976,351,929
Ministries		123,850,000	8,293,972	63,206,027	50,000	195,399,999	416,986,767
Implementing Agencies		236,110,858	5,200,000	9,800,000		251,110,858	535,874,644
Regulatory Agencies		527,000	2,760,657	7,720,000		11,007,657	23,490,519
Academics		**1,419,125**	**11,772,214**	**1,089,359**	**-**	**14,280,698**	30,475,241
International			3,842,000			3,842,000	8,198,890
National		1,419,125	7,930,214	1,089,359		10,438,698	22,276,351
Universities							-
Active	Status	353,935,716	7,960,657	13,558,682		375,455,055	801,227,177
Pipeline			11,655,972	6,053,345		17,709,317	37,791,970
Complete		7,971,267	8,410,214	62,253,359		78,634,840	167,808,024

Table 26: Analysis of multilateral financial flows

Description	Climate relevance	Type of Means of Implementation (MoI)	Recipient	Start Date	End Date	Donor Institution	Implementing Agency	Amount	Type	Status
Ghana Energy Development and Access Project GEDAP (formerly) Development of Renewable Energy and Energy Efficiency	Mitigation		Electricity Company of Ghana	2007	2017	IDA	WB	100,000,000	Loan	Active
				2007	2017	Africa Catalytic Growth Fund		50,000,000	Loan	Active
				2007	2017	AFDB	AFDB	18,250,000	Loan	Active
				2007	2017	Global Partnership on output based aid	WB	6,250,000	Loan	Active
Solar PV Systems to Increase Access to Electricity Services in Ghana	Mitigation		Ministry of Power	2008	2011	Global Partnership on output based aid		4,350,000	Grant	Complete
Ghana Urban Transport	Mitigation		Ministry of Transport	2005	2015	FDA		20,000,000	Grant	Active
				2005	2015	IDA		45,000,000	Loan	Active
Natural Resource and Environmental Governance Program (NREG)	Mitigation MoI	Finance	Ministry of Finance	2008	2012	FDA		4,100,000	Grant	Complete
				2008	2012	EU	EU	5,474,000	Grant	Complete
				2008	2012	IDA	WB	40,000,000	Grant	Complete
				2010		EU		Unknown	Grant	Complete
				2010		FDA	WB	1,590,000	Loan	Complete
				2010		IDA		10,000,000	Grant	Complete
Chainsaw Milling Project	Mitigation		FC	2007	2012	EU	EU	2,860,858	Grant	Complete
Forest Investment Program	Mitigation		MLNR	2015	2020	Strategic Climate Fund	WB	29,500,000	Grant	Active
				2015	2020	Strategic Climate Fund and Africa Development Fund	AFDB	15,000,000	Grant	Active
				2015	2020	Strategic Climate Fund	IFC	10,000,000	Loan	Active
REDD+ R-PP Implementation	Mitigation MoI	Finance	FC	2010	2013	Word Bank, FCPF	WB	3,400,000	Grant	Active
FCPF REDD+ Readiness Additional financing	Mitigation MoI	Finance	FC	2015	2017	Word Bank, FCPF		5,200,000	Grant	Pipeline
Low Emission Capacity Building Project	Mitigation MoI	Finance	MESTI	2012	2016	EC, Germany, Australia	UNDP	888,682	Grant	Active
Community Resilience through Early Warning	Adaptation	Finance	NADMO	2012	2015	Norway		5,200,000	Grant	Active

Africa Adaptation Programme	Adaptation	Finance	EPA	2010	2013	Japan	UNDP	2,760,657	Grant	Active
Integrating Green Economy into Ghana's Medium-Term Development Plan	Sustainable Dev.	Finance	MESTI	2014	2015	Netherlands		50,000	Grant	Active
China-Ghana South-South Cooperation on Renewable Energy Technology Transfer	Mitigation MoI	Technology Transfer	Energy Commission	2015	2018	Denmark		2,720,000	Grant	Active
Institutional Support to the Implementation of the Sustainable Energy for All (SE4ALL) Action Plan	Mitigation	Finance	Energy Commission	2013	2015	UNDP		527,000	Grant	Active
Support for Development and Operation of COCOBOD's Ghana Cocoa Platform	Sustainable Dev. MoI	Finance	Cocoa Board	2013	2015	UNDP/UN-REDD and Mondelēz Cocoa Life.		1,200,000	Grant	Active
Facilitating Implementation & Readiness For Mitigation	Mitigation MoI	Finance	MESTI	2013	2015	Denmark	UNEP/DTU	300,000	Grant	Active
Ghana Cocoa REDD+ Programme	Mitigation		Ghana Cocoa Board and Forestry Commission	2015	2016-2020, 2020-2036	World Bank	WB	58,750,000	Result Based Payment	Active
Green Climate Fund Readiness Programme	Sustainable Dev. MoI	Finance	MESTI	2015	2016	Government of Germany	UNDP/UNEP /WRI	853,345	Grant	Pipeline
Natural Resource and Environmental Governance Program Technical Assistance	Mitigation MoI	Technical Assistance	Ministry of Finance	2014	2016	World Bank	WB	5,000,000	Grant	Active
CARE Adaptation learning programme for Africa	Adaptation		Care International	2010	2014	DFID, DANIDA, Ministry of Foreign Affairs Finland,	DFID	7,930,214	Grant	Complete
URAdapt: Managing water in the urban-rural interface for climate change resilient cities	Adaptation		IWMI	2009	2012	International Development Research Centre of Canada, DFID		480,000	Grant	Complete
CLIMAFRICA Project	Adaptation MoI	Capacity Building	CSIR, CRI, SRI &FORIG for Ghana	2010	2014	European Union	EU	78,023	Grant	Complete
Advancing REDD+ in Ghana: Preparation of REDD Pilot schemes in Off-Reserve Forests and Agro-Forests	Mitigation MoI	Finance	FORIG	2013	2014	ITTO	ITTO	366,954	Grant	Complete
Reducing Emissions from Deforestation and Forest Degradation through Collaborative Management with Local Communities	Mitigation	Finance	FORIG	2010	2014	ITTO		760,408	Grant	Complete

Capacity building for CDM forestry in the framework of SFM emphasizing community forests and poverty alleviation in Ghana	Mitigation MoI	Finance	FORIG	2011	2014	ITTO	ITTO	644,382	Grant	Complete
Resilient Landscapes for Sustainable Livelihoods	Adaptation		MoFA, UNU-INRA, UNDP, WFP, FAO	2013	2016	FAO & UNDP	UNDP	3,362,000	Grant	Pipeline
REDD through stakeholder engagement	Mitigation		CSIR-FORIG	2009	2012	ITTO	ITTO	658,716	Grant	Active
Increased Resilience to Climate Change in Northern Ghana Through the Management Of Water Resources and Diversification of Livelihoods"	Adaptation		MESTI	2015	2019	Adaptation Fund Board	UNDP	8,293,972	Grant	Pipeline

4.1.1.3 Summary GEF financial flows

Table 27: Summary of GEF financial flows

Parameters		Mitigation	Adaptation	MoI	Enabling Activities	Totals (US$)	Totals (GhC)
Total Grants		**32,422,727**	**4,418,182**	**70,000**	**880,000**	**37,790,881**	**80,646,385**
Agriculture	**Recipient Sectors**	13,250,000	2,500,000			15,750,000	33,610,755
Energy		12,172,727				12,172,727	25,976,797
Transport		7,000,000				7,000,000	14,938,114
Health			1,918,182			1,918,182	4,093,431
Environment				70,000	880,000	922,000	2,027,295
Active	**Status**	32,422,727	2,500,000		880,000	35,802,727	76,403,600
Pipeline						0	-
Complete			1,918,182			1,918,182	4,093,431
Government	**Recipients Institutions**	32,422,727	4,418,182	70,000	880,000	37,790,909	80,646,413
Ministries		20,250,000	4,418,182		380,000	25,048,182	53,453,227
Implementing Agencies		6,500,000				6,500,000	13,871,105
Regulatory Agencies		5,672,727		70,000	500,000	6,242,727	13,322,081

Table 28: Analysis of GEF financial flows

Description	Climate relevance	Type of Means of Implementation (MoI)	Recipient	Start Date	End Date	Implementing Agency	Amount (US$)	Type	Status
Promoting of Appliance Energy Efficiency and Transformation of the Refrigerating Appliances Market in Ghana	Mitigation		Energy Commission	2011	2013	UNDP	5,672,727	Grant	Active
Ghana Energy Development and Access Project GEDAP (formerly) Development of Renewable Energy and Energy Efficiency	Mitigation		Electricity Company of Ghana	2007	2017	WB	6,500,000	Grant	Active
Ghana Urban Transport	Mitigation		Ministry of Transport	2005	2015	WB	7,000,000	Grant	Active
Technology Needs Assessment (TNA) update	Adaptation MoI	Finance	EPA	2012	2013	UNEP/DTU	70,000	Grant	Complete
Third National Communication to UNFCCC	Enabling Activities	Finance	Environmental Protection Agency	2011	2014	UNEP	500,000	Grant	Active
Biennial Update Report to UNFCCC	Enabling Activities	Finance		2013	2014	UNEP	352,000	Grant	Active
Climate Change and Health Project	Adaptation		Ministry of Health	2010	2013	UNDP	1,918,182	Grant	Complete
Sustainable Land and Water Management Project	Mitigation		MESTI	2011	2018	WB	13,250,000	Grant	Active
Promoting value chain approach to climate change adaptation in Ghana	Adaptation		Ministry of Food and Agriculture	2012	2015	IFAD	2,500,000	Grant	Active

Table 29: Analysis of domestic contributions

Description	Climate relevance	Recipient	Start Date	End Date	Contribution	Channel	Amount (US$)	Type	Status
Ghana Energy Development and Access Project GEDAP (formerly) Development of Renewable Energy and Energy Efficiency	Mitigation	Electricity Company of Ghana	2007	2017	Ghana	National Funds	43,280,000	National budget	Active
National Forestation Plantation Development Program (NFPDP)	Mitigation	Forestry Commission n	2010	2014	Ghana	National Funds	18,744,000	National budget	Active

Table 30: Analysis of co-financing

Description		Climate relevance	Type of Means of Implementation	Recipient	Start Date	End Date	Contribution	Amount	Type	Status
Ghana Urban Transport	In cash co-co-financing	Mitigation		Ministry of Transport	2005	2015	Ghana	18,000,000	National budget	Active
Ghana Natural Resource and Environmental Governance		Mitigation MoI	Finance	Ministry of Finance	2010		Ghana	2,000,000	National budget	Complete
Third National Communication to UNFCCC	In-kind co-financing	Enabling Activities	Finance	Environmental Protection Agency	2011	2014	UNEP	60,000	Grant	Active
Biennial Update Report to UNFCCC		Enabling Activities	Finance		2013	2014	UNEP	30,000	Grant	Active
Sustainable Land and Water Management Project		Mitigation		MESTI	2011	2018	WB	4,500,000	Grant	Active
Climate Change and Health Project		Adaptation		Ministry of Health	2010	2013	UNDP	850,000	Grant	Complete
Promoting of Appliance Energy Efficiency and Transformation of the Refrigerating Appliances Market in Ghana		Mitigation		Energy Commission	2011	2013	UNDP	800,000	Grant	Complete

4.1.2 Non-monetized capacity building and technology support received

The summary information on non-monetized capacity building and technology support received for the period 2011-2014 is shown in table 31.

Table 31: Summary information on non-monetized capacity building and technology support received for the period 2011-2014

Support Type	Description of Activity	Climate Relevance	Donor	Status
Capacity Building	Information matter project: training on GHG data management, emission baseline and domestic MRV. Third Party Review of National GHG Inventory Review – Energy Section. Opportunity for experience sharing in the preparation of BUR.	Mitigation (GHG Inventory Energy Sector)	German Federal Ministry for Economic Cooperation and Development (BMZ), GIZ	On-going till 2016
	Sustainable GHG Management Project in West Africa: Third Party Review of National GHG Inventory Review – AFOLU Section. Training on Land use mapping using Google map engine tool.	Mitigation (GHG Inventory AFOLU sector	Australia, USA, Netherlands, UK, Belgium, New Zealand, UNFCCC, FAO, UNDP, UNDP	On-going till 2017
	Capacity Development for REDD Project: Hands on training on Use of 2006 IPCC guidelines and ALU software for AFOLU GHG Accounting. Improvement of GHG Inventory Report- Third Party Review of National GHG Inventory Review – AFOLU Section.	Mitigation (GHG Inventory AFOLU sector	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). International Climate Initiative, Coalition for Rainforest Nations (CfRN).	2012-2014. Possibility of Phase 2
	Training on Non-Annex 1 GHG Inventory software	Mitigation (GHG Inventory Management)	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	2014
	Training on 2006 IPCC Software	Mitigation (GHG Inventory Management)	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	2011-2014
	Training on development of Regional Grid Emission Factors	Mitigation (Baseline assessment)	UNFCCC CDM West Africa Region Collaboration Centre	2014
	Training on development of standard baselines in Waste and Transport sectors			
	Third FAO Regional Workshop on Statistics for Greenhouse Gas Emissions"	Mitigation (GHG Inventory AFOLU)	United Nations Food and Agriculture Organization (FAO)	2013
	Training on Annex 1 Party GHG Review including methodological, reporting and review guidelines.	Mitigation (GHG Inventory Reviews)	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	On-going
	CGE Training programmes on National Communications and BUR	Mitigation, Adaptation	United Nations Framework Convention on Climate Change (UNFCCC) Secretariat	On-going
	Training on Long-range energy alternatives planning system.	Mitigation	Stockholm Environment Institute	2013

4.2 Information on Support Needed

4.2.1 Financial support needed

Table 32 contains the summary of information on the financial support Ghana needs to be able to effectively respond to climate change. The financial needs have identified based on the priority programmes in the national climate change policy and other related measures.

Table 32: Information on financial support needed

Sector/Activity	Outcome/purpose	Alignment to policy/measures	Amount Needed (US$)	Implementing Entities	Scope of support requested			Type of support needed	Priority[14]
					Finance	Technology	Technical Assistance		
Improvements in national data system for continuous data collection AFOLU	Ensure continuous generation of high quality activity data	Focus programme 10: National Climate Change Policy	120,000	Forestry Commission, EPA CERGIS & MoFA	x		x	Grant	High
Comprehensive study of fugitive emissions in the emerging oil & gas sector	Make available high quality activity and emission factor for the major oil and gas operations	Focus programme 10: National Climate Change Policy	200,000	EPA, Energy Commission, Petroleum Commission	x		x	Grant	High
Development of country-specific emission factors for road transport, livestock, solid and domestic liquid waste and improvement in data collection systems	Increase confidents in the transport GHG emission estimation	Focus programme 10: National Climate Change Policy	350,000	EPA, Ministry of transport, DVLA, Energy Commission	x		x	Grant	High
Conduct climate impacts assessment: Use of statistical and dynamic crop and hydrological modeling	Improve methodology for conduct climate impacts assessment as basis for effective adaptation	Focus programme 1 to 9: National Climate Change Policy	300,000	EPA, relevant research and sectors institutions	x			Grant	High

[14] This was determined based on the following factors: whether or not the activity contribute to improve key category, data availability and level of uncertainty of the activity data.

Development and improvement of non-energy sector mitigation assessment	Estimate mitigation potential in non-energy sectors with increased certainty	Low Carbon Development Strategy	70,000	EPA and relevant sectors	x		x	Grant	Medium
Facility level carbon accounting programme	Facilitate regular reporting of emission and activity from industry.	Low Carbon Development Strategy	120,000	EPA, Ministry of Trade, Associations of Industry	x			Grant	High
Waste sector activity data improvement and management project	Identify, collect activity data and improve ways for continuous collection.	Low Carbon Development Strategy	190,000	EPA and Ministry of Local Government and Rural Development	x			Grant	High
Energy statistics development and improvement project	Improve quality of energy statistics including its metadata and uncertainty estimation	National Energy Planning, Domestic MRV	150,000	Energy Commission, EPA, Ghana Statistical Service	x			Grant	High
Industry and ODS Activity data collection project	Collect relevant industry and ODS activity data through a national survey	Focus programme 10: National Climate Change Policy	150,000	EPA, Ministry of Trade, Ghana Custom Services	x			Grant	High
Development of guidelines for MRV implementation in M&E institutions	Operationalize domestic MRV system including GHG, Support and policies/measures	Focus programme 10: National Climate Change Policy	120,000	EPA, NDPC, Ghana Statistical Services, Ministry of Finance				Grant	Medium
Support to water conservation and irrigation systems	Ensure availability of water for multiple uses (including rainwater harvesting) in a changing climate whilst reducing flood related disaster risk in rural communities.	Focus programme 1: National Climate Change Policy	150,000,000	Local Government Authorities	x		x	Grant	Medium
Sustainable wood-based fuel production and development for domestic energy supply	improve efficiency of wood fuel production and ensure development of alternative bio-fuels for sustainable energy supply in Ghana	Focus programme: 4 & 5 of National Climate Change Policy	150,000,000	Ministries of Lands and Natural Resources of Food and Agriculture	x		X	Grant	Medium

4.3. Tracking climate-related financial flows

Many institutions receive funds in different forms from all sorts of channels that do not pass through the Ministry of Finance. This has led to a multiplicity of uncoordinated climate activities in the country that does not tend to address the priorities that have been set out in the national climate change policy. In addition, domestic financing of climate change activities is difficult to estimate over a given time frame. This is because in the national budget there is no clear demarcation of climate expenditure items and this leads to challenges in tracking actual expenditures during implementation of the climate change activities and programmes. The Ministry of Finance and the EPA are putting in place a national climate finance-tracking tool that will sufficiently track all climate supported expenditure from Ghana government and donors. In this regard, The Ministry of Finance is planning to collaborate with the ISSER to undertake Climate Public Expenditure and Institutional Review (CPEIR). The structure for tracking of climate related financial flows would be interwoven into the domestic monitoring reporting and verification (MRV) system. Figure 13 shows the key elements of the climate tracking architecture.

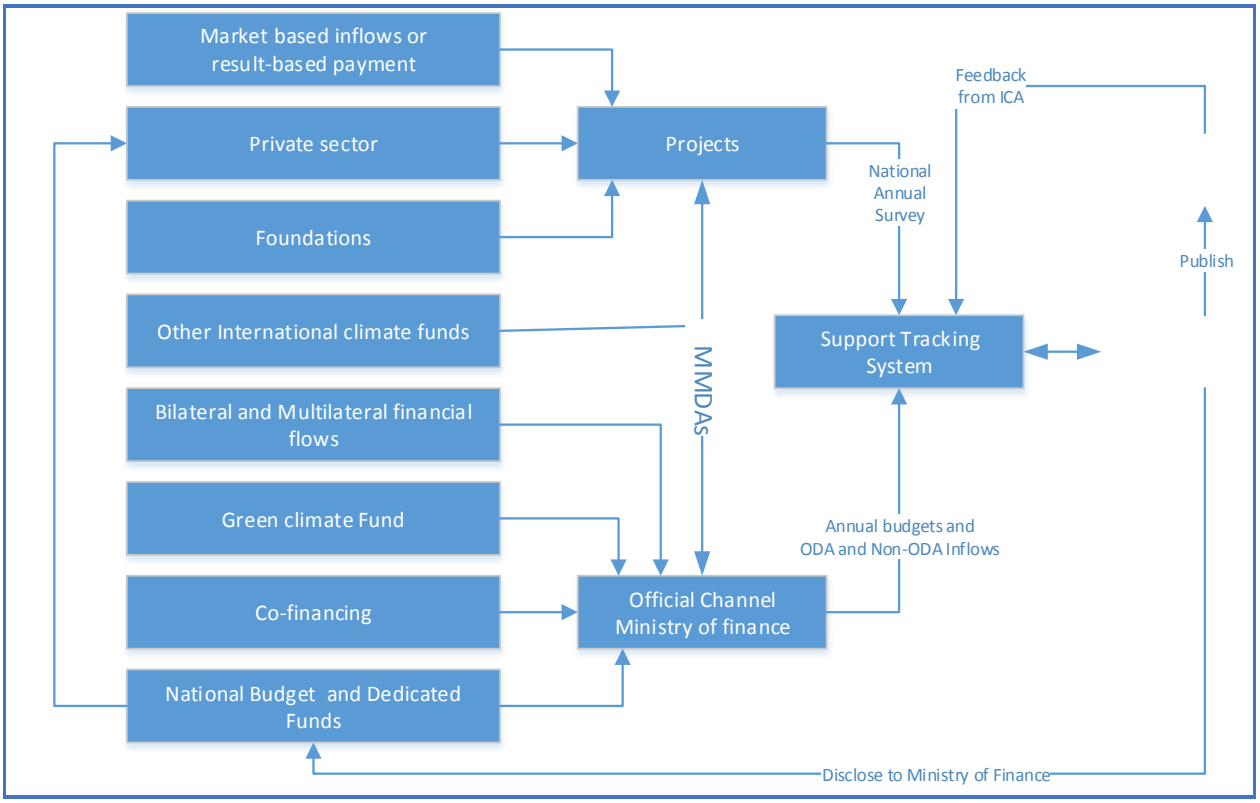

Figure 13: Climate-related financial flow tracking system

4.4 Support received for BUR preparation

Financial support for the preparation of the BUR was received from the Global Environment Facility (GEF) through UNEP as the implementing agency. In 2013, GEF/UNEP approved US$ 352,000 for Ghana to start the preparation of its BUR after the project proposal and implementation plan were submitted and approved. Although the support Ghana received was timely and effectively enabled the country to meet its reporting obligation, it did not cover the full cost for preparing the BUR other partners also contributed through technical assistance.

Table 33: List of Capacity Building Received during the BUR preparation

Activity	Capacity Needed	Capacity received	Source of Support
Use of 2006 IPCC guidelines and ALU software for AFOLU GHG Accounting	Data processing and management strategies.	Training on AFOLU data collection and management.	Rainforest Coalition, CD REDD Project,
	Training on ALU and IPCC software on ALU	Hands-training on use of IPCC software for AFOLU.	
	Training on 2006 IPCC Guidelines and software	Training on GHG Inventory	GIZ Information Matters project
			UNFCCC CGE Training
GHG National System improvement	GHG Data management and institutional arrangement.	GHG MRV Training	UNEP/GEF, Information Matters project
		Training GHG MRV Management	
	Strengthening national system for GHG	Establishment of online climate change data hub	UNEP/GEF, UNDP, Low Emission Capacity Building Project
		Development of GHG Manual	
		Development QA/QC Plan	
Improvement of GHG Inventory Report	Review of National Inventory Report	Technical review of Energy section of National Inventory Report	GIZ Information Matters project
		Technical review AFOLU section of National Inventory Report	Rainforest Coalition, CD REDD Project, Sustainable GHG Management in, West Africa
		Technical review of entire National Inventory Report	UNFCCC Secretariat
Development of Marginal abatement cost curve	Training on marginal abatement curves	Training on mitigation assessment	UNEP/GEF during preparation of Third National Communication
Improvement in mitigation baseline setting	Training on how to make baseline transparent	Training workshop on baselines	UNEP/GEF during preparation of Third National Communication
			GIZ Information Matters project
Continuous training of GHG Experts	Training new technical expert on GHG at the international level	Training of 6 GHG review experts	UNFCCC GHG Review Training Programme
Development of mitigation scenario for non-energy sector	Training on marginal abatement curves	Training on mitigation assessment	UNEP/GEF during preparation of Third National Communication

5. Information on Domestic MRV System

5.1 Elements of Ghana's domestic MRV system

Ghana's approach to develop and operationalize its domestic MRV system focuses on integration into the existing national development M&E superstructure rather than setting up new layer institutional structures. Ghana considers this approach as an efficient and cost-effective way of mobilizing institutions and setting up processes for performing MRV functions on sustainable basis at both project, sector and national levels (see figure 14). Ghana's attention has been on designing a simple-to-integrate MRV structure that is acceptable and less burdensome to the identified institutions but which at the same time, meets the essential ingredients for MRV. Because the MRV is seeking to integrate into the existing development M & E structures, performing any additional MRV function will not require new law. The institutions will rather draw their authority to perform their MRV functions from the existing legal framework that mandates them to carry out the development of M & E and regulatory tasks.

The domestic MRV system aims at making sure that the existing sector or national development M&E system is able to "monitor" (a) GHG emissions or reductions attributed to a particular mitigation action (policy, programme, measure or project; (b) climate-related support provided by Government of Ghana or received from donors or the market in a form of finance, technology transfer and capacity to enable implementation of a certain action or as a result of an action taken in a particular sector of the economy; (c) sustainable development benefits of mitigation actions.

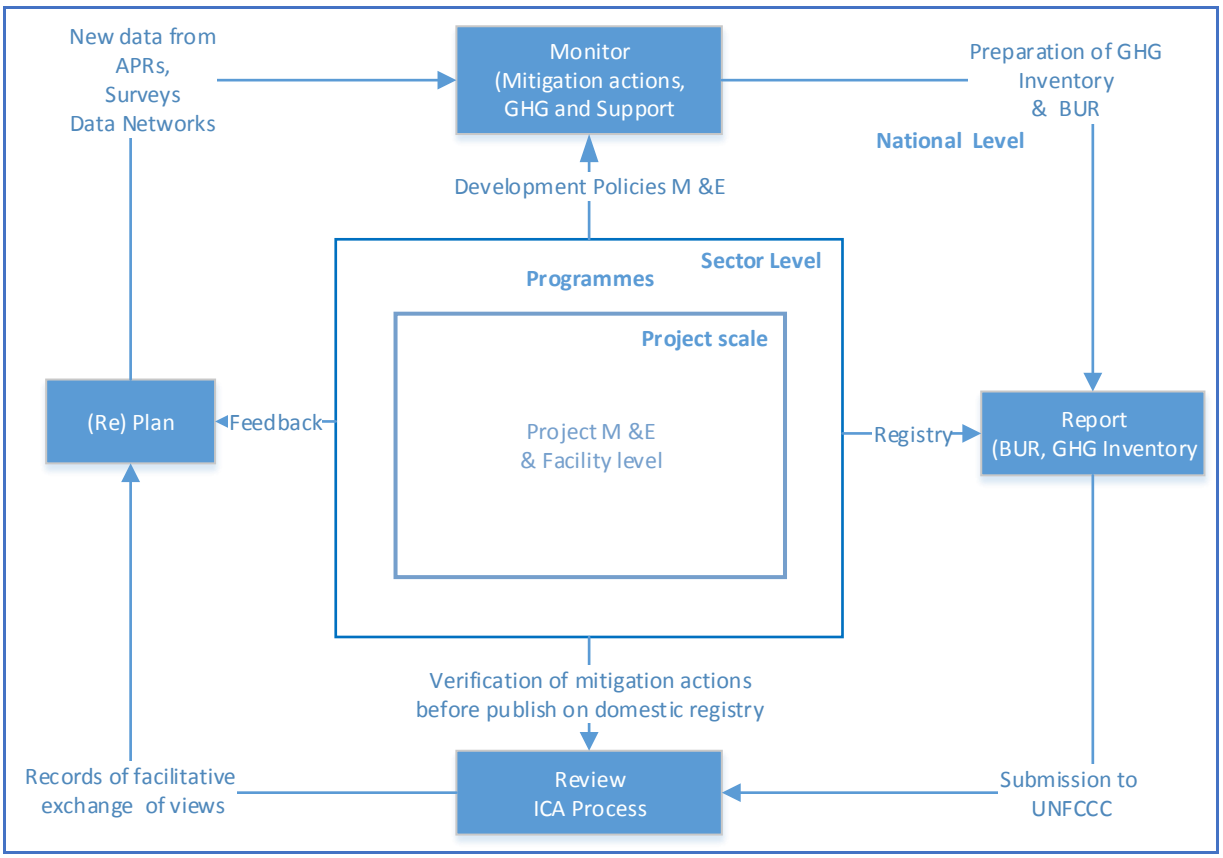

Figure 14: Element of Ghana's Domestic MRV system

In addition, reporting on (a) GHG Inventories, (b) mitigation actions and its effects and (c) support received in a timely manner. All these information will be reported in the National Inventory Report (NIR) and the BUR and communicated to the UNFCCC in order to kick-start the International Consultation and Analysis (ICA) process which will constitute the second layer of verification. The first layer of verification of information on GHG emissions, impacts of mitigation actions and support will be performed by the national registry entity before it's recognized and uploaded on the online registry.

5.2 Steps taken to develop Ghana's domestic MRV system

The designing and operationalization of the domestic MRV system will be rolled out in 4 stages from 2015 to 2020. The phased out programme is sequenced as follows: (a) planning and design; (b) integration; (c) piloting and testing; and (d) functional deployment. The domestic MRV system will have different hardware and software elements which will together work as one functional unit. The arrangements of the functional units of the MRV configuration is shown in figure 15.

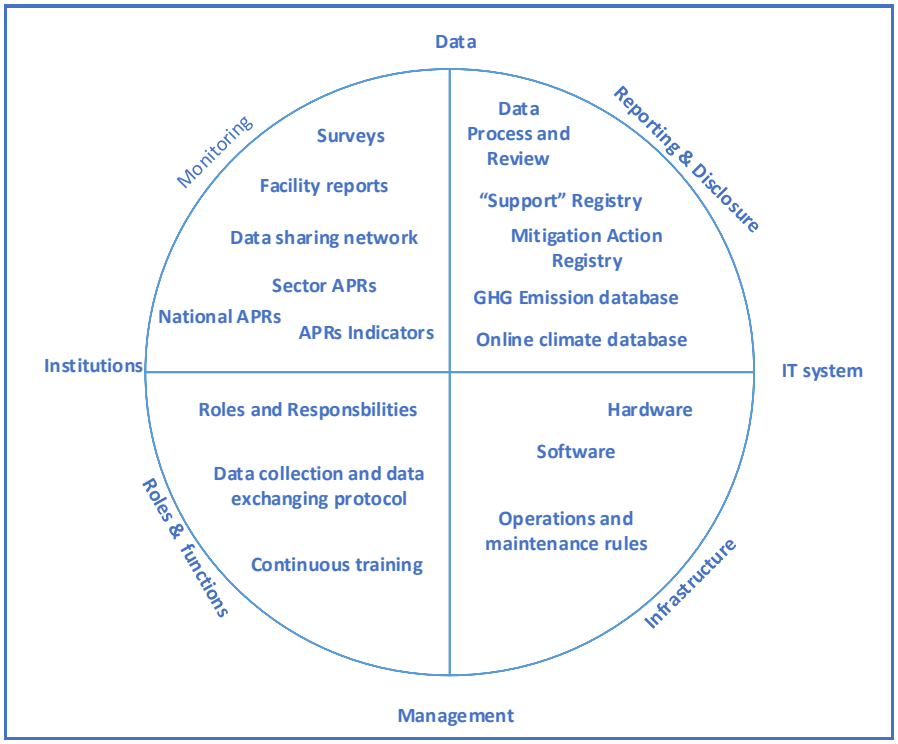

Figure 15: Elements of domestic MRV

5.2.1 Stages for developing Domestic MRV

5.2.1.2 Planning and staging

At the planning stage, the roles and responsibilities of the EPA as the technical coordinating entity, NDPC, the Ghana Statistical Service Ministries of Finance, Energy (Energy Commission), Food and Agriculture, Transport and Lands and Natural Resources (Forestry Commission) within the MRV system, will be determined through consultations. The inventory of existing M&E data generation points will be set into a network of data sharing web via the central climate data hub. The network will be deployed at MRV prototype by 2015 (see figure 16).

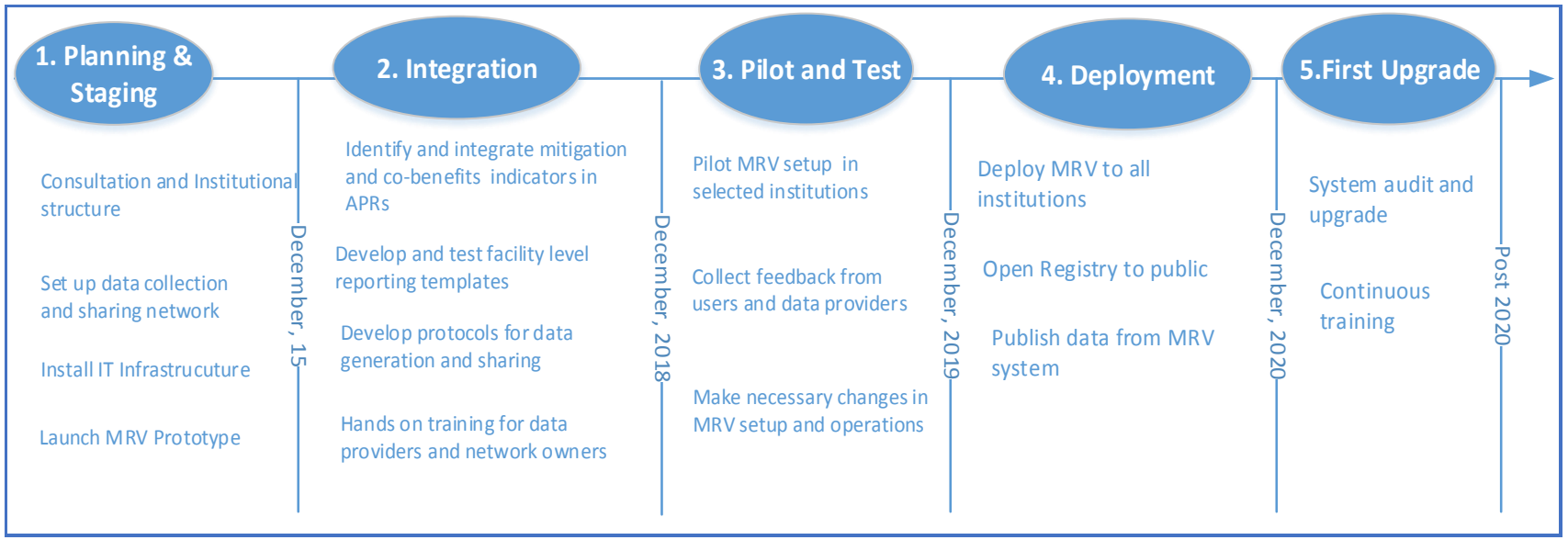

Figure 16: Timelines for rolling out Domestic MRV system

5.2.1.3 M&E and MRV Integration

The MRV setup will be integrated into existing development of M&E both at the national, sectoral and probably at the district levels where possible. As part of the integration process, indicators for mitigation actions, effects and co-benefits for key policies and measures will be developed and included in the national M&E framework. The M&E framework will track the implementation of national and sector policies and programmes and report annually in the Annual Progress Report (APR). The national APR is a compilation of sector APRs. The APR will then become the main M&E framework for monitoring implementation of mitigation actions and their GHG impacts and co-benefits. Within the new framework, the Ministry of Finance will continue its annual survey of climate finance inflows and domestic contributions through the national budget. The existing annual report submitted by industry to regulatory bodies such as EPA and Energy Commission will be used to monitor facility level reporting. MRV/M&E templates will be developed and incorporated into the existing reporting template. Regular hands on training will be organized for data providers and data network owners (see figure 16).

5.2.1.4 Pilot, Test, Deployment and Upgrades

By 2020 the full functional integrated domestic MRV system will become operational after initial sector piloting and testing. The MRV setup will be piloted in the Forestry and Energy Sectors to test the capability range of the system. The feedback from the pilots will be used to update the MRV system before full deployment begins by December 2020. Regular biennial system-wide audit and stakeholder consultations will be performed to identify areas of improvements.

Annex 1: GHG Inventory Summary Tables (2012)

Annex 1.1. Table A: Summary table

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			Emissions (Gg)	
Categories	**Net CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF6**	**NOx**	**CO**
Total National Emissions and Removals	**14811.73**	**398.05**	**24.39**	**0.00**	**112.71**	**0.00**	**110.57**	**1842.80**
1 - Energy	**12594.78**	**30.45**	**0.88**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1.A - Fuel Combustion Activities	**12593.46**	**30.44**	**0.88**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1.A.1 - Energy Industries	3239.88	0.11	0.02				0.00	0.00
1.A.2 - Manufacturing Industries and Construction	1320.79	2.44	0.14				0.00	0.00
1.A.3 - Transport	6300.43	1.69	0.40				0.00	0.00
1.A.4 - Other Sectors	1732.36	26.20	0.32				0.00	0.00
1.A.5 - Non-Specified	0.00	0.00	0.00				0.00	0.00
1.B - Fugitive emissions from fuels	**1.32**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1.B.1 - Solid Fuels	0.00	0.00	0.00				0.00	0.00
1.B.2 - Oil and Natural Gas	1.32	0.01	0.00				0.00	0.00
1.B.3 - Other emissions from Energy Production	0.00	0.00	0.00				0.00	0.00
1.C - Carbon dioxide Transport and Storage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.C.1 - Transport of CO2	0.00						0.00	0.00
1.C.2 - Injection and Storage	0.00						0.00	0.00
1.C.3 - Other	0.00						0.00	0.00
2 - Industrial Processes and Product Use	**353.64**	**0.00**	**0.00**	**0.00**	**112.71**	**0.00**	**0.00**	**0.00**
2.A - Mineral Industry	267.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A.1 - Cement production	0.00						0.00	0.00
2.A.2 - Lime production	0.00						0.00	0.00
2.A.3 - Glass Production	0.00						0.00	0.00
2.A.4 - Other Process Uses of Carbonates	267.44						0.00	0.00
2.A.5 - Other (please specify)	0.00	0.00	0.00				0.00	0.00
2.B - Chemical Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.1 - Ammonia Production	0.00						0.00	0.00
2.B.2 - Nitric Acid Production			0.00				0.00	0.00
2.B.3 - Adipic Acid Production			0.00				0.00	0.00
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0.00				0.00	0.00

2.B.5 - Carbide Production	0.00	0.00					0.00	0.00
2.B.6 - Titanium Dioxide Production	0.00						0.00	0.00
2.B.7 - Soda Ash Production	0.00						0.00	0.00
2.B.8 - Petrochemical and Carbon Black Production	0.00	0.00					0.00	0.00
2.B.9 - Fluorochemical Production				0.00	0.00	0.00	0.00	0.00
2.B.10 - Other (Please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C - Metal Industry	66.05	0.00	0.00	0.00	112.71	0.00	0.00	0.00
2.C.1 - Iron and Steel Production	5.29	0.00					0.00	0.00
2.C.2 - Ferroalloys Production	0.00	0.00					0.00	0.00
2.C.3 - Aluminium production	60.76				112.71		0.00	0.00
2.C.4 - Magnesium production	0.00					0.00	0.00	0.00
2.C.5 - Lead Production	0.00						0.00	0.00
2.C.6 - Zinc Production	0.00						0.00	0.00
2.C.7 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D - Non-Energy Products from Fuels and Solvent Use	20.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D.1 - Lubricant Use	20.15						0.00	0.00
2.D.2 - Paraffin Wax Use	0.00						0.00	0.00
2.D.3 - Solvent Use							0.00	0.00
2.D.4 - Other (please specify)	0.00	0.00	0.00				0.00	0.00
2.E - Electronics Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.1 - Integrated Circuit or Semiconductor				0.00	0.00	0.00	0.00	0.00
2.E.2 - TFT Flat Panel Display					0.00	0.00	0.00	0.00
2.E.3 - Photovoltaics					0.00		0.00	0.00
2.E.4 - Heat Transfer Fluid					0.00		0.00	0.00
2.E.5 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.1 - Refrigeration and Air Conditioning				0.00			0.00	0.00
2.F.2 - Foam Blowing Agents				0.00			0.00	0.00
2.F.3 - Fire Protection				0.00	0.00		0.00	0.00
2.F.4 - Aerosols				0.00			0.00	0.00
2.F.5 - Solvents				0.00	0.00		0.00	0.00
2.F.6 - Other Applications (please specify)				0.00	0.00		0.00	0.00
2.G - Other Product Manufacture and Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G.1 - Electrical Equipment					0.00	0.00	0.00	0.00
2.G.2 - SF6 and PFCs from Other Product Uses					0.00	0.00	0.00	0.00

2.G.3 - N2O from Product Uses			0.00				0.00	0.00
2.G.4 - Other (Please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H.1 - Pulp and Paper Industry	0.00	0.00					0.00	0.00
2.H.2 - Food and Beverages Industry	0.00	0.00					0.00	0.00
2.H.3 - Other (please specify)	0.00	0.00	0.00				0.00	0.00
3 - Agriculture, Forestry, and Other Land Use	**1859.36**	**176.09**	**21.93**	**0.00**	**0.00**	**0.00**	**110.57**	**1842.80**
3.A - Livestock	0.00	101.22	2.97	0.00	0.00	0.00	0.00	0.00
3.A.1 - Enteric Fermentation		95.90					0.00	0.00
3.A.2 - Manure Management		5.33	2.97				0.00	0.00
3.B - Land	1835.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.B.1 - Forest land	-29325.89						0.00	0.00
3.B.2 - Cropland	26038.99						0.00	0.00
3.B.3 - Grassland	4382.43						0.00	0.00
3.B.4 - Wetlands	101.41		0.00				0.00	0.00
3.B.5 - Settlements	681.89						0.00	0.00
3.B.6 - Other Land	-42.90						0.00	0.00
3.C - Aggregate sources and non-CO2 emissions sources on land	23.43	74.86	18.96	0.00	0.00	0.00	110.57	1842.80
3.C.1 - Emissions from biomass burning		65.21	5.95				110.57	1842.80
3.C.2 - Liming	0.00						0.00	0.00
3.C.3 - Urea application	23.43						0.00	0.00
3.C.4 - Direct N2O Emissions from managed soils			9.73				0.00	0.00
3.C.5 - Indirect N2O Emissions from managed soils			3.10				0.00	0.00
3.C.6 - Indirect N2O Emissions from manure management			0.17				0.00	0.00
3.C.7 - Rice cultivations		9.66					0.00	0.00
3.C.8 - Other (please specify)		0.00	0.00				0.00	0.00
3.D - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.1 - Harvested Wood Products	0.00						0.00	0.00
3.D.2 - Other (please specify)	0.00	0.00	0.00				0.00	0.00
4 - Waste	3.96	191.52	1.58	0.00	0.00	0.00	0.00	0.00
4.A - Solid Waste Disposal	0.00	68.63	0.00	0.00	0.00	0.00	0.00	0.00
4.B - Biological Treatment of Solid Waste	0.00	0.75	0.06	0.00	0.00	0.00	0.00	0.00
4.C - Incineration and Open Burning of Waste	3.96	0.87	0.01	0.00	0.00	0.00	0.00	0.00
4.D - Wastewater Treatment and Discharge	0.00	121.27	1.51	0.00	0.00	0.00	0.00	0.00
4.E - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Memo Items (5)								
International Bunkers	**1186.17**	**0.08**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1.A.3.a.i - International Aviation (International Bunkers)	348.54	0.00	0.01				0.00	0.00
1.A.3.d.i - International water-borne navigation (International bunkers)	837.62	0.08	0.02				0.00	0.00
1.A.5.c - Multilateral Operations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annex 1.2 - Table B: Short Summary table

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			Emissions (Gg)	
Categories	**Net CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF6**	**NOx**	**CO**
Total National Emissions and Removals	**14811.73**	**398.05**	**24.39**	**0**	**112.71**	**0.00**	**110.57**	**1842.80**
1 - Energy	**12594.78**	**30.45**	**0.88**	**0**	**0.00**	**0.00**	**0.00**	**0.00**
1.A - Fuel Combustion Activities	12593.46	30.44	0.88				0.00	0.00
1.B - Fugitive emissions from fuels	1.32	0.01	0.00				0.00	0.00
1.C - Carbon dioxide Transport and Storage	0.00						0.00	0.00
2 - Industrial Processes and Product Use	**353.64**	**0.00**	**0.00**	**0**	**112.71**	**0.00**	**0.00**	**0.00**
2.A - Mineral Industry	267.44	0.00	0.00				0.00	0.00
2.B - Chemical Industry	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00
2.C - Metal Industry	66.05	0.00	0.00	0	112.71	0.00	0.00	0.00
2.D - Non-Energy Products from Fuels and Solvent Use	20.15	0.00	0.00				0.00	0.00
2.E - Electronics Industry	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00
2.F - Product Uses as Substitutes for Ozone Depleting Substances				0	0.00		0.00	0.00
2.G - Other Product Manufacture and Use	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00
2.H - Other	0.00	0.00	0.00				0.00	0.00
3 - Agriculture, Forestry, and Other Land Use	**1859.36**	**176.09**	**21.93**	**0**	**0.00**	**0.00**	**110.57**	**1842.80**
3.A - Livestock		101.22	2.97				0.00	0.00
3.B - Land	1835.93		0.00				0.00	0.00
3.C - Aggregate sources and non-CO2 emissions sources on land	23.43	74.86	18.96				110.57	1842.80
3.D - Other	0.00	0.00	0.00				0.00	0.00
4 - Waste	**3.96**	**191.52**	**1.58**	**0**	**0.00**	**0.00**	**0.00**	**0.00**
4.A - Solid Waste Disposal		68.63					0.00	0.00
4.B - Biological Treatment of Solid Waste		0.75	0.06				0.00	0.00
4.C - Incineration and Open Burning of Waste	3.96	0.87	0.01				0.00	0.00
4.D - Wastewater Treatment and Discharge		121.27	1.51				0.00	0.00
4.E - Other (please specify)	0.00	0.00	0.00				0.00	0.00
Memo Items (5)								
International Bunkers	1186.17	0.08	0.03	0	0.00	0.00	0.00	0.00
1.A.3.a.i - International Aviation (International Bunkers)	348.54	0.00	0.01				0.00	0.00
1.A.3.d.i - International water-borne navigation (International bunkers)	837.62	0.08	0.02				0.00	0.00

Annex 2: Time series table on total emissions (1990-2012)

Category	Total Emissions ($MtCO_2e$)																						
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total National Emissions and Removals	**14.22**	**10.22**	**10.59**	**13.36**	**14.62**	**12.74**	**14.09**	**14.58**	**17.32**	**17.29**	**16.32**	**18.43**	**20.16**	**21.19**	**19.87**	**20.90**	**24.31**	**26.79**	**26.01**	**28.00**	**30.42**	**30.62**	**33.66**
1 - Energy	**3.50**	**2.98**	**3.23**	**3.38**	**4.10**	**3.86**	**4.70**	**4.45**	**7.31**	**6.99**	**5.54**	**6.21**	**7.87**	**7.57**	**6.75**	**6.93**	**8.91**	**10.59**	**9.39**	**10.28**	**11.28**	**11.65**	**13.51**
1.A - Fuel Combustion Activities	**3.50**	**2.98**	**3.23**	**3.38**	**4.10**	**3.86**	**4.70**	**4.45**	**7.31**	**6.98**	**5.54**	**6.20**	**7.87**	**7.57**	**6.75**	**6.93**	**8.91**	**10.59**	**9.39**	**10.28**	**11.27**	**11.63**	**13.50**
1.A.1 - Energy Industries	0.07	0.10	0.08	0.24	0.31	0.22	0.09	0.12	1.56	1.15	0.55	0.93	2.20	2.01	0.73	1.23	2.46	3.08	2.22	1.78	3.20	3.00	3.25
1.A.2 - Manufacturing Industries and Construction	0.49	0.50	0.58	0.60	0.69	0.66	0.48	0.30	0.48	0.47	0.70	0.72	0.75	0.76	0.81	0.85	0.92	0.96	1.10	0.99	1.11	1.23	1.41
1.A.3 - Transport	1.47	1.31	1.47	1.42	1.70	1.56	2.25	2.06	2.97	3.23	2.81	2.88	3.10	2.91	3.38	2.87	3.38	3.89	3.79	4.63	4.80	5.41	6.46
1.A.4 - Other Sectors	1.47	1.06	1.10	1.11	1.41	1.42	1.88	1.97	2.29	2.13	1.48	1.68	1.82	1.88	1.83	1.97	2.15	2.65	2.27	2.88	2.17	1.99	2.38
2 - Industrial Processes and Product Use	**0.81**	**0.82**	**0.85**	**0.83**	**0.68**	**0.66**	**0.67**	**0.74**	**0.30**	**0.52**	**0.77**	**0.79**	**0.66**	**0.13**	**0.08**	**0.20**	**0.51**	**0.24**	**0.29**	**0.21**	**0.24**	**0.44**	**0.47**
2.A - Mineral Industry	**0.01**	**0.02**	**0.02**	**0.02**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**	**0.03**	**0.03**	**0.04**	**0.05**	**0.11**	**0.14**	**0.16**	**0.23**	**0.19**	**0.21**	**0.25**	**0.27**
2.A.1 - Cement production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A.2 - Lime production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A.3 - Glass Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.A.4 - Other Process Uses of Carbonates	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.05	0.11	0.14	0.16	0.23	0.19	0.21	0.25	0.27
2.A.5 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B - Chemical Industry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2.B.1 - Ammonia Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.2 - Nitric Acid Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.3 - Adipic Acid Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.5 - Carbide Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.6 - Titanium Dioxide Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.7 - Soda Ash Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.8 - Petrochemical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

and Carbon Black Production																							
2.B.9 - Fluorochemical Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.B.10 - Other (Please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C - Metal Industry	**0.80**	**0.80**	**0.82**	**0.80**	**0.65**	**0.63**	**0.63**	**0.69**	**0.25**	**0.47**	**0.71**	**0.75**	**0.61**	**0.07**	**0.00**	**0.07**	**0.35**	**0.07**	**0.05**	**0.01**	**0.01**	**0.17**	**0.18**
2.C.1 - Iron and Steel Production	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2.C.2 - Ferroalloys Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.3 - Aluminum production	0.80	0.80	0.82	0.80	0.64	0.62	0.62	0.69	0.25	0.47	0.71	0.74	0.60	0.07	0.00	0.06	0.35	0.06	0.04	0.00	0.00	0.16	0.17
2.C.4 - Magnesium production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.5 - Lead Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.6 - Zinc Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.C.7 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D - Non-Energy Products from Fuels and Solvent Use	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**
2.D.1 - Lubricant Use	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02
2.D.2 - Paraffin Wax Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D.3 - Solvent Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.D.4 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E - Electronics Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.1 - Integrated Circuit or Semiconductor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.2 - TFT Flat Panel Display	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.3 - Photovoltaics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.4 - Heat Transfer Fluid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.E.5 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.1 - Refrigeration and Air Conditioning	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2.F.2 - Foam Blowing Agents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2.F.3 - Fire Protection	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.4 - Aerosols	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.5 - Solvents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.6 - Other Applications (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G - Other Product Manufacture and Use	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2.G.1 - Electrical Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G.2 - SF6 and PFCs from Other Product Uses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G.3 - N2O from Product Uses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.G.4 - Other (Please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H.1 - Pulp and Paper Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H.2 - Food and Beverages Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H.3 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 - Agriculture, Forestry, and Other Land Use	**8.61**	**5.06**	**5.03**	**7.59**	**8.18**	**6.48**	**6.86**	**7.43**	**7.65**	**7.62**	**7.72**	**8.98**	**9.09**	**10.82**	**10.26**	**10.83**	**11.83**	**12.32**	**12.53**	**13.55**	**14.67**	**14.08**	**15.17**
3.A - Livestock	**1.72**	**1.78**	**1.74**	**1.76**	**1.81**	**1.88**	**1.92**	**1.95**	**2.01**	**2.06**	**2.20**	**2.14**	**2.18**	**2.26**	**2.35**	**2.37**	**2.43**	**2.49**	**2.55**	**2.62**	**2.82**	**2.80**	**3.05**
3.A.1 - Enteric Fermentation	1.20	1.25	1.22	1.23	1.27	1.32	1.34	1.37	1.40	1.44	1.47	1.49	1.52	1.58	1.63	1.65	1.69	1.73	1.77	1.82	1.87	1.94	2.01
3.A.2 - Manure Management	0.52	0.53	0.52	0.53	0.54	0.56	0.58	0.59	0.60	0.62	0.73	0.65	0.66	0.68	0.71	0.72	0.74	0.76	0.78	0.80	0.95	0.86	1.03
3.B - Land	**-3.02**	**-6.60**	**-6.44**	**-3.84**	**-3.23**	**-5.05**	**-4.67**	**-4.09**	**-3.87**	**-3.90**	**-4.00**	**-2.65**	**-2.62**	**-0.99**	**-0.76**	**-0.93**	**-0.06**	**0.38**	**0.80**	**1.20**	**1.85**	**1.31**	**1.84**
3.B.1 - Forest land	-17.44	-21.80	-22.42	-20.60	-20.77	-23.38	-23.78	-23.98	-24.55	-25.36	-26.25	-25.63	-26.35	-25.46	-25.97	-26.88	-26.76	-27.06	-27.37	-27.71	-27.80	-29.09	-29.33
3.B.2 - Cropland	12.39	13.01	13.63	14.25	14.87	15.49	16.11	16.73	17.35	17.97	18.59	19.21	19.83	20.45	21.07	21.69	22.31	22.93	23.55	24.16	24.78	25.40	26.04
3.B.3 - Grassland	2.09	2.19	2.29	2.40	2.50	2.61	2.71	2.82	2.92	3.02	3.13	3.23	3.34	3.44	3.55	3.65	3.75	3.86	3.96	4.07	4.17	4.28	4.38
3.B.4 - Wetlands	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10
3.B.5 - Settlements	0.01	0.05	0.10	0.15	0.20	0.25	0.29	0.34	0.39	0.44	0.49	0.50	0.52	0.54	0.55	0.57	0.58	0.60	0.62	0.63	0.65	0.67	0.68
3.B.6 - Other Land	-0.12	-0.11	-0.10	-0.09	-0.08	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
3.C - Aggregate sources and non-CO2 emissions sources on land	**9.91**	**9.88**	**9.73**	**9.68**	**9.60**	**9.64**	**9.61**	**9.57**	**9.51**	**9.46**	**9.52**	**9.49**	**9.53**	**9.54**	**8.67**	**9.39**	**9.47**	**9.45**	**9.17**	**9.72**	**9.99**	**9.98**	**10.29**
3.C.1 - Emissions from biomass burning	8.12	8.01	7.90	7.78	7.67	7.56	7.44	7.33	7.22	7.10	6.99	6.90	6.81	6.72	6.63	6.54	6.46	6.37	5.94	6.19	6.10	6.06	6.03
3.C.2 - Liming	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.C.3 - Urea application	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
3.C.4 - Direct N2O Emissions from managed soils	1.31	1.32	1.30	1.35	1.38	1.48	1.55	1.59	1.63	1.70	1.82	1.89	1.97	2.06	1.40	2.06	2.18	2.25	2.35	2.56	2.78	2.79	3.02
3.C.5 - Indirect N2O Emissions from managed soils	0.35	0.42	0.41	0.43	0.43	0.46	0.48	0.49	0.50	0.52	0.59	0.57	0.59	0.61	0.48	0.62	0.67	0.68	0.71	0.77	0.88	0.84	0.96
3.C.6 - Indirect N2O Emissions from manure management	0.03	0.04	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05
3.C.7 - Rice cultivations	0.08	0.09	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.10	0.09	0.08	0.11	0.11	0.11	0.11	0.12	0.10	0.12	0.15	0.17	0.24	0.20
3.C.8 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.1 - Harvested Wood Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.D.2 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 - Waste	**1.31**	**1.36**	**1.48**	**1.55**	**1.66**	**1.73**	**1.85**	**1.96**	**2.07**	**2.17**	**2.29**	**2.45**	**2.55**	**2.67**	**2.79**	**2.94**	**3.07**	**3.64**	**3.80**	**3.95**	**4.24**	**4.45**	**4.52**
4.A - Solid Waste Disposal	0.09	0.10	0.17	0.19	0.25	0.27	0.33	0.35	0.41	0.44	0.50	0.58	0.63	0.71	0.76	0.82	0.88	0.95	1.03	1.13	1.23	1.31	1.44
4.B - Biological Treatment of Solid Waste	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
4.C - Incineration and Open Burning of Waste	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.03
4.D - Wastewater Treatment and Discharge	1.15	1.20	1.25	1.30	1.35	1.40	1.47	1.54	1.60	1.67	1.74	1.82	1.86	1.92	1.98	2.07	2.14	2.64	2.73	2.79	2.96	3.08	3.01
4.E - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items (5)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
International Bunkers	**0.04**	**0.07**	**0.11**	**0.05**	**0.11**	**0.07**	**0.18**	**0.18**	**0.26**	**0.29**	**0.34**	**0.20**	**0.23**	**0.23**	**0.27**	**0.30**	**0.49**	**0.45**	**0.48**	**0.55**	**0.58**	**1.73**	**1.20**
1.A.3.a.i - International Aviation (International Bunkers)	0.03	0.06	0.10	0.05	0.10	0.07	0.17	0.18	0.26	0.29	0.34	0.20	0.23	0.22	0.27	0.30	0.29	0.31	0.30	0.31	0.27	0.34	0.35
1.A.3.d.i - International water-borne navigation (International bunkers)	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.21	0.14	0.18	0.24	0.31	1.40	0.85

Annex 3: Detailed description of mitigation actions and their effects

Annex 3.1 Renewable Energy mitigation actions

Electricity Supply – Solar PV Electrification Programme		
General information	Name of action	Grid-connected solar installations
	Sector	Energy
	Scale	National Grid
	Gas	CO_2
	Status	On-going
	Start Year	1999
	End Year	2018
Implementation information	Implementing entities	Ministry of Power – cluster of initiatives Off-grid/Mini grid installations and enabling activities Off-grid solar PV remote public institutions on lake side and island community – Government of Spain Off-grid solar electrification for remote public institutions (World Bank, GEDAP) Monitoring implementation of solar lantern and home systems by ARB Apex Bank (World Bank, GEDAP) Human Resource Development for disseminating solar PV (JICA) Establishment of Renewable Energy Feed-in Tariff system Designing and operationalization of renewable energy fund Installation of 9,536 solar systems in deprived off-grid communities in 2009 and other installations translate to *3,413.05 kWP.*
	Grid-connected solar installations	Ministry of Power – 50kWp (1998)
		Energy Commission - 4.25kWp (2008)
		Kwame Nkrumah University of Science and Technology - 24kWp (2008)
		Valley View University - 8.36 kWp (2010)
		Presby Women's Centre - 4.18 kWp (2010)
		Pure Company Ltd - 4.18 kWp (2010)
		Dr. George Puplampu Clinic – 4 kWp

		Trade Works Company Ltd (Office) - 33.85 kWp (2011)
		Wienco Gh Ltd - 42.77 kWp (2011)
		Noguchi Memorial Institute, Uni. Of Ghana – 715 kW (2013)
		Volta River Authority (VRA), Navrongo- 2,500 kWp (2013)
		Residences – 24.05kWp
		Elecnor foundation - 29.9kWp
		3S International Limited – 100kWP
		Total = 3,544kWp
	Solar Installation companies and Manufacturers	DENG; Ghana Ecotech Energy; Eco-solar & Construction Ltd; Jatropha Africa Ltd; The Blues Solar Company Limited; Power World Ltd.; Solar Light Company; SA.R.E. Ltd.; EcoZone Ltd.
Target	Establish 3.54MW national grid connected utility-scale solar systems in selected institutions and VRA installations. Installation of 9,536 solar systems in deprived off-grid communities from 2009 to 2014 and other individual standalone installations, which translates into 3.41MW.	
Programme objective	Assessment of effect of installation of solar Photovoltaic for electricity generation: 3.54 MW of solar power built by 2014 displacing option from crude-oil fired thermal base load on the national grid. The solar plants have 100% efficiency have electricity availability of 30% and a lifetime of 30 years. Determine whether or not the off-grid solar installation would have any direct GHG benefits considering uncertainties associated with the baseline. The overall installed capacity off-grid capacity of 3.41MW.	
Objectives of this assessment	(1) Understand what effect has occurred after the installation of solar system on the grid and off-grid; and (2) project future GHG savings from expansion of grid-connected solar systems.	
Defining project assessment boundary	Primary effect - reduction in GHG emissions by avoiding burning of additional light crude oil to generate thermal electricity for off-grid communities. Significant secondary effect – reduction of indoor pollution from burning of kerosene or biomass for lighting and cooking respectively as a result of electricity generation from the off-grid solar PVs.	
Identifying effects and mapping the causal chain	The Solar PV electrification programme seeks to put in place enabling financial, regulatory and technical framework to support penetration of solar PV share in the electricity generation mix. The solar PV electrification support installation of grid-connected and standalone home solar systems. Emission reduction from the grid-connected Solar system will be realized from the reduction in the burning crude oil to generate electricity on the national grid. With 3.54Mw generation capacity and availability of 30%, 9,303MWh/yr electricity would be produced with zero emissions. Additional 8,961MWh/yr off-grid solar PV electricity would be generated in homes, hospitals and non-electrified island communities. The off-grid solar PV electricity will decrease burning of kerosene and biomass fuel.	
Defining the GHG assessment	The reduction in CO_2 emissions from avoided burning of crude oil to generate electricity on the national grid. This is expected to be significant and thus included in the GHG assessment	

boundary

boundary. The CO_2 emission savings from the grid connected solar PV arise from corresponding amount of crude oil that would be used to generate 9,303MWh/yr of electricity on the national grid. The emissions savings from the off-grid solar PV installations may arise, however the identification of the accurate baseline activities is difficult. Because of lack data and the uncertainties associated baseline, the emission reduction estimation from the off-grid Solar PV installation was excluded.

Baseline Emissions

Baseline emissions

Fuel = Light crude oil

Avoided electricity generated from light crude oil fired thermal plant = 9,303MWh/yr

Average grid emission factor = 0.56tCO_2/MWh

Baseline emission = avoided electricity generated from light crude oil fired thermal plant (9,303MWh/yr) x grid emission factor (0.56tCO_2/MWh) = 5,209.68tCO_2/yr

Emission savings from Mitigation options

Mitigation options

With the assumption that, electricity generated from solar PVs have zero emissions. Thus emissions savings from the grid-connected solar electricity would be equivalent to the avoided emissions from the traditional grid-connected electricity. The total emission savings from this intervention amounted to 5.21ktCO_2/yr. However, according to the projections in the strategic energy plan, by 2020 the total installed solar capacity would increase from 3.54MWh to 12.5MWh. This translated into the result in the table below:

Year	Solar PV installed capacity	30% availability	Electricity production (MWh/yr)	GEF (tCO2/MW)	Emission savings (kt/yr)	Cumulative Emission savings (ktCO_2)
2014	3.54	0.3	9,303.12	0.56	5.21	5.21
2015	5.033	0.3	13,227.51	0.7	9.26	14.47
2016	6.527	0.3	17,151.90	0.7	12.01	26.48
2017	8.020	0.3	21,076.30	0.7	14.75	41.23
2018	9.513	0.3	25,000.69	0.7	17.50	58.73
2019	11.007	0.3	28,925.08	0.7	20.25	78.98
2020	12.500	0.3	32,849.47	0.7	22.99	101.97

Monitoring Performance over time		Key performance indicators identified including: Number of Solar PV installation units. Annual questionnaires and pipeline applications at the Energy Commission for permitting Total grid-connected installed capacity of solar PVs Actual electricity availability dispatched to the national
Assessing uncertainty		Qualitative 100% efficiency of installed Solar PVs may not be realized. 30% electricity availability from installed Solar PVs may be lower or higher than expected Projected 12.5% increase in grid capacity of Solar by 2020 may not be realized. Average Grid Emission Factor may vary depending on which power plant are on stream.
Methodology		WRI GHG project protocol
Assumptions		Solar plants have 100% efficiency have electricity availability of 30% and a lifetime of 30 years. Electricity generation from solar has zero emission footprint. Emissions from baseline electricity would be avoided in the Solar PV scenario
Non-GHG Effects		Job creation opportunities for artisan and electricians for installation and regular service maintenance of the installed solar units. Contribute to realizing energy security objectives in the national energy policy.
Funding	Cost	Estimated Amount ($) – unknown
	Sources	Government of Ghana Mechanism
		Private sector – 100% private cost
		Donor - 0% Donor Channel - NA
Tech Transfer		Open Market

General information	**Name of action**	**Households (HH) Solar Lantern Distribution Programme**
	Sector	Energy
	Scale	National (HH) – Off-grid non-electrified communities. Remote communities on islands and lakeside communities with road access.
	Phases	Phase 1 - 2013 to 2014, Phase 2 - 2014 -2016, Phase 3- up to 2018
	Distribution model	Phase 1 – Trade *in* - community trade-in old kerosene lantern for the solar lanterns. S*ubsidy* - HH pay subsidized fees in cash for solar lanterns without turning in their old kerosene lantern.
		Phase 2- 50% grant subsidy and ensure sustainable solar promotion using commercial mass media and social marketing concepts to create critical mass demand and awareness for solar lanterns.
		Phase 3 - Further reduced subsidy. Continue with the market promotional support for a sustainable market chain development
	Gas	CO_2
	Status	On-going
	Start Year	2013
	End Year	2018
Implementation information	Implementing entities	Ministry of Power – facilitated distribution of solar lantern. Renewable Energy Unit is responsible for the programme.
Target	Distribute 200,000 solar lanterns by 2018 at 70% subsidized price to off-grid communities. as part of government's policy to minimize impacts of the implementation of "petroleum products .subsidy removal" Phase 1 target – 20, 000 solar lanterns Phase 2 target – 50,000 solar lanterns Phase 3 target - 130,000 solar lanterns	
Programme objective	Seeks to distribute thousands of solar lanterns to off-grid rural communities so as to reduce their dependence on kerosene lamps for lighting.	
Objectives of this assessment	(1) to understand what effect has occurred after the distribution of solar lanterns in the phase 1 and 2; and (2) project the expected impacts in phase 3.	
Defining project assessment boundary	Primary effect - reduction in GHG emissions by avoiding combustion of kerosene fuel for lighting. Significant secondary effect – reduction of indoor pollution from burning of kerosene fuel for lighting by switching to solar lanterns.	
Identifying	The solar lantern distribution programme aims at replacing kerosene lantern with solar lantern. The	

effects and mapping the causal chain	reduction of dependence on kerosene for lighting is expected to reduce GHG emission by avoiding burning of kerosene. Removing the subsidies on kerosene and redirecting it to the social interventions will bring great benefits to the people for whom the subsidy was meant. The expected savings to government may result in expenditures that are likely to increase or decrease emissions depending on how the funds are put use. The avoided burning of kerosene fuel for lighting will lead to a reduction of indoor pollution and avoid the exposure to women and children to harmful gases.
Defining the GHG assessment boundary	The reduction in CO_2 emissions from lower kerosene use for lighting in HH is expected to be significant and thus included in the GHG assessment boundary. The likely savings to government may result in expenditures that are likely to increase or decrease emissions. Because of lack of data on how government used the savings, this activity was excluded from the boundary. The expected reductions in indoor pollution from lower kerosene use for lighting are excluded in the assessment boundary because of lack of data.
Estimating baseline emissions	Baseline option data *Fuel = Kerosene* Lighting hours /month = 120 hours Fuel use/month = 3 litres Fuel use/lantern/year = 36 liters or 1.27GJ *Programme level* Number of kerosene = 200,000 Total kerosene use/year = 7,200,000 liters or 253,719.43GJ <u>Phase 1 (ex-post)</u> Number of kerosene = 23,522 Total kerosene use/year = 846,792litres or 29,839.9GJ

	Replacement scenarios (expert assumptions)	Share of total lanterns	No of Splits	No. Solar Lantern use	No. Kerosene Lantern use
A	Full replacement (when HH trade in kerosene lantern for use solar of lantern to meet 4hr lighting needs)	35%	8232.7	8232.7	
B	Partial replacement (HH trade in 1 kerosene lantern for solar lantern). Use Solar lanterns for 75% and kerosene lamps for 25% to lighting needs respectively)	50%	11761	8820.75	2940.25
C	Dual use replacement (HH trade in 1 kerosene lantern for solar lantern. Use Solar lanterns for 50% and kerosene lamps for 50% to lighting needs	15%	3528.3	1764.15	1764.15

	respectively)				

Scenario A information (35% full replacement)

Lighting hours /month = 120 hours displaced by Solar Lanterns

Fuel use/month = 3 liters

Fuel use/lantern/year = 36 liters or 1.27GJ

Number replaceable kerosene lanterns = 8232.7

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

Scenario A baseline emissions (tonnes/yr) = unit kerosene consumption per year (1.27GJ) x No. of full replaceable kerosene lanterns (8,232.7) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 754.39tCO_2e/yr

Scenario B information (50% partial replacement – 75% solar and 25% kerosene dual use)

75% solar lantern replacement option

Lighting hours /month = 90 hours displaced by Solar Lanterns

Fuel use/month = 2.25 liters

Fuel use/lantern/year = 27 liters or 0.95GJ

Number replaceable kerosene lanterns = 8,820.75

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

25% kerosene lantern complement use option

Lighting hours /month = 30 hours complement use of kerosene lanterns

Fuel use/month = 0.75 liters

Fuel use/lantern/year = 9 liters or 0.31GJ

Number kerosene lanterns = 2940.25

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

75% solar lantern replacement option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.95GJ) x No. of replaceable kerosene lanterns (8,820.8) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 606.15tCO_2e/yr

25% kerosene lantern complement use option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.31GJ) x No. of kerosene lanterns (2,940.3) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 67.35tCO_2e/yr

Total net baseline emissions (tonnes/yr): *baseline emissions from 75% kerosene lantern replacement option (606.15t/yr) - baseline emissions from 25% kerosene lantern complement use option (67.35t/yr) = 538.80tCO_2e/yr.*

Scenario C information (15% dual use – 50% solar and 50% kerosene dual use)

50% solar lantern replacement and 50% kerosene lantern complement use options

Lighting hours /month = 60hrs displaced by solar lanterns and 60hrs complement use of kerosene lanterns

Fuel use/month = 1.5 liters for each option

Fuel use/lantern/year = 18 liters or 0.63GJ for each option

Number replaceable kerosene lanterns or kerosene lanterns = 1764.15

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

50% solar lantern replacement option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.63GJ) x No. of replaceable kerosene lanterns (1,764.2) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 80.82tCO_2e/yr

50% kerosene lantern complement use option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.63GJ) x No. of kerosene lanterns (1,764.2) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 80.82tCO_2e/yr

Total net baseline emissions (tonnes/yr): *baseline emissions from 50% kerosene lantern replacement option (80.82t/yr) - baseline emissions from 50% kerosene lantern complement use option (80.82t/yr) = 0tCO_2e/yr*

Baseline emissions for phase 1 (tonnes/yr) = Scenario A (754.39t/yr) + Scenario B (538.80t/yr) + Scenario C (0t/yr) = 1, 293.19tCO_2e/yr

Phase 2 (ex-ante)

Number of kerosene = 50,000

Total kerosene use/year = 1,800,000 liters or 63,429.9GJ

Replacement scenarios (expert assumptions)		Share of total lanterns	No of Splits	No. Solar Lantern use	No. Kerosene Lantern use
A	Full replacement (when HH trade in kerosene lantern for use solar lantern to meet 4hr lighting needs)	35%	17,500	17,500	
B	Partial replacement (HH trade in 1 kerosene lantern for solar lantern). Use Solar lanterns for 75% and kerosene lamps for 25% to lighting needs respectively)	50%	25,000	18,750	6,250
C	Dual use replacement (HH trade in 1 kerosene lantern for solar lantern Use Solar lanterns for 50% and kerosene lamps for 50% to lighting needs respectively)	15%	7,500	3,750	3,750

Scenario A information (35% full replacement)

Lighting hours /month = 120 hours displaced by Solar Lanterns

Fuel use/month = 3 liters

Fuel use/lantern/year = 36 liters or 1.27GJ

Number replaceable kerosene lanterns = 18,750

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

Scenario A baseline emissions (tonnes/yr) = unit kerosene consumption per year (1.27GJ) x No. of full replaceable kerosene lanterns (17,500) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 1603.59tCO_2e/yr

Scenario B information (50% partial replacement – 75% solar and 25% kerosene dual use)

75% solar lantern replacement option

Lighting hours /month = 90 hours displaced by Solar Lanterns

Fuel use/month = 2.25 liters

Fuel use/lantern/year = 27 liters or 0.95GJ

Number replaceable kerosene lanterns = 18,750

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

25% kerosene lantern complement use option

Lighting hours /month = 30 hours complement use of kerosene lanterns

Fuel use/month = 0.75 liters

Fuel use/lantern/year = 9 liters or 0.31GJ

Number kerosene lanterns = 6,250

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

75% solar lantern replacement option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.95GJ) x No. of replaceable kerosene lanterns (18,750) x [Emission $factor_{CO2}$(71.9 kg/GJ)/1000] x [Emission $factor_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission $factor_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 1,288.48tCO_2e/yr

25% kerosene lantern complement use option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.31GJ) x No. of kerosene lanterns (6,250) x [Emission $factor_{CO2}$(71.9 kg/GJ)/1000] x [Emission $factor_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission $factor_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] =

429.48tCO_2e/yr

Total net baseline emissions (tonnes/yr): *baseline emissions from 75% kerosene lantern replacement option (1288.48t/yr) - baseline emissions from 25% kerosene lantern complement use option (429.48t/yr) = 858.99tCO_2e/yr*

Scenario C information (15% dual use – 50% solar and 50% kerosene dual use)

50% solar lantern replacement and 50% kerosene lantern complement use options

Lighting hours /month = 60hrs displaced by solar lanterns and 60hrs complement use of kerosene lanterns

Fuel use/month = 1.5 liters for each option

Fuel use/lantern/year = 18 liters or 0.63GJ for each option

Number replaceable kerosene lanterns or kerosene lanterns = 3750

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

50% solar lantern replacement option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.63GJ) x No. of replaceable kerosene lanterns (3750) x [Emission $factor_{CO2}$(71.9 kg/GJ)/1000] x [Emission $factor_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission $factor_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] =

171.8tCO_2e/yr

50% kerosene lantern complement use option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.63GJ) x No. of kerosene lanterns (3,750) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 171.8tCO_2e/yr

Total net baseline emissions (tonnes/yr): *baseline emissions from 50% kerosene lantern replacement option (171.8t/yr) - baseline emissions from 50% kerosene lantern complement use option (171.8t/yr) = 0tCO_2e/yr*

Baseline emissions for phase 2 (tonnes/yr) = Scenario A (1603.59t/yr) + Scenario B (858.99t/yr) + Scenario C (0t/yr) = 2462.58tCO_2e/yr

Phase 3 (ex-ante)

Number of kerosene = 126,478

Total kerosene use/year = 4,553,208 litres or 160,449.6GJ

Replacement scenarios (expert assumptions)		Share of total lanterns	No of Splits	No. Solar Lantern use	No. Kerosene Lantern use
A	Full replacement (when HH trade in kerosene lantern for use solar lantern to meet 4hr lighting needs)	35%	44267.3	44267.3	
B	Partial replacement (HH trade in 1 kerosene lantern for solar lantern). Use Solar lanterns for 75% and kerosene lamps for 25% to lighting needs respectively)	50%	63239	47429.25	15809.75
C	Dual use replacement (HH trade in 1 kerosene lantern for solar lantern Use Solar lanterns for 50% and kerosene lamps for 50% to lighting needs respectively)	15%	18971.7	9485.85	9485.85

Scenario A information (35% full replacement)

Lighting hours /month = 120 hours displaced by Solar Lanterns

Fuel use/month = 3 liters

Fuel use/lantern/year = 36 liters or 1.27GJ

Number replaceable kerosene lanterns = 44,267.3

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

Scenario A baseline emissions (tonnes/yr) = unit kerosene consumption per year (1.27GJ) x No. of full replaceable kerosene lanterns (44,267.3) x [Emission $factor_{CO2}$(71.9 kg/GJ)/1000] x [Emission $factor_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission $factor_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 4,056.37tCO_2e/yr

Scenario B information (50% partial replacement – 75% solar and 25% kerosene dual use)

75% solar lantern replacement option

Lighting hours /month = 90 hours displaced by Solar Lanterns

Fuel use/month = 2.25 liters

Fuel use/lantern/year = 27 liters or 0.95GJ

Number replaceable kerosene lanterns = 47,429.25

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

25% kerosene lantern complement use option

Lighting hours /month = 30 hours complement use of kerosene lanterns

Fuel use/month = 0.75 liters

Fuel use/lantern/year = 9 liters or 0.31GJ

Number kerosene lanterns = 15,809.75

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

75% solar lantern replacement option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.95GJ) x No. of replaceable kerosene lanterns (47,429.25) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 3,259.29tCO_2e/yr

25% kerosene lantern complement use option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.31GJ) x No. of kerosene lanterns (15,809.75) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 1,086.43tCO2e/yr

Total net baseline emissions (tonnes/yr): *baseline emissions from 75% kerosene lantern replacement option (3,259.29t/yr) - baseline emissions from 25% kerosene lantern complement use option (1,086.43t/yr) = 2,172.86tCO2e/yr*

Scenario C information (15% dual use – 50% solar and 50% kerosene dual use)

50% solar lantern replacement and 50% kerosene lantern complement use options

Lighting hours /month = 60hrs displaced by solar lanterns and 60hrs complement use of kerosene lanterns

Fuel use/month = 1.5 liters for each option

Fuel use/lantern/year = 18 liters or 0.63GJ for each option

Number replaceable kerosene lanterns or kerosene lanterns = 9,485.85

CO_2 emission factor = 71.9 kg/GJ

CH_4 emission factor = 0.007 kg/G

N_20 emission factor = 0.0006 kg/GJ

CH_4 GWP = 21

N_20 GWP = 321

50% solar lantern replacement option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.63GJ) x No. of replaceable kerosene lanterns (9,485.85) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 434.57tCO_2e/yr

50% kerosene lantern complement use option

Scenario B baseline emissions (tonnes/yr) = unit kerosene consumption per year (0.63GJ) x No. of kerosene lanterns (9,485.85) x [Emission factor$_{CO2}$(71.9 kg/GJ)/1000] x [Emission factor$_{CH4}$ (0.007 kg/GJ)/1000 x GWP (21) + CO_2] x [Emission factor$_{N20}$ (0.0006 kg/GJ)/1000 x GWP(321) + CH_4] = 434.57 CO_2e/yr

	Total net baseline emissions (tonnes/yr): *baseline emissions from 50% kerosene lantern replacement option (434.57t/yr) - baseline emissions from 50% kerosene lantern complement use option (434.57t/yr) = 0tCO_2e/yr* *Baseline emissions for phase 2 (tonnes/yr) = Scenario A (4,056.37t/yr) + Scenario B (2,172.86t/yr) + Scenario C (0t/yr) = 6229.23tCO_2e/yr*
Estimating ex-post mitigation effects	To estimate project scenario emissions, the same emissions estimation method is used, but the assumed parameter values in the project scenario are different. The emissions estimation method is based on the assumption that, solar lanterns have zero emissions. Thus, estimated baseline equal avoided emissions Phase 1 avoided emissions = 1,293.19tCO2e/yr in 2013/2014 Phase 2 avoided emissions = 2,462.58 tCO2e/yr in 2014/2015 Phase 3 avoided emissions = 6,229.23 tCO2e/yr by 2018
Projections beyond 2018 (ex-ante projected savings	Projected that beyond 2018, the Solar Lantern market will continue to expand leading to additional penetration of the Solar Lanterns. The expansion of the market will be influenced by the growth in HH population (2.5% pa), which will lead to of 5% penetration p.a. The expected emission savings due to additional penetration of Solar Lantern at 5% annually translate to:

Year	Emission (t)	Cumulative (kt)
2014	1293.19	1.29
2016	2462.58	3.76
2028	10722.48	88.51

Trend of annual savings are provided in the cumulative table below:

Year	Emission (t)	Cumulative (kt)	Comments
2014	1293.19	1.29	
2015	2462.58	3.76	
2016	2650.36	9.99	
2017	2838.15	16.71	
2018	3025.94	23.94	
2019	6229.23	31.67	Project Impacts phase
2020	6728.48	16.71	
2021	7227.73	23.94	
2022	7726.98	31.67	
2023	8226.23	39.89	Projected 15% savings from HH replacement from the markets.
2024	8725.48	48.62	

	2025	9224.73	57.84	
	2026	9723.98	67.57	
	2027	10223.23	77.79	
	2028	10722.48	88.51	
Monitoring Performance over time	Key performance indicators are identified, including the number of homes that have collected Solar Lanterns and are in used Solar Lanterns penetration (share of HH electricity lighting) through survey @ 5 years interval (GLSS) No of Kerosene lanterns retrieve (at time of distribution) No of solar lanterns distributed by HH and districts (at the time distribution) Quantities of kerosene use in targeted communities			
Assessing uncertainty	• If the projected HH size increases beyond 2.6%, the estimated 5% annual growth rate of Solar Lanterns penetration might be more than what has been used. • Projected emissions would not fully be realized in the event that the communities are connected to the national grid. In the event the HH get access to the grid, they are expected to use grid electricity for 100% lightning.			
Methodology	WRI GHG project protocol			
Assumptions	• Distributed solar lanterns target only off-grid (home) rural HH not commercial entities. • The amount of light intensity (lumens) and light available to the user from the solar lamps will determine the number of hours it will be used by the beneficiaries. • A kerosene lamp producing 37 lumens for 4 hours per day will consume about 3 liters of kerosene per month. • Each HH will get one Solar Lamp. Replacement will depend on the scenarios described above.			
Non-GHG Effects	• Reduction in burden of subsidy on government in the medium to long term (avoided GH¢74 million subsidy on kerosene annually). Equivalent of cost of over 822,000 solar lanterns within one year. • Removing the subsidies on kerosene and redirecting it to the social interventions will bring great benefits to the people for whom the subsidy was meant. • Switching to cleaner off-grid lighting solutions at minimal cost to the consumer. Market price of solar is Gh Cedis 90 whereas government is distributed solar lanterns at 30 Ghana cedis. • Ensuring better illumination and total elimination of smoke exposure to women and children. • Solar lanterns had minimal battery replacement, which is safe for human health and the environment. • Solar lanterns are cost effective and environmentally friendly (reduction in local air pollution).			

Funding	Cost	Estimated Amount ($) – 2 million
	Sources	Government of Ghana - 100% Mechanism – Direct Cash investment
		Private sector – market participation
		Donor - 0%Donor Channel - Not Applicable
Technology Transfer	Open Market	

Annex 3.3 Demand side energy efficiency mitigation actions

Lighting		
General information	Name of action	Households (HH) CFL light exchange programme
	Sector	Energy
	Scale	National (HH)
	Gas	CO_2
	Status	Completed
	Start Year	2007
	End Year	2007
Implementation information	Implementing entities	Energy Commission - distribution of CFL bulb to households. Conducted post distribution survey to evaluate the overall the impacts of the action.
		Energy Foundation – distribution, installation CFL bulbs and collection of incandescent bulbs from households. Led in the awareness creation programmes that accompanied the action.
		Ministry of Power – provided short-term policy measure to address generation shortfalls, importation of CFLs.
Target	Free distribution of 6 million CFL bulbs in exchange for incandescent bulbs in HH during 2007 power crises.	
Project objective	Improve energy efficiency of lighting by using energy-efficient light bulbs and reduce peak demand for electricity.	
Objectives	The objectives are: (1) to understand what effect has occurred after implementation of the project; and (2) to track and report it effectiveness after project implementation.	
Defining project assessment boundary	Project activity 1 - Primary effect - reduction in combustion emissions from generating grid-connected electricity. Significant secondary effect – potential mercury emissions from disposal of CFL bulbs, increases in off-pocket incomes in HH through saving electricity cost.	
Identifying effects and mapping the causal chain	The 6m CFL replacement programme aims at changing inefficient incandescent bulbs in households with efficient CFL bulbs, which is expected to reduce electricity consumption, thereby reduce GHG emissions from power generation. The energy savings is likely to result in consumers having more disposable income. The additional disposal incomes available to the household are likely to be used in consumption of more goods and	

	services, thereby increasing/decreasing emissions. The extent of the emissions will depend on how the additional income is put use. With the reduction in peak demand of electricity, there are possible savings to government expenditure on electricity generation at peak hours. The disposal of CFL is a potential source of mercury emissions. The expectations are that 6million incandescent bulbs will be replaced and collected.
Defining the GHG assessment boundary	The reduction in CO_2 emissions from lower electricity use for lighting in HH is expected to be significant and thus included in the GHG assessment boundary. The likely increases/decreases in emissions from the potential additional consumption of goods and services are difficult to assess because there was no evidence on how the additional income will be put to use. It is largely influenced by the income situations and needs of the affected households. Hence, it is excluded from the boundary. The likely savings to government may result in expenditures that are likely to increase or decrease emissions. Because of lack of data on how government used the savings, this activity was excluded from the boundary. The likely mercury emissions from the improper disposal of CFL were excluded from the boundary because of lack of data.
Estimating baseline emissions	Baseline data *CFL Distribution information* Total CFL bulbs distributed in 2007 = 6million Number of CFL distributed per HH = 4 No of HH targeted = 1,500,000 No of incandescent light replaced = 4 per each HH (6million) *Information on lightning hours and potential electricity savings* Average power rating of incandescent lights = 40 watts Average power ratings CFL bulbs (average of the dominant CFL distributed – 20, 15 and 9 watts) = 15 watts Average interior lighting hours per day = 6 hours Average exteriors lighting hours per day = 8 hours Average lighting hours per day = 7 hours Ideal lighting hours per year = 365 days x exterior and interior lighting hours per day (14 hour) = 5,110hours Actual lighting hours per year = ideal lighting hours (5,110) – light outs hours (255.5) = 4854.5hours

	Total electricity consumption of incandescent lights per day = power rating (40watts) x average daily lighting hours (7 hours) = 0.28kWh/day Total electricity consumption of CFL bulbs per day = power rating (15watts) x average daily lighting hours (7 hours) = 0.105kWh/day
	The baseline scenario is assumed to be the continuation of historical trends of HH electricity use for lightning, which contribute to high demand in peak period. The trend is dependent on projected changes in household income/size and current rates of increases in grid-connected electrification, absent the project. *Baseline emissions for household (t CO2e/year) = lightning hours x average power rate of incandescent bulbs (kWh/year) x No of incandescent bulbs (4 per HH) x baseline emission factor (t CO_2e/kWh)*. The estimated values of the parameters in this equation are assumed to be: Number of incandescent bulbs (6,000,000, 4/HH) Average power ratings of incandescent bulbs (40 watts) Average interior and exterior lightning hours (202.27 days) Baseline grid emission factor (0.57t CO_2e/MWh) No of HH (1,500,000) Baseline emissions in a given year are calculated as = 0.28kWHh/day x 202.27 days x 6million x 0.57 tCO2e/MWh = 193, 694.55 tCO_2e in 2007
Estimating GHG effects ex-post	To estimate project scenario emissions, the same emissions estimation method is used, but the assumed parameter values in the project scenario are different. The emissions estimation method is: *Project scenario emissions for household electricity use for lighting (t CO2e) = lightning hours x difference in power rate of CFL bulbs (kWh/year) x No of CFL bulbs (4 per HH) x baseline emission factor (tCO_2e/kWh)*.

Project scenario electricity use for lightning hours is estimated to be 202.27 days, power rating of CFL bulbs is 15 watts, electricity use for CFL lightning is 0.105kWH/day, savings in electricity use is 0.175kwh/day. The project scenario emission factor is assumed to be the same as in the baseline scenario (0.57 tCO_2e/MWh), since the policy does not affect the emissions intensity of electricity generation. Based on the assumption that 100 percent of 1.5 million households replaced CFL as a result of the project and has reduced household electricity use for lightning 37.5 percent. So the policy has led to a 40 percent reduction in electricity use for lightning.

Project scenario savings in year the project was implemented in 2007 are calculated as lightning hours (202.75) x difference in electricity savings (0.175KWh/day) x 6million CFL bulbs x 0.57 tCO2e/MWh =121,3kt in 2007

The distribution of 6million bulbs led to a penetration of 70% leaving 30% of the market to the private sector to provide. The 30% of the CFL market was assumed to grow at 15% p.a in the first seven year. This translates to additional 900,00CFL bulb penetration each year from the private market. With a potential 35.39KWh electricity savings per year. Total CFL bulbs doubled from 6 million in 2007 at the point of introduction to 12,300,000 bulbs in 2014. Similarly, in the same period, the grid emission factor changed from 0.57 tCO_2e/MWh in 2007 to 0.43 in 2011, 0.48 in 2012 and 0.7 in 2014.

With the same calculations above, the emission savings due to the continuous expansion of the CFL market is provided in the table below:

Year	CFL penetration (No. of bulbs)	MWh/year	GEF** (tCO_2/MWh)	Emissions (kt)	Cumulative CO_2 savings (kt)
2007	6,000,000	212,384.38	0.57	121.1	121.1
2008	6,900,000	244,242.03	0.57	139.2	260.3
2009	7,800,000	276,099.69	0.57	157.4	296.6
2010	8,700,000	307,957.34	0.57	175.5	332.9
2011	9,600,000	339,815.00	0.43	146.1	321.7
2012	10,500,000	371,672.66	0.48	178.4	324.5
2013	11,400,000	403,530.31	0.7	282.5	460.9
2014	12,300,000	435,387.97	0.7	304.8	587.2

***GEF = Grid emission factor calculated every year from the electricity generation mix.*

Projections beyond 2014 (ex-ante projected savings	Projected that beyond 2014, the CFL market will continue to expand leading to additional penetration of the CFL lights. The expansion of the market will be influenced the growth HH population of 2.6% p.a. The projected emission reduction due to additional penetration of CFL bulbs at 2.6% p.a translated to the emission reductions due to electricity savings provided in the table below. The grid emission factor is projected to decrease from 0.7tCO2/MWh to 0.6 tCO_2/MWh due to the availability of the indigenous natural gas from Atuabo Gas Processing Plant for thermal electricity generation.

Year	CFL penetration (No. of bulbs)	MWh/year	GEF (tCO_2/MWh)	Emissions (kt)	Cumulative CO_2 savings (kt)
2015	12,619,800	446,708.06	0.6	268.0	855.3
2016	12,947,915	458,322.47	0.6	275.0	1130.3
2017	13,284,561	470,238.85	0.6	282.1	1412.4
2018	13,629,959	482,465.06	0.6	289.5	1701.9
2019	13,984,338	495,009.15	0.6	297.0	1998.9
2020	14,347,931	507,879.39	0.6	304.7	2,303.6

Monitoring Performance over time	Key performance indicators are identified, including the number of homes that have collected CFL and installed CFL. CFL penetration (share HH electricity lighting) through survey @ 5 years interval (GLSS) No of incandescent bulbs retrieve (at time of distribution) Electricity Peak demand (MW) (at the time distribution) Import of CFL versus incandescent (quantity of imports – after distribution) No of CFL produced locally (units) No of tested CFL in market meeting the efficiency standards (random)
Assessing uncertainty	Qualitative (a) not all the CFL bulbs will meet the required energy efficiency standards. Thus 15W consumption of CFL might be more or less. Grid Emission Factors (GEF) beyond 2014 is projected based on expected development in the electricity sector. The projected reduction in GEF might be more or less. The assumption that additional natural gas will be available for grid electricity will depend on the time technical installation of gas processing plant become operational. Ante-GEF for 2007-2014 (ex-ante), beyond 2014, actual GEF will depend on the predominant fuels used for thermal power generation. If the projected HH size increase beyond 2.6%, the estimated growth rate of CFL penetration might be more than what has been used.
Methodology	WRI GHG project protocol

Assumptions	• CFL power rating of 15W remains constant for its lifespan, which is estimated as 6000hours. The CFL reaches its life span; consumers are likely to replace with CFL of the same specifications. • The ban on the importation of incandescent bulbs in 2009 will eradicate incandescent bulbs from the market • Standard and labeling regulation will ensure that high quality CFL bulbs in the local market and provide options for consumers in the market. • Public awareness on efficient lighting help consumers make informed market choice (preference higher star rated efficient light) in the purchase of CFL bulbs. • Each year, the potential electricity saving will depend on the number CFL in use which represents the number of incandescent that would have been used without this action. • Distribution of the 6million CFL bulbs will boost local CFL market to 70%. The remaining 30% of the market share was left for the private to provide. • HH using incandescent bulbs trade and replace with CFLs at the point of distribution. • HH identified for the distribution of the CFL is representative nationwide covered 138 districts with the exception of Bunkprugu-Yunyoo, which had not been connected to the national grid and therefore had no grid electricity. • HH can afford the cost of buying new CFLs available provided it is available in the local market. • CFL can last the desired lightning hours for HH (exterior and interior) and the incentive to revert to use incandescent bulbs is minimal. • Power ratings of CFLs are tested/quoted on the label
Non-GHG Effects	• After household survey conducted by the energy commission, • Reduction in electricity demands in peak hours (124 MW of peak hour electricity saving from the monitoring from Volta River Authority. This translated to USD 3.6million (source: CFL exchange programme impact assessment report, 2008. Energy Commission). • Delayed investment in power generation expansion - Given the cost of generating 1kW of thermal electricity at peak periods from TICO to be US$ 850/kW the peak savings of 124 MW resulted in a delay in investment of about US$ 105 million. • Net income savings for households - 25 districts recorded a mean electricity savings of 270 kWh which translates to GH¢31.00 for the period January to June 2008. In addition, 64 districts remained on the same level of their electricity consumption whilst only 49 districts exceeded their electricity consumption by 151 kWh for the

	same period. This resulted in an additional payment of about GH¢18.00 per household. • Technology transfer due to greater penetration CFLs and introduction LED in the local light markets. The overall lighting market value is estimated at USD 30-50million. • Job creation through establishment of two local factories to produce CFLs in Ghana. • Reduction in cost of electricity bill for HHs (40% reduction of electricity cost for lighting)	
Funding	Cost	Estimated Amount ($) – 15 million
	Sources	Government of Ghana - 100% Mechanism – Direct Cash investment
		Private sector –value of 30% CFL market share at time of the distribution
		Donor - 0% Donor Channel - NA
Tech Transfer	Open Market	
Capacity Building	Indigenous (Ghanaian) private firms installation and training of local electricians	

Energy Efficiency - Household		
General information	Name of action	Promoting appliance Energy and Transformation of Refrigeration Appliance Market
	Sector	Energy
	Scale	National (HH)
	Gas	CO_2 and CFC (R12)
	Status	On-going
	Start Year	2011
	End Year	2014
Implementation information	Implementing entities	Energy Commission - Project Implement Entity
		Retail Outlets - Cool World Electrical Retail Stores, Rowi Limited, Somovision, Melcom Ghana Limited and Appliance Masters
		Testing Centre – Ghana Standard Authority
		Recycling Centres – Used fridges dismantling centres (City Waste Management Company and Presank Ltd)
		UNDP/GEF – GEF Implementing Entity
		Participating Bank – Eco-bank Ghana Limited
Objective of Action	The primary objective of the project is to improve the energy efficiency of appliances marketed and used in Ghana through the introduction of a combination of regulatory tools such as Minimum Energy Performance Standards and Information Labels (S&L), and innovative economic tools (rebate scheme).	
Target for innovative economic incentive tool (rebate scheme)	Replacement of 15,000 old and inefficient refrigerators with energy efficient ones by year 3 of project implementation under the rebate scheme	
Objectives assessment	The objectives are: (1) to understand what effect has occurred during implementation of the project; and (2) to track and report it effectiveness after project implementation.	
Defining project assessment boundary	Project activity 1 - strengthen structures and mechanisms for implementation of appliance energy efficiency standards and labels (S&L). *Primary effect*: create enabling regulatory and institutional framework to ensure availability of standards efficient fridges in the market. Contribute indirectly to electricity and CO_2 savings. Project activity 2: Increase consumers and retailer's awareness and improved	

	marketing of appliance energy efficiency standards and labels. *Primary effect*: Number of targeted 15 000 households become aware of rebate scheme and S & L for efficient appliance. The awareness will increase sales of efficient fridges, thereby increasing electricity saving and reduce emissions Project activity 3: Establish refrigerating appliance test facilities. *Primary effect*: verification and enforcement of standards power ratings of efficient fridges to ensure transparency. Ensure that projected 70.2% electricity saving new efficient fridges is achieved. Project activity 4: Establish used appliance and ODS collection and disposal facilities *Primary effect:* avoided ODS emissions from dismantling of used fridges through collection of ODS for destruction. Project activity 5 - Conduct of refrigeration appliance rebate and exchange Program throughout Ghana that distribute at least 15,000 efficient appliances *Primary effect* – reduction in combustion emissions from generating grid-connected electricity *Significant secondary effect* – saving in electricity cost will increase disposable income. The use of the disposal incomes might result in increases/decreases in emissions.
Identify effects and mapping the causal chain	Replacing used fridges with efficient ones is expected to reduce electricity consumption, thereby reduce GHG emissions from thermal power generation. The energy savings is also expected to result in consumers having more disposable income, leading to the consumption of more goods and services, thereby increasing/decreasing emissions depending on how the additional income is put use. Replacement of inefficient fridges which contains ODS refrigerant with new fridges will lead to additional emission reduction.
Define the GHG assessment boundary	The reduction in CO_2 emissions from reduced electricity use for refrigeration is expected to be significant, so they are included in the GHG assessment boundary. The likely increases/decreases in emissions from the potential additional consumption of goods and services are expected to be insignificant based on the fact it is difficult to assess how the additional income will be put to use. It is largely influenced by the income situations and needs of the affected households. Hence, it is excluded from the boundary. Reduction in emission from avoided ODS emission expected to be significant based on initial estimates, so it is included from the boundary.
Estimate baseline emissions	Baseline for Households (ex-ante) The baseline scenario is assumed to be the continuation of historical HH energy electricity trends for refrigeration, dependent on projected changes in household income/size, current rates of increases in grid connected electrification, current of rate

	of household with fridges and the absent the project. In addition, there are large estimate 2,000,000 refrigeration appliances with poor energy efficiency and ozone depleting substances as at 2011. To estimate baseline emissions for the 2,000, 000 households: Baseline emissions for household (t CO_2e/year) = electricity use for refrigeration (kWh/year) x (1 + % change in pop.) x baseline emission factor (t CO_2e/MWh) x No of electrified HH (70% of total HH out of which 70% use fridge& - HH using efficient fridges already). The estimated values of the parameters in this equation are assumed to be: Average annual historical electricity use (1.140 MWh/year) Baseline grid emission factor (0.44t CO_2/MWh) No of HH (70% x 5.5million) – 3.85million HH. 70% HH use fridges – 2.695million HH 25.8% of 2.695million HH use efficient fridges already 2million HH use inefficient fridges % Pop change (2.6%) Baseline emissions in a given year are calculated as = 1.14 MWh/year x 1.026 x 0.44 tCO_2e/MWh x 2milllion HH = 1.03 MtCO_2/year. Baseline emissions in a given year are calculated as = No. of used refrigerators x average ODS/refrigerator x GWP The estimated values of the parameters in this equation are assumed to be: No. of refrigerators = 2million Average ODS in used refrigerator = 0.4kg GWP = 8,100 Baseline emissions in a given year are calculated as = 2 million x 0.4kg x 8,100 = 6,480 Mt CO_2e/year B. Project baseline 1. Primary effects through electricity savings Baseline emissions at the end of the project in 2014 is calculated as = 1.14 MWh/year x 1.026 x 0.48 tCO_2e/MWh x 15,000 = 8.21 ktCO_2 2. Secondary effects through avoided ODS emissions Baseline emissions at the end of the project in 2014 calculated as = 15,000 x 0.4kg x 8,100 = 48.6 kt CO_2e

Estimating GHG effects ex-ante	To estimate project scenario emissions, the same emissions estimation method is used, but the assumed parameter values in the project scenario are different. The emissions estimation method is: Project emissions scenario for household (t CO_2) = electricity use for refrigeration (kWh/year) x baseline emission factor (t CO_2e/kWh) x No of electrified HH (70% of total HH out of which 70% use fridge-55,000 HH). Project scenario electricity use for efficient is estimated to be 500 KWh/year, based on the assumption that 55,000 electrified HH will replace their old fridge as a result of the project and to reduce household electricity use for refrigeration 43.9 percent. The project scenario emission factor was assumed to be the same as in the baseline scenario (0.48 tCO_2e/MWh), since the project does not affect the emissions intensity of electricity generation. Project scenario emissions at the end of the project in 2014 is calculated as = 0.5 MWh/year x 55,000 0.48 t CO_2e/MWh = 3.6 ktCO_2/year. (primary effect) The GHG effect of the project was estimated ex-ante to be a reduction of 4.61kt CO_2 (reduced emissions) at the end of 2014. Avoided ODs emissions Project scenario at the end of the project is calculated as = 0 ktCO_2e (secondary effect) The GHG effect of the project due avoided ODS emission was estimated ex-ante to be a reduction of 48.6 ktCO_2e/year (reduced emissions) at the end of 2014. total estimated ex-ante GHG effect of the project = (primary effect +secondary effects) = 4.61 ktCO_2 + 48.6 ktCO_2e = 53.21 ktCO_2e
Monitoring Performance over time	Key performance indicators are identified, including the number of homes that have bought new refrigerators. Number new fridges sold at retail centres under rebate scheme. Quantity of ODS recovered. Amount payments of rebate per new fridge. Total amount expenditure on turn in appliance. Number of inefficient fridge collected (no) at recycling centres HH demand/consumption before/after (KWh) , Import of new fridges versus used ones (quantity of imports) Monitoring reveals that only 33.3 percent (5000) of household have bought new fridge under the rebate scheme and turn in 5000 old fridges and are in use.

Estimating GHG effects ex-post	The parameters in the project baseline calculation are updated with actual data on fridges exchanged (5000) under the rebate and amount of ODS recovered and changes in baseline/project grid emission factors (0.58tCO_2/MWh). Ex-post project baseline (as at 2014) Primary effects through electricity savings at the end of the project is calculated as = 1.14 MWh/year x 1.026 x 0.58 tCO_2/MWh x 5,000 = 3.3 $ktCO_2$ Secondary effects from avoided ODS emissions at the end of the project is calculated as = 5,000 x 0.4kg x 8,100 = 16.2 kt CO_2e Ex-post project scenario (as at 2014) Primary effects through electricity savings is calculated as = 0.5 MWH/year x 1.026 x 0.58 tCO_2/MWh x 5,000 = 1.44 $ktCO_2$ Secondary effects from avoided ODS emissions Is calculated as = 5,000 x 0kg x 8,100 = 0 kt CO_2e Actual total estimated ex-post GHG effect of the project = (primary effect +secondary effects) = 1.85 $ktCO_2$ + 16.2 $ktCO_2e$ = 18.04 $ktCO_2e$ Post-project saving (capitalization period of 10 years) 10 years after the project, additional 10,000 new fridges will be sold without the rebate and grid emission factor would change from 0.58tCO_2/MWh to 0.61 tCO_2/MWh because of the projected pattern of investment in electricity generation capacity Projected ex-ante post project emission savings by 2025 = (primary effect +secondary effects) = 2.84 $ktCO_2$ + 36.24 $ktCO_2e$ = 40.08 $ktCO_2e$ Overall GHG effect = (actual primary + secondary effect by 2014 + projected primary + secondary effect in capitalization period by 2025) = (18.04 $ktCO_2e$ +40.08$ktCO_2e$ = 58.12$ktCO_2e$)
Assessing uncertainty	Uncertainty is assessed in qualitative terms was carried out to identify possible variations in the factors that can affect the actual and projected savings due to the project. Not all new fridges will meet all the required energy efficiency standards when throughout the refrigerating hours. Thus the estimated 0.5MWh/year consumption might be more or less, GEF beyond 2014 might change due to projected changes in the generation mix. Ex-ante grid emission factor is likely to increase depending on the predominant fuels used for thermal power generation. It is also possible that not, all 0.4kg ODS in the used fridges will be recovered. In case the recovering yield reduces, emission will increase and vice versa.
Methodology	WRI GHG project protocol

Assumptions		• Average consumption of an old and inefficient refrigerator is 1,140KWh/yr • Each target household has one refrigerator, which will be replaced by the exchanged one. • When old refrigerators are turned in, the new ones would be used by the affected households • The new refrigerators will have HFC refrigerants, however it is only during decommissioning stage that the refrigerant will be salvaged hence project emission scenario for HFC is assumed to be zero. • The load shedding exercise can vary the projected impacts of the project on targeted households since electricity consumption hours might reduce. • After the project lifespan, the average of 1000 refrigerators would be purchased each year for the next 10years amounting to 10,000 in the tenth year in the capitalization period. • Coal fired plants are anticipated in the country after 2020 and hence with the recurrent trend of investment in the electricity generation capacity, grid emission factor up 2025 is assumed to be 0.61 tCO_2/MWh • By the 10th year, the ban on the importation and sales of used refrigerators would be fully enforced • By the 10th year households will be more informed on standards and labels of refrigerators.
Non-GHG Effects		• Reduction in electricity household demands and expenditure (640KWh/year*electricity price @ 34 GhC/year = GhC 21,760 for 5,000HH/year • Recycling, retailing centres and assembling plants established – (100 direct jobs created), • Technology transfer (refrigerator test facility, Dismantling facility, and efficient refrigerators) • Refrigeration market transformation (appliance labeling and import ban of used appliances) • E-waste management (ferrous and plastic materials recovered • Phasing out of CFC • Health benefits (scavengers)
Funding	Cost	Estimated Amount ($) – 6.1 million
	Sources	GoG - 4.4million (72%) Financing type – Direct Cash investment and in-kind Funding of rebate scheme – Electricity Demand Management Fund (EDMF)

		Private sector – 0%
		Donor - 28% Donor Channel - Multilateral fund (GEF)
Tech Transfer		Open Market
Capacity Building		Indigenous (Ghanaian) private firms installation and training of local electricians

Energy Efficiency - Commercial /Industry		
General information	Name of action	Installation of capacitors in commercial/industry buildings
	Sector	Energy
	Scale	National (Commercial/Industry)
	Gas	CO_2
	Status	On-going
	Start Year	2012
	End Year	2020
Implementation information	Implementing entities	Energy Commission - facilitate distribution and installation of capacitors
		Electricity company of Ghana -
		Installation companies – electrical installation of capacitors
Objective of Action	The primary objective of the project is to improve the energy efficiency in commercial and industry buildings with the installation of capacitor banks that increase the power factor and ensure efficiency in electricity consumption by cutting down electricity losses.	
Target	Install 27 capacitors in commercial public building and upscale to cover 1,047 commercial and industry electricity consumers with factor less than 0.9	
Objectives assessment	The objectives are: (1) to understand what effect has occurred after the installation of capacitors in 27 commercial public buildings; and (2) project the expected of impacts (GHG, energy and cost savings) of the installation of capacitors in 1200 commercial and industrial buildings.	
Defining project assessment boundary	*Primary effect* – reduction in combustion emissions from generating grid-connected electricity *Significant secondary effect* – saving in electricity cost will increase disposable income. The use of the disposal incomes might result in increases/decreases in emissions.	
Identify effects and mapping the causal chain	Installation of capacitors in commercial and public buildings is expected to reduce electricity demand, thereby reduce GHG emissions from avoided electricity generation. The energy savings is also expected to result in consumers having more disposable income, leading to the consumption of more goods and services, thereby increasing/decreasing emissions depending on how the additional income is put use.	
Define the GHG assessment	The reduction in CO_2 emissions from decreased electricity demand is expected to be significant, so they are included in the GHG assessment boundary. The likely increases/decreases in emissions from the potential additional consumption of goods	

boundary	and services are expected to be insignificant based on the fact it is difficult to assess how the additional income will be put to use. It is largely influenced by the income situations and needs of the affected commercial or industrial entity. Hence, it is excluded from the boundary.
Ex-post emission savings	Ex-post emission savings from the installation of capacitor in 27 public buildings The baseline scenario is assumed to be the continuation of historical high maximum demand of electricity, low power factor with associated power factor surcharge. In the ex-post emission saving situation, capacitors are installed in 27 selected public buildings which is expected have lower maximum demand, high power factor and no power factor surcharge. To estimate ex-post emissions savings for the 27 public buildings: Ex-post emissions saving (t CO_2/year) = average old maximum demand in 27 public building (358kVA) – new maximum demand (299kVA) in 27 public building x conversion factor from KVA to kWh (720) x new power factor (0.98) x Grid emission factors (0.54tCO_2/MwH) = 585t/yr The economic life of each installed capacitor is averagely estimated at 10 years. By the tenth year, a total of 5.9kt emission saving has been projected from the installation of capacitors in 27 public buildings.
Estimating ex-ante GHG effects	To estimate the expected emission savings from scaling up of the installation of capacitors from 27 public buildings to 1,047 commercial/industrial facilities. To estimate ex-ante savings emissions, the same emissions estimation method is used. The emissions estimation method is: To estimate ex-ante emissions savings for the 1,1047 commercial/industrial buildings: Ex-post emissions saving (t CO_2/year) = average old maximum demand in 1,047 public building (468.9kVA) –average new maximum demand (3932.7kVA) in 1047 public building x conversion factor from KVA to kWh (720) x new power factor (0.98) x Grid emission factors (0.54tCO_2/MwH) = 39,377.81t/yr The economic life of each installed capacitor is averagely estimated at 10 years. By the tenth year, a total of 393.78kt emission saving has been projected from the installation of capacitors in 1047 public buildings.
Monitoring Performance over time	Key performance indicators identified are, • The number of commercial and industrial entities installed capacitors. • Changes in maximum demand on electricity bills on monthly basis • Expenditure on monthly electricity bill (maximum demand charge and power factor surcharge).

Assessing uncertainty		Uncertainty is assessed in qualitative terms was carried out to identify possible variations in the factors that can affect the actual and projected savings due to the project. • Not all 1,047 commercial/industrial buildings are likely to install capacitors at the same time. They will do so on condition that the payback period of the installation of the capacitors is favorable. • Possible variations in the projected 10 economic life of capacitors. • Projected grid emission factor of 0.7tCO2/Mwh from 2015 might change depending on the actual electricity generation mix on the public grid.
Methodology		WRI GHG project protocol
Assumptions		• Installed capacitor will reduce loss of reactive power which will lead to decrease in maximum demand in public buildings • Capacitors will correct power factor to a minimum of 0.98 on the scale of perfect 0-1 • The reduction in maximum demand after installation of capacitors will cut cost.
Non-GHG Effects		Reduction in electricity demands and expenditure. With an average monthly maximum demand savings of GhC. 34 and GhC. 860 avoided power factor surcharge, the total cost of installation of the capacitor will take at average of 12 months to pay back.
Funding	Cost	Estimated Amount ($) – 5.9 million
	Sources	Government of Ghana - 0% Financing type – private investment
		Private sector – 100%
		Donor - 0 Donor Channel -
Technology Transfer		Open Market
Capacity Building		Indigenous (Ghanaian) private firms installation and training of local electricians

Annex 3.4 Supply side energy efficiency mitigation actions

Electricity Supply – Fuel Switch in thermal plants		
General information	Name of action	Natural Gas Fuel Replacement Programme
	Sector	Energy
	Scale	National (Electricity generation)
	Gas	CO_2
	Status	On-going
	Start Year	2010
	End Year	2013
Implementation information	Implementing entities	Ministry of Power – Sets target in the national energy policy for generating electricity from 50% NG-fired thermal plants by 2020.
		Volta River Authority (VRA) – VRA's Aboadze Thermal Power Plant in Ghana is West Africa Gas Pipeline Company (WAPCo)'s foundation customer for the supply of natural gas to the electric power utilities.
		Independent Power Producer (IPPs) – TAPCO, TICO, Sunon Asogli, TT1PP, TT2PP
		West Africa Gas Pipeline Company (WAPCo) – owns and operates the West Africa Gas Pipeline. N-Gas Limited transports natural gas through WAGP (620km) which primarily comes from the Niger Delta and consist of associated and non-associated gas from various gas fields in the Delta region.
Target	The primary objective of the WAGP project is to transport Nigerian-produced natural gas to commercially viable markets in Ghana thereby: providing a reliable source of energy for electrical power generation; providing a commercially viable market for Nigerian natural gas produced at oil wells, reducing the need to flare this gas; and facilitating regional cooperation and integration of reliable energy services through a large-scale joint venture partnership among four nations in the region.	
Project objective	Fuel switch from light crude oil (LCO) to natural gas at a grid-connected stationary combustion thermal plant resulting in reduction in combustion emissions from generating electricity.	
Objectives	The objectives are: (1) to understand what effect has occurred after implementation of the project; and (2) to track and report it effectiveness after project implementation.	
Defining project assessment boundary	**Project activity 1 -** **Primary effect** - reduction in combustion emissions from generating grid-connected electricity. **Significant secondary effect –** avoidance of, or reduction in flaring of associated gas in Niger	

	Delta oil fields.
Identifying effects and mapping the causal chain	The fuel replacement programme aims at generating electric power from thermal plant using relatively cleaner and cheaper fuel, which is expected to reduce GHG emissions. Electric power generation from relatively cleaner, relatively low-priced source of fuel is expected to result in financial savings to the country. Depending on demand scenarios, savings are estimated to be between US$67 million and US$610 million. Additional financial savings to the state could be used to invest in expansion of electricity generation capacity, thereby increasing or decreasing emissions. The extent of the emissions will depend on how the additional financial is put use. Supply of natural gas from Nigeria to the electric power plant in Ghana could contribute to reducing emission from gas flaring. Possible leakage from the network of gas distribution pipeline could be source of emissions.
Defining the GHG assessment boundary	The reduction in CO_2 emissions from the NG fuel replacement of LCO in electric power plants expected to be significant and thus included in the GHG assessment boundary. The levels of emission reduction depend on the total quantities of NG supplied to the thermal plants that have the capacity to produce electricity from natural gas. The quantities of LCO displaced by NG will also determine the amount of CO_2 emission savings. The likely increases/decreases in emissions from the use of additional financial savings accrued to the country in capital investments in the energy and non-energy sectors are difficult to assess because there is no evidence on how the state intends to use the income. How the income is used is largely influenced by the policy choices made by the government. Hence, it is excluded from the boundary. There is no data on the amounts of avoided gas flaring at the Niger Delta oil fields due to supply of gas through the West Africa Gas Pipeline. Even in the case where data exists; the level of uncertainties associated with using such data may be high. Hence, it is excluded from the boundary. The possible methane emissions from gas distribution network are excluded from the boundary because of lack of data.
Estimating baseline emissions	**Baseline data on *Thermal Electricity generation sources*** Thermal plants Electricity Generated (GWh) LCO Fraction (GWh) NG Fraction (GWh) 2010 2011 20122010 2011 20122010 2011 2012 TAPCO 1,160 1137 1061 317 290.4 933.2 917 846.1 127.8 TICO 657 1168 484.3 584.6 1,085.4 72.4 82.6 TT1PP 750 559 622 168.9 434 265.7 390.1 188 TT2PP 50 141 50 141 Sunon-Asogli 138 1224 848 1224

848

Total 2,122 3,627 3,840

The heat rates of LCO or NG fuels for each thermal plant were used to generate quantities of LCO or NG input in KJ/KWh.

Thermal Plants	Quantities of input LCO (GJ) 2012	2011	2010
TAPCO	9,210,813.7	2,400,225.5	317.00
TICO	14,946,038.6	7,394,324.0	484.30
TT1PP	5,885,384.8	2,290,714.2	
TT2PP			
Suno-Asogli			

Thermal Plants	Quantities of input NG (GJ) 2012	2011	2010
TAPCO	4,234,529.52	12,905,229.65	11,800,466.28
TICO	470,596.32	1,308,550.20	
TT1PP	1,859,357.88	5,846,395.61	860,680.31
TT2PP	1,568,793.96	374,202.32	
Suno-Asogli	8,345,129.76	12,282,837.71	1,469,425.39

NB: heat rate for each fuel type per thermal plant is the ratio of fraction electricity produced and the input quantities of fuel for at typical year.

IPCC default Emission factors

Fuel type		**Emission factor**
LCO	CO_2	0.0745 (t/GJ)
NG	CO_2	0.0578(t/GJ)
Based on previous calculated data from TAPCO. The following implied emission factors were used LCO = 0.615 kt/GWh and NG = 0.439 kt/GWh		

The baseline scenario is assumed to be the continuation of historical trends where all the quantities thermal electricity is produced from relatively expensive and less clean LCO fuel. The trend is dependent on projected changes on the availability (reliable supply) of

alternative fuel and favorable crude oil price, absent the fuel replacement programme.

*Baseline emissions for LCO (kt CO_2e/year) = input LCO fuel (GJ) * emission factor(kt/GWh) *GWP*

Input LCO Fuel =heat rate x quantity electricity generated from LCO =.

Baseline emissions in a given year are calculated as

	CO_2 emissions from LCO (kt)		
Plants	**2010**	**2011**	**2012**
TAPCO	563.6140	520.0118	78.5410
TICO	163.3034	44.5253	50.7644
TT1PP	109.4722	239.7492	115.5427
TT2PP*			116.8752
Suno-Asogli*			621.7122
* LCO CO_2 *equivalent emissions if absence of NG*			

Estimating GHG effects ex-post

To estimate project scenario emissions, the same emissions estimation method is used, but the assumed parameter values in the project scenario are different. The emissions estimation method is:

*Project emissions for LCO (kt CO_2e/year) = heat rate x quantity electricity generated from LCO = input NG fuel (GJ) * emission factor (kt/GWh)$_{LCO}$- * emission factor(kt/GWh)$_{NG}$ *GWP.*

Project scenario with the reliable availability of NG, the plants with the technology capability to produce electricity (dueled-fuel plant) from NG which displace the use of LCO. In addition, plants with single fuel technology capability will either be in operation or close down depending on availability of gas in the market.

CO_2 emissions from NG (kt)			
Plants	**2010**	**2011**	**2012**
TAPCO	402.87	371.71	56.14
TICO	116.73	31.83	36.29
TT1PP	84.93	171.37	82.59
TT2PP			90.68
Sunon-Asogli			482.35

Emission savings are calculated from the difference between the emissions from electricity generated from LCO and NG for each thermal plant and aggregate for each year. The projected saving a based on 50% policy target by 2020.

Emission savings (kt)

Plants	2010	2011	2012
TAPCO	160.74	148.31	22.40
TICO	46.57	12.70	14.48
TT1PP	24.54	68.38	32.95
TT2PP			26.20
Sunon-Asogli			139.36
Total	**231.85**	**229.38**	**235.39**
Cumulative total			**696.63**

Projections beyond 2012 (ex-ante projected savings	Projected that beyond 2012, the policy target is that 50% of thermal electric power will generated from NG fuel by 2020. With reliable supply of natural gas from WAGPCo and with the coming to indigenous gas from Atuabo (in Ghana) the possibility of attaining 50% target is high. This is also in addition to the expectation that by 2015 a number of thermal plants that have been licensed by the Energy Commission will come on line. This is expected to translate to 25% additional emissions savings by 2020 if bearing all condition precedent. This projection was based on the strategic energy planning data obtained from the LEAP.
Monitoring Performance over time	Key performance indicators identified are: • Total quantities of NG gas delivered from West Africa Gas Pipeline to onshore Ghana • Thermal plant efficiency monitoring • Total Quantities of indigenous gas distributed from Atuobo by Ghana Gas Company • Quantities of electricity generated and delivered to the grid from dueled fuel and single fuel thermal plants. • Fraction of total national electricity generated from thermal plants and fractions from LCO and NG
Assessing uncertainty	• Heat rates may vary depending on the type technology and efficiency of the thermal plant. • Default emission factor of fuel is conservative. It may be higher or lower than the actual emission factor from the plant.
Methodology	WRI GHG project protocol
Assumptions	• IPPs that operate dueled fuel thermal plant will replace LCO with NG once gas delivered in the market because of the competitive price. • NG Single fuel IPPs will shut down in the event NG is supply to the market stops.
Non-GHG Effects	• **Financial saving to Government of Ghana** - Depending on demand scenarios, savings are estimated to be between US$67 million and US$610 million (EIA, 2004).

		Projected fuel cost savings over the lifetime of the project are expected to be between US$94 million and US$109 million, based on the mid-level gas demand projection (modified P50) (WAGP, 2004). • **Income tax -** Projected income taxes to be paid by WAPCo to Ghana over the lifetime of the project is in the range of US$466 million to US$588 million3 (WAGP, 2004). • **Meeting Energy Demand in Ghana** - WAGP is the most cost-effective means of providing the primary energy needed to fuel power stations and satisfy the growing demand for electric power in Ghana.
Funding	Cost	Estimated Amount ($) – The total capital investment for WAGP, estimated at US$500 million
	Sources	GoG - Unknown at the time of publication
		Private sector – financed by the joint venture partners, each holding a percentage of the shares in the project.
		Donor - 0%
Tech Transfer		Open Market relate to the program
Capacity Building		Harmonizing competent skills at the national level

Avoided Fugitive Emissions and Electricity Supply		
General information	Name of action	Natural Gas Recovery and Utilization from Jubilee Field that Otherwise be Flared or Vented
	Sector	Energy
	Scale	National (Avoid fugitive emissions and electricity generation)
	Gas	CO_2, and CH_4
	Status	On-going
	Start Year	2011
	End Year	2015 (plant was commissioned in December, 2014)
Implementation information	Implementing entities	*Ministry of Petroleum* – Contracted $1billion loan from China Development Bank
		China Development Bank – $1billion to cover full cost of project at 30% interest
		Ghana Gas Company – Build, own and operate infrastructure required for the gathering, processing, transporting and marketing of natural gas resources in the country.
		Sinopec International Petroleum Service Corporation (Sinopec) - Engineering, Procurement, Construction and Commissioning contractor
		Volta River Authority (VRA) – Gas Off taker to Aboadze Thermal Plants
		AECOM Technology Corporation (AECOM) – Project Management Contractor
		Jubilee Partners – Supplier of Raw Gas
Natural Gas Deposits		200 billion standard cubic feet (SCF) in offshore Jubilee fields.
Processing Capacity of Gas plant		150 million standard cubic feet per day
Pipeline network		2km flexible raiser tie-in pipeline by Jubilee Partners 58km 12inch shallow offshore intake pipeline – Ghana Gas Company 111km onshore pipeline - Ghana Gas Company
Main Products from the Atuabo Gas Processing Plan		Lean or dry gas to be pumped to VRA Aboadze Thermal plant for electricity generation. Liquefied Petroleum Gas (LPG) for domestic use.

	Condensates and Pentanes for the energy market
Market Mechanism	Part of this project is seeking CDM approval. CDM credits will be generated following approval by the Executive Board.
Project objective	Recover volume associated gas from jubilee field which would have been flared and subsequently processed into lean gas for electricity generation, LPG for domestic use and other products such condensates and Pentanes for the energy market.
Objectives	The objectives are: (1) to understand what effect has occurred after implementation of the project; and (2) to track and report it effectiveness after project implementation.
Defining project assessment boundary	Primary effect - reduction in combustion emissions from generating grid-connected electricity in Aboadze thermal plants operated by the VRA. Significant secondary effect – (a) avoided fugitive emissions from quantities of associated that would have been flared without off-taking the gas from the Jubilee field, (b) reduction combustion emissions from avoided use for wood fuel for cooking, (c) combustion emissions from the fossil fuel use in processing of lean gas, LPG and other products, (d) Fugitive emissions from gas storage tanks and transmission of processed lean gas to Aboadze and distribution of LPG.
Identifying effects and mapping the causal chain	The project aims at making relatively cleaner and cheaper fuel delivered from Atuabo Gas Plant to the thermal plants to generate electric power, which is expected to reduce GHG emissions. Electric power generation from relatively cleaner, relatively low-priced source of fuel is expected to result in financial savings to the country. Depending on demand scenarios, savings are estimated to be between US$400 million and US$500 million a year. Additional financial savings to the Country could be used to invest in expansion of electricity generation capacity (establish 400MW plant each year) thereby increasing emissions. The extent of the emissions will depend on how the additional financial is put use. The supply of associated gas from the Jubilee Field to the Atuabo gas processing plant and the subsequent use in electricity plant and LPG in homes will to fugitive methane emissions from gas flaring. Possible leakage from the network of gas transmissions pipeline from the off-shore and on-shore pipeline could be source of methane fugitive emissions. The use of cleaner LPG from the Atuabo plant for household cooking will reduce the dependence on wood fuel for cooking. The use of more LPG to displace wood fuel for cooking will reduce GHG emissions.
Defining the GHG assessment boundary	The reduction in CO_2 emissions from the NG fuel replacement of LCO in electric power plants expected to be significant and thus included in the GHG assessment boundary. The levels of emission reduction depend on the total quantities of NG supplied to the thermal plants that have the capacity to produce electricity from natural gas. The

quantities of LCO displaced by NG will also determine the amount of CO_2 emission savings.

The likely increases/decreases in emissions from the use of additional financial savings accrued to the country in capital investments in the energy and non-energy sectors are difficult to assess because there is no evidence on how the state intends to use the income. How the income is used is largely influenced by the policy choices made by the government. Hence, it is excluded from the boundary. Although there are data on production quantities of associated gas, throughput amount to Atuabo Gas processing plant, and the quantities used and re-injected, it is not disaggregated enough for emission calculation. The level of uncertainties associated with using such data is high. Hence, it is excluded from the boundary. The possible methane emissions from gas distribution network are excluded from the boundary because of lack of data. Data on processed LPG from the Atuabo gas processing plant is not available because the plant is currently not producing LPG for domestic use.

Estimating baseline emissions

Baseline data on *Thermal Electricity generation sources*

The baseline scenario is assumed to be the continuation of historical trends where all the quantities thermal electricity is produced from relatively expensive and less clean LCO fuel. The trend is dependent on projected changes on the availability (reliable supply) of alternative fuel and favorable crude oil price, absent the fuel from the Atuabo Gas processing plant.

Baseline emissions for LCO ($ktCO_2e$/year) = input LCO fuel (GJ) * emission factor(kt/GWh) *GWP

Input LCO Fuel = heat rate x quantity electricity generated from LCO

Baseline emissions in a given year are calculated as based on the following assumptions:

Atuabo gas processing plant supplies 120 million scf of lean gas a day.

VRA Aboaze will off-take 100% of all 120 million scf and utilized in TAPCO and TICO plants after the first year. However, in the in the first year, only 50% of the gas will be utilized by VRA because of technical and licensing procedures from Energy Commission and Ghana Petroleum Authority.

Facility Level Estimation (TAPCO Thermal Plant)		
1. Plant information		
Baseline Fuel	Light Crude Oil (LCO)	
Plant Availability	0.85	%
No. of hours in a year	4054	hours

2. Electricity Production and LCO Use		
Capacity of TAPCO	240	MW
Total Electricity generation at 85% availability	827.016	GWh
Total Electricity generation at 85% availability	827016000	KWh
Gas Heat Rate HHV	8250	kJ/Kwh
LCO consumed	6822882	GJ

3. Baseline emission Information		
LCO CO_2 emission factor	0.0733	tCO_2/GJ
LCO CH_4 emission factor	0.000003	tCO_2/GJ
LCO N_2O emission factor	0.0000006	tCO_2/GJ
Total CO_2 emission/year	500.1172506	$ktCO_2$
Total CH_4 emission/year	0.429841566	$ktCO_2e$
Total N_2O emission/year	1.269056052	$ktCO_2e$
Total emissions /year	501.82	$ktCO_2e$

Baseline emissions are conservatively projected from 2015 to 2025

Year	Baseline Emissions ($ktCO_2e$)
2015	501.82
2016	1,003.63
2017	1,003.63
2018	1,003.63
2019	1,003.63
2020	1,003.63
2021	1,003.63
2022	1,003.63
2023	1,003.63
2024	1,003.63

	2025	1,003.63

Estimating GHG effects ex-post

To estimate project scenario emissions, the same emissions estimation method is used, but the assumed parameter values in the project scenario are different. The emissions estimation method is:

*Project emissions for LCO (kt CO_2e/year) = heat rate x quantity electricity generated from LCO = input NG fuel (GJ) * emission factor (kt/GWh)$_{LCO}$- * emission factor(kt/GWh)$_{NG}$ *GWP.*

Project scenario with the reliable availability of NG from Atuabo, the plants with the technology capability to produce electricity (dueled-fuel plant) from NG which displace the use of LCO.

Facility Level Estimation (TAPCO Thermal Plant)		
1. Plant information		
Mitigation Fuel	Lean Gas	
Plant Availability	0.85	%
No. of hours in a year	4054	hours
2. Electricity Production and LCO Use		
Capacity of TAPCO	240	MW
Total Electricity generation at 85% availability	827.016	GWh
Total Electricity generation at 85% availability	827016000	KWh
Gas Heat Rate HHV	7981	BTU/Kwh
Gas consumed	6600414.696	mmBTU
Gas consumed	6,286,109.23	GJ
3. Baseline emission Information		
LCO CO_2 emission factor	0.0561	tCO_2/GJ
LCO CH_4 emission factor	0.000001	tCO_2/GJ
LCO N_2O emission factor	0.0000001	tCO_2/GJ
Total CO2 emission/year	352.65	$ktCO_2$

	Total CH4 emission/year	0.13	$ktCO_2e$
	Total N2O emission/year	0.19	$ktCO_2e$
	Total emissions /year	352.98	$ktCO_2e$

Emission savings are calculated from the difference between the emissions from electricity generated from LCO and NG for each thermal plant and aggregate for each year.

Year	Emissions Savings ($ktCO_2e$)	Lean Gas from Atuabo Plant (Mscf)
2015	148.84	60
2016	297.68	120
2017	297.68	120
2018	297.68	120
2019	297.68	120
2020	297.68	120
2021	297.68	120
2022	297.68	120
2023	297.68	120
2024	297.68	120
2025	297.68	120
Cumulative	3125.64	1,260

Monitoring Performance over time

Key performance indicators identified are:

- Thermal plant efficiency monitoring
- Total Quantities of indigenous gas distributed from Atuabo by Ghana Gas Company
- Quantities of electricity generated and delivered to the grid from dueled fuel and single fuel thermal plants.
- Fraction of total national electricity generated from thermal plants and fractions from LCO and NG.

Assessing uncertainty

Heat rates may vary depending on the type technology and efficiency of the thermal plant.

Default emission factor of fuel is conservative. It may be higher or lower than the

		actual emission factor from the plant.
Methodology		WRI GHG project protocol
Assumptions		• VRA operate dueled fuel thermal plant will replace LCO with NG once gas delivered in the market because of the competitive price. • 50% of the lean gas from Atuabo will be off-take by VRA in the first year. In the second year VRA will off-take 100% lean gas from Atuabo. • Fuel used in the recovery associated gas at the Jubilee field and the processing at the Atuabo plant was not estimated due to lack of data and also avoid possible double counting. • Fugitive emissions from flaring and leakage of transmission and distribution pipeline were not estimated due to lack of data.
Non-GHG Effects		Financial saving to Government of Ghana - The Ghana Gas project, which has begun producing gas to power the thermal plants of the country's energy generator VRA, could mean a 20°/o reduction in fuel costs to the power industry - or savings of $2billion over a 10-year period. For the industry as a whole, this is enough to fund one 400MW power plant every other year. Ghana Gas would also produce 180,000 tonnes of LPG a year, which represents 75% of Ghana's 240,000 tonnes of LPG consumed annually. Further savings would be made by Ghana as well on the millions of dollars spent on the importation of LPG into the country annually, he noted. This will contribute to reduce dependence on traditional biomass and reduce pressure on the forest resources. Improving energy security in Ghana – Availability of indigenous gas from Atuabo will reduce the impact of international market price volatility on Ghana and also ensure that readily availability of gas to meet future electricity demand.
Funding	Cost	Estimated Amount ($) – The total capital investment estimated at US$1 billion
	Sources	GoG - 100% Mechanism - Loan
		Private sector – Loan from China Development Bank
		Donor - 0% Donor Channel - NA
Tech Transfer		From the SINOPEC - Engineering, Procurement, Construction and Commissioning contractor
Capacity Building		Harmonizing competent skills at the national level

Annex 3.4 Transport sector mitigation action

Road Transport		
General information	Name of action	Accra Bus Rapid Transit System (Component 3 of Ghana Urban Transport Project
	Sector	Energy – Transport
	Scale	City level - Kasoa to Central Business District (CBD) Corridor
	Gas	CO_2
	Status	On-going
	Start Year	2007
	End Year	2014
Implementation information	Implementing entities	Ministry of Transport - overall sector responsibility for this project in close collaboration with Ministry of Local Government and Rural Development
		Ministry of Local Government and Rural Development - has overall responsibility for the regulation of passenger transport in the urban areas falling under the jurisdiction of MMDAs
		Department of Urban Roads - implementing agency for the project. DUR will have direct responsibility for project management (including Procurement, safeguards management, financial management, and monitoring and evaluation).
		Urban Transport Advisory Committee (UTAC) - ensure key Technical inputs, multi stakeholder consultation, collaboration, coordination, and information dissemination for urban transport policy development and implementation.
		Greater Accra Public Transport Executive - interim planning and regulating entity.
Target	Construction and operation of a new bus rapid transit system (BRT) for urban transport of passengers including replacement, extensions or expansions of existing mix traffic situation on the Kasoa – CBD corridor in Accra.	
Project objective	Improving urban transport mobility and promote shift to environmentally sustainable transport mode through development of BRT system on Kasoa – CBD corridor.	
Objectives	The objectives are: (1) to assess how the implementation of the BRT system contributes to emission reduction on the BRT corridor.	
Defining project assessment boundary	Component 3 of Ghana Urban Transport Project - Primary effect – emission reductions resulting from displacement of more-GHG-intensive transportation modes by less-GHG-intensive ones. Secondary effects - reduction in air pollutants from less GHG intensive transport modes.	
Identifying effects and mapping the causal chain	The BRT system aims at promoting shift to environmentally sustainable transport mode through bus-based on high occupancy mobility. Expected GHG emission reduction will result from the lower fuel consumption per passenger and travel time on the same distance on the corridor. Reduction in fuel consumption and improvement in travel time will lead to reduction in air pollution. Guarantee	

Defining the GHG assessment boundary	The reduction in CO_2 emissions as a result of lower fuel use for a relatively shorter travel time on the BRT corridor is expected to be significant and thus included in the GHG assessment boundary. The likely emissions of precursor pollutants are excluded from the boundary because of lack of measured data. The use of generic emission factors for the estimation of diffused air pollutants from transport is considered high uncertain.
Estimating baseline emissions	Baseline data *a. Vehicle population* Data on vehicle population was obtained from Driver Vehicle Licensing Authority (DVLA) for 2012 baseline. The data provides breakdown of annual vehicle registration for the whole country and Accra (which is 41% of the national total). Disaggregation of vehicle population by type of vehicle, 2012 and further on the BRT corridor is in the table below:

Vehicle	National data	Accra	BRT Corridor
Car/Taxi*	710,044	29,1118	11,858
Truck#	296,742	121,664	7,246
Buses**	173,651	71,197	1,757
MC	349,809	143,422	659
Bicycle			439
Total	1,530,246	627,400	21,959

Source: DVLA and estimations with data from BRT traffic survey, 2012
* Car and taxi added together, # Light duty and heavy duty vehicles, ** Tro-tro and buses

Vehicle categories	Car/Taxi	Buse	Truck	MC	Bike	Total
Road space use	54%	33%	8%	3%	2%	
Passenger carriage/	15%	84%	0%	1%	0%	
Passenger capacity (no)	7107	3979	0	474	0	
Vehicle population	11,858	1,75	7,246	659	439	21,959

Source: BRT traffic survey, 2012

The split of vehicles on the BRT corridor was based on traffic characterization survey undertaken in 2012. For each category of vehicle class on the BRT corridor, the total daily passenger carried was used to obtain the passenger capacity.

b. Passenger Information

Item	Information	Source /Remarks
No. of BRT articulated Buses	90	BRT office
Occupancy of Euro 3 buses	110	Full capacity in peak hours. Source: Bogota BRT PDD
AM Peak	6am-9am (3hours)	BRT corridor traffic survey, 2012.
Inter Peak	9am – 3pm (6 hours)	
PM Peak	3pm – 7pm (4 hours)	
Post Peak	7pm -6am (11 hours)	

Distance of 1 round trip	54.7 (km)	BRT corridor traffic survey, 2012. Inbound trip: Kasoa-CMB station. Outbound trip Rawlings park- Kasoa
Passenger per inbound trip in peak hours	70	Expert judgment. Total passenger per trip is 130.
Passenger per outbound trip in peak hours	50	
Time for 1 round trip	81.6 (minutes)	BRT corridor traffic survey, 2012.
No of stops per 1 round trip	41 (Stops)	
Passenger per inbound trip in inter peak hours	40	Expert judgment Total passenger per trip is 70.
Passenger per outbound trip in inter peak hours	30	
Passenger per inbound trip in post peak hours	20	Expert judgment Total passenger per trip is 50.
Passenger per outbound trip in post peak hours	30	
If 50 BRT buses are in service during peak hour		Expert judgment
Total inbound and outbound passengers in AM and PM peak hours (A)	30,600 passengers	This is the product of the number of peak hour buses in service (50), the number of passengers per 1 round trip (150) and the number of trips in AM peak (2.2 trips), PM (2.9 trips).
If 20 BRT buses are in service between peak hours		Expert judgment
Total inbound and outbound passengers in inter peak hours (B)	6,160 passengers	This is the product of the number of peak hour buses in service (20), number of passengers per 1 round trip (70) and the number of trips in inter peak (4.4 trips)
If 4 BRT buses are in service after peak hours		Expert judgment
Total inbound and outbound passengers after peak hours (C)	1,620	This is the product of the number of peak hour buses in service (4), the number of passengers per 1 round trip (50) and the number of trips in inter peak (8.1 trips)
Total passengers carried in 1 round trip (inbound and outbound) per day for all segment of travel = 38,380 passengers		

Note: *The BRT passengers' carriage will be the same number of passengers who will be affected in the scenario without the BRT NAMA project. The distribution of passengers among vehicle categories was informed by the traffic survey conducted in 2012.*

C. Traffic information

The traffic information is presented in four parts. The first part relates to characterization of the different vehicles on the BRT corridor by fuel types, which is based on the type of vehicles and the population of specific vehicular class. Information on the share of vehicular types and the use of fuels was obtained from expert judgment. For car/taxi, expert judgment indicated that diesel cars/taxis constituted 25%, gasoline 50% and LPG 15%. For buses, 70% are diesel and 30% gasoline. Trucks and motorcycles use diesel and gasoline respectively while bikes were considered as non-motorized. Using this expert judgment and the vehicular population on the BRT corridor, we estimate the vehicular type by type of fuel and present in the table below:

Vehicular type disaggregated by type of fuel

Vehicle type	Car/taxi	Buses	Trucks	Motorcycle	Bike
Diesel	2964	1230	7246		0
Gasoline	7115	527	0	659	0
LPG	1779				

Source: Authors estimates

The second part of the traffic information is on the allocation of passengers to different vehicle categories according to fuel types. The allocation share was based on expert judgment, similar to the characterization of vehicles to fuel types. We assume that trucks are used for mainly freight transport and therefore will not benefit from the proposed BRT. Results of or calculation in the table below. In the table, the value 1,439.25 means that about 1439.25 trips (inbound and outbound) on the corridor were made by diesel cars/taxis.

Passengers per vehicle class

Vehicle type	Car/taxi	Buses	Motorcycle
Diesel	1439.25	22567.44	
Gasoline	3454.2	9671.76	383.8
LPG	864		

Source: Authors' estimation

The third part is on information relating to traffic circulation, in particular, annual distances covered in km. The daily distance covered by each vehicle category was obtained from the product of the total distance of BRT corridor (54.7km) and the respective road space use. In order to derive the daily distance covered by vehicles in each fuel category, the total distance covered by each vehicle category multiplied the total number of vehicles in each fuel category. Refer to the table below

Daily distances by vehicles in each fuel category (km/day)

Vehicle	Car/taxi	Buses	Trucks	Motorcycle	Bike
	29.538	18.0	4.3	1.6	1.09
Diesel	87564.4	22197.4	31710.6		
Gasoline	210154.	9513.1		1081.0	
LPG	52538.6				

The final part of the traffic information is on fuel consumption of different vehicle category by fuel types measured in liter/passenger-km and the total daily distance (km) for each fuel class in a specific vehicle category to calculate the fuel consumption per year. This is done by first calculating the fuel consumption in liter/passenger-km and the fuel consumption per day in liters/day.

Fuel consumption (liter/passenger-km)

Fuel Vehicle Class	Car/taxi	Buses	Trucks	Motorcycle
Diesel	0.048	0.043	0.007	0.007
Gasoline	0.049	0.044	0.007	
LPG	0.073			

Fuel consumption per day (Liters/day)

Fuel Vehicle Class	Car/taxi	Buses	Trucks	Motorcycle
Diesel	4203.1	954.5	221.97	
Gasoline	10297.6	418.6		7.57
LPG	3835.3			

The fuel consumption per day in litres/day is then multiplied by 300 days as the service operation days to obtain the fuel consumption per years in litres/year (table below).

Fuel consumption per day (litres/year)

Fuel Vehicle	Car/taxi	Buses	Trucks	Motorcycle
Diesel	1260928.6	286346.7	66592.3	
Gasoline	3089275.1	125573.2		2270.2
LPG	1150597.4			

Ex-ante baseline emissions

Three GHG emissions (CO_2, CH_4 and N_2O) for each fuel vehicle class were determined using appropriate emission factors and the total fuel consumption per annum and presented in the table below.

Table 13: GHG emissions for the year 2012

GHG	Emission Factor (IPCC default) (kg/liter)			Emissions for 2012 (tonnes)					
				Car/taxi			Buses		Motor cycle
	Gasoline	Diesel	LPG	Gasoline	Diesel	LPG	Gasoline	Diesel	Gasoline
CO2	2.02	2.41	1.4	6240.3	3038.8	1610.8	253.6	690.1	4.59
CH4	0.00097	0.00013	0.00139	3.00	0.16	1.60	0.12	0.04	0.002
N2O	9.36E-05	0.00013	4.4781E-06	0.29	0.16	0.01	0.01	0.04	0.000
Total (kt) in 2012				3.09	6.39	1.65	0.70	0.26	0.0047
Grand total				12.1kt total emissions in 2012					

With a baseline emission of 12.1 kt in 2012, emission baseline scenario is generated up to the year 2040 using the growth rate vehicle population, which is estimated at 7% per annum. This results in a cumulative baseline emission scenario of 1,054,100 tCO2. Details of the calculations are presented as table.

Baseline emission scenario

Year	No of Vehicle		Emission (kt)	
	Yearly	Commutative	Yearly	Cumulative
2012	21959.0	21959.0	12.1	12.1
2013	23496.1	45455.1	12.9	25.0
2014	25140.8	70596.0	13.9	38.9
2015	26900.7	97496.8	14.8	53.7
2016	28783.8	126280.6	15.9	69.6
2017	30798.6	157079.3	17.0	86.5
2018	32954.5	190033.9	18.2	104.7
2019	35261.4	225295.3	19.4	124.1
2020	37729.7	263025.0	20.8	144.9
2021	40370.7	303395.7	22.2	167.2
2022	43196.7	346592.5	23.8	191.0
2023	46220.5	392813.0	25.5	216.4
2024	49455.9	442268.9	27.2	243.7
2025	52917.8	495186.8	29.2	272.8
2026	56622.1	551808.9	31.2	304.0
2027	60585.6	612394.6	33.4	337.4
2028	64826.6	677221.2	35.7	373.1
2029	69364.5	746585.7	38.2	411.4
2030	74220.0	820805.8	40.9	452.2
2031	79415.4	900221.2	43.8	496.0
2032	84974.5	985195.7	46.8	542.8
2033	90922.7	1076118.5	50.1	592.9
2034	97287.3	1173405.8	53.6	646.5
2035	104097.4	1277503.2	57.4	703.9
2036	111384.2	1388887.5	61.4	765.3
2037	119181.1	1508068.6	65.7	830.9
2038	125991.2	1634059.9	69.4	900.3
2039	134810.6	1768870.6	74.3	974.6
2040	144247.4	1913118.0	79.5	1054.1

Ex-ante Mitigation Calculation	In the mitigation scenario, we assume that the number of BRT Euro 3 buses which will be used will increase from 50 in the first year to 60 in the second year and to 90 in the third year and remain at that throughout the implementation of the project. The total kilometers covered per day by each bus will be 273.5km. The total kilometers covered in the first will be 59,076 km, second year will be 70,891 km and the third year will be 106,337 km. Based on expert judgment, the fuel consumption in liter/passenger-km is assumed to be 0.0144.

Year	Liters	Emissions (kt)			Emissions (kt	
		$C0_2$	CH_4	N_2O	Total	Cumulative
1	851	2.05	0.0001	0.0001	2.088	2.09
2	1.021	2.46	0.0001	0.0001	2.506	4.59
3	1.531	3.69	0.0002	0.0002	3.758	8.35
4	4.977	11.99	0.0006	0.0006	12.216	20.57
5	4.977	11.99	0.0006	0.0006	12.216	32.78
6	4.977	11.99	0.0006	0.0006	12.216	45.00
7	4.977	11.99	0.0006	0.0006	12.216	57.22
8	4.977	11.99	0.0006	0.0006	12.216	69.43
9	4.977	11.99	0.0006	0.0006	12.216	81.65
10	4.977	11.99	0.0006	0.0006	12.216	93.86
11	4.977	11.99	0.0006	0.0006	12.216	106.08
12	4.977	11.99	0.0006	0.0006	12.216	118.29
13	4.977	11.99	0.0006	0.0006	12.216	130.51
14	4.977	11.99	0.0006	0.0006	12.216	142.73
15	4.977	11.99	0.0006	0.0006	12.216	154.94
16	4.977	11.99	0.0006	0.0006	12.216	167.16
17	4.977	11.99	0.0006	0.0006	12.216	179.37
18	4.977	11.99	0.0006	0.0006	12.216	191.59
19	4.977	11.99	0.0006	0.0006	12.216	203.81
20	4.977	11.99	0.0006	0.0006	12.216	216.02
21	4.977	11.99	0.0006	0.0006	12.216	228.24
22	4.977	11.99	0.0006	0.0006	12.216	240.45
23	4.977	11.99	0.0006	0.0006	12.216	252.67
24	4.977	11.99	0.0006	0.0006	12.216	264.88
25	4.977	11.99	0.0006	0.0006	12.216	277.10
26	4.977	11.99	0.0006	0.0006	12.216	289.32
27	4.977	11.99	0.0006	0.0006	12.216	301.53
28	4,977	11.99	0.0006	0.0001	12.216	313.75

From the table with the BRT NAMA scenario, GHG emission will cumulatively increase from about 2.09tCO_2e in 2012 to about 313.75ktCO_2e kt in 2040. Real emission saving will depend on when the BRT project starts full implementation. The total savings from the BRT NAMA will amount to about 728,131tCO_2e by 2040.

Monitoring Performance over time	Key performance indicators are identified, • CO_2 emissions in BRT corridors (tonnes per annum) • Av. travel time by bus (min) on BRT pilot corridor • Av. Travel speed (km/hr) on BRT pilot corridor • Passenger share of bus (large) % • GHG Emissions from vehicles in Accra along the pilot BRT corridor ($MTCO_2$/Yr) • Length of BRT corridor developed • Bus-km /bus/day (pilot)
Assessing uncertainty	Qualitative. The projected average speed, annual distances and fuel consumption per vehicle class might change. The levels of changes depend on the traffic situation on the BRT

		corridor, which is defined by the number and, type of buses in operations, its maximum capacity. The use of default emission factors for CO_2 and CH_4 and N_2O will depend on the amount of fuel grade and the performance condition of engine. Any change in the default emission factors to country-specific emission factors might significantly vary the projected emissions. The use of expert judgment in the allocation of vehicle into different fuel classes might result in under or overestimation of emissions. Future changes in the vehicle population per class or category might lead to changes in the projected emission savings. The projected
Methodology		CDM approved methodology AM0031 - Baseline methodology for bus rapid transit projects
Assumptions		• There will be 90 high occupancy Euro 3 standard buses. • Buses have dedicated lanes on the BRT corridor • Average speed in AM and PM peak hours differs and might change depending on the number of buses in operation. • After the third year of operation, the total fuel consumption on the BRT corridor has been assumed to be constant.
Non-GHG Effects		• Number of trips by public transportation increased by 10% in pilot corridor • CO_2 equivalent tons emitted by ground transport decrease by 22% • Number of NMT trips increase by 5% in intervened areas. • Reduction in travel time by at least 8 minutes per trip by public transport along pilot corridor. • Traffic congestion levels decreased in the BRT and the bus corridors, compared, compared to the levels before the BRT
Funding	Cost	Estimated Amount ($) – 29 million
	Sources	GoG - 2 million counterpart funding Mechanism – Direct Cash investment, credit (IDA), Grant (GEF)
		Private sector – 0%
		Donor - 100% (GEF, World Bank and AFD) Donor Channel - multilateral
Tech Transfer		Open Market
Capacity Building		Training packages to private buses operators

Annex 3.5 AFOLU sector mitigation action including REDD+

Forest Management		
General information	Name of action	National Forest Plantation Development Programme (NFPDP)
	Sector	AFOLU
	Scale	National (on and off forest reserves
	Gas	CO_2
	Status	On-going
	Start Year	2002
	End Year	On-going
Implementation information	Implementing entities	Ministry of Lands and Natural Resources - fund mobilization, management of plantation development fund, contracts annual outlook and ensure alignment with national forest and wildlife policy
		Forestry Commission - operational coordination and supervision Forest Services Division - exercised general oversight and monitored field activities to ensure compliance with quality standards for plantation establishment.
		Out-source private management service companies (Zoil Services Limited and Eco tech Services Limited) – plantation establishment and management Messrs. African Foresters Brigade supply seedlings.
		District Assemblies – Employment and recruitment
Objective of Action	The primary objective of the NFPDP is to (a) restore the forest cover of degraded forest lands, (b) generate employment as means to reduce rural poverty, (c) improve environmental quality and provide an opportunity for the country to tap the emerging benefits from the climate change market for carbon sequestration, (d) reduce the wood deficit situation in the country and (e) enhance production of food crops and contribute to food security in the country.	
Scope of NFPDP	Launched in 2002 and 2010 by the two former Presidents. Components Modified Taungya System (MTS) - establishment of plantations by the Forest Services Division (FSD) in partnership with farmers Government Plantation Development Programme (GPDP) - utilized hired labor and contract supervisors to establish industrial plantations. Funded through the Highly Indebted Poor Countries (HIPC) benefits. Under this scheme plantations developed are owned by	

	government and the respective landowners who are entitled to royalty payments. Community Forest Management Project (CFMP) - CFMP, which was funded with a loan from African Development Bank, adopted the MTS model. Private Commercial Plantation Developers and the Model Plantation. *FSD Model* - purely research based scheme introduced to offer the FC plantation managers the opportunity to undertake mixed species trials, experiment various planting designs and tree spacing. *Expanded Plantation Programme* – cover private lands located outside forest reserves. The Expanded Plantation program ensures that most of the District/ Municipals Assemblies without degraded forest reserves would also benefit from the job opportunities being created through the plantation development program
Target	Average of 15,300 Ha of degraded forestlands (on or off reserve forest land) planted and maintained under each components.
Objectives assessment	The objectives are: (1) to understand what effect has occurred during and after implementation of the programme; and (2) to track and report on the effectiveness of the NFPDP.
Defining project assessment boundary	*Primary effect* – CO_2 emission reduction resulting from the carbon stock enhancement through planting or restoring trees on lands that are considered degraded forest. The primary effect is the increased removals and storage of CO_2 by means of biological processes, particularly in trees and soil. *Significant secondary effect* – the following were identified as the potential secondary effects associated with the plantation activities: (a) CO_2 emissions from fossil fuel use: in site preparation, e.g., on-site mechanical clearing of vegetation and planting preparation, Nursery production of seedlings, (b) Transportation - Products, employees, and herbicides are transported to and from the plantation, resulting in CO2 emissions from the combustion of fossil fuels.
Identify effects and mapping the causal chain	Increasing carbon stocks through planting or restoring tree through afforestation of degraded lands will lead to CO_2 emission reduction. Site preparation, transportation and nursery production activities that use fossil fuel will produce CO_2 emissions as part of the afforestation exercise.
Define the GHG assessment boundary	Carbon stock enhancement through tree planting will lead to higher CO_2 removal through aboveground and belowground biomass and soil carbon pools. The CO_2 removal through aboveground and below ground biomass and soil carbon pools is expected to be significant, so they are included in the GHG assessment boundary. Although the CO_2 emissions from fossil fuel use to support afforestation activities such as nursery development, site preparation and transportation is likely to occur, the emission levels are generally smaller. Due to the lack of reliable baseline data, the emission estimates from such activities are excluded from the boundary.
Emissions saving	The baseline land use under NFPDP is degraded off-reserve and on-reserve forestland. Most degraded lands are predominated by grasslands or shrubs. Plantation enhances carbon

estimation

stocks of the degraded land by 80%. Breakdown of the GHG savings from the NFPDP is in the tables below

Years	Planted Areas (k Ha)	Annual Growth Rate (t.dm/ha)	Annual biomass increment (kt dm)	Carbon fraction of DM	NFPDP Annual carbon uptake increment (kt C)	Baseline carbon uptake increment (kt C)	Net NFPDP annual carbon uptake increment (kt C)
2002	18.95	7.28	137.96	0.5	68.98	13.80	55.18
2003	19.15	7.28	139.41	0.5	69.71	13.94	55.76
2004	23.21	7.28	168.96	0.5	84.48	16.90	67.58
2005	15.19	7.28	110.60	0.5	55.30	11.06	44.24
2006	16.02	7.28	116.60	0.5	58.30	11.66	46.64
2007	16.08	7.28	117.07	0.5	58.54	11.71	46.83
2008	10.70	7.28	77.88	0.5	38.94	7.79	31.15
2009	11.36	7.28	82.71	0.5	41.36	8.27	33.08
2010	18.60	7.28	135.43	0.5	67.71	13.54	54.17
2011	11.25	7.28	81.89	0.5	40.94	8.19	32.76
2012	8.98	7.28	65.38	0.5	32.69	6.54	26.15
2013	15.00	7.28	109.20	0.5	54.60	10.92	43.68

Years	increment uptake to 20th year (kt C)	Cumulative carbon uptake increment (kt C)	Start CO2 savings year Kt CO_2	End year of rotation cycle Kt CO_2	Annual rate of CO_2 reduction Kt CO_2
2002	1103.65	1103.65	202.34	4046.71	192.22
2003	1115.30	2218.94	204.47	4089.42	194.25
2004	1351.68	3570.62	247.81	4956.16	235.42
2005	884.78	4455.40	162.21	3244.18	154.10
2006	932.80	5388.20	171.01	3420.27	162.46
2007	936.57	6324.78	171.71	3434.11	163.12
2008	623.06	6947.84	114.23	2284.55	108.52
2009	661.68	7609.52	121.31	2426.17	115.24
2010	1083.43	8692.95	198.63	3972.57	188.70

	2011	655.11	9348.06	120.10	2402.07	114.10
	2012	523.02	9871.08	95.89	1917.75	91.09
	2013	873.60	10744.68	160.16	3203.20	152.15

Monitoring Performance over time

Key performance indicators used by the monitoring team from the plantation unit of the Forest Service Division include

- Annual area planted under each component
- Number of seedling supplied to private sector developers
- Survival rate /mortality rate
- Rate of thinning
- Number of Jobs created per year
- Planting and maintenance cost per year

Assessing uncertainty

- Uncertainty assessed in qualitative terms was carried out to identify possible variations in the factors that can affect the actual and savings due to NFPDP.
- The default average annual biomass growth rate might vary at different growth stages.
- 80% impact of carbon stock enhancement on degraded forestland baseline could be higher or lower than expected.

Methodology

WRI GHG project protocol

Assumptions

- 20-year rotation cycle after first year of planting.
- Annual growth rate of plantation remains same throughout the 20 year rotation period
- After 20-year rotation period, plantation trees will be harvested. In the 20th year, when trees are harvested, estimate removal may reduce.
- The rate of annual carbon uptake will depend on the degree of permanence, which is determined by the risk posed by pest, fire and intermittent unplanned harvesting.

Non-GHG Effects

Job creation. Direct jobs created each year is provided in the table below:

Years	Planted Areas (kHa)	Direct jobs created	Food produced (tonnes)	Cost ($ at GhC 3)
2002	18.95	37763	15,952	3,925,986.04
2003	19.15	38261	106,077	9,404,240.16
2004	23.21	36196	150,468	7,102,370.64

		2005	15.19	33904	761,019	3,147,397.75
		2006	16.02	47326	880,087	3,318,235.11
		2007	16.08	14786	160,000	3,893,106.50
		2008	10.70	14476	517,456	5,573,568.79
		2009	11.36	21473		2,353,791.26
		2010	18.60	28469		6,814,254.67
		2011	11.25	21310		3,892,986.30
		2012	8.98	29227	46,502. 78	7,189,876.26
		2013	15.00	30,120		
Funding	Cost	Estimated Amount ($) – 52 million				
	Sources	Government of Ghana - 32million (60%) Financing type – Direct Cash investment Funding– National Plantation Fund				
		Private sector – 8million (15%)				
		Donor - 13million Donor Channel - HIPC (25%)				
Source of Information		Annual Reports – National Plantation Development Programme				

REDD+ Activities		
General information	Name of action	Forest Investment Programme
	Sector	AFOLU
	REDD+ Stage	Piloting transformation via policy reforms and pilot activities
	Scale	Western Region (HFZ) and Brong Ahafo (HFZ and the transition to the woodland savannah zone.
	Gas	CO_2
	Status	Planned (Pipeline)
	Start Year	2015
	End Year	2018
Implementation information	Implementing entities	Project 1: Securing the integrity of natural forests and woodland resources TCC+ : facilitate implementation of the project 1 Ministry of Lands and Natural Resources (MLNR) Forestry Commission Ministry of Environment, Science, Technology and Innovation (MESTI) – FORIG Ghana Cocoa Board
		Project 2: Enhancement of carbon stocks Ministry of Lands and Natural Resources (MLNR) will be the executing agency for this project. Technical staff responsible for the implementation of the Forest Investment Programme. Forestry Commission Ministry of Finance Ministry of Environment, Science, Technology and Innovation (MESTI)
		Project 3: Climate smart agriculture and watershed services Ministry of Lands and Natural Resources (MLNR) will be the executing agency for this project. Technical staff responsible for the implementation of the Forest Investment Programme. Forestry Commission Ministry of Finance

		Ministry of Environment, Science, Technology and Innovation (MESTI)
Project Scope of FIP	Project 1: Securing the integrity of natural forests and woodland resources Component 1: Research, Capacity Building, and Monitoring – all ecological zones Component 2: Governance and Regulatory regimes – all ecological zones Component 3: Ecological Networks and Biodiversity Conservation – High forest zone Component 4: Management of Forest Resources – High forest Project 2: Enhancement of carbon stocks Component 1: Rehabilitation of degraded natural forests – High forest zone Component 2: Plantation development – High forest zone Component 3: Sustainable wood fuel production – Savanna and Forest Savanna Transition Zone. Project 3: Climate smart Agriculture and Watershed Services Component 1: Promote Climate-Smart Cocoa Landscapes – High forest zone Component 2: Promote Climate-Smart Agriculture (food crops) – High Forest Transition, and Savanna Zones Promote Watershed Services – High Forest Transition and Savanna Zones	
Scope FIP emission reduction strategies	Project 1: Securing the integrity of natural forests and woodland resources *Component 1: Research, Capacity Building, and Monitoring* – ensure that adequate baseline information is collected, information is disseminated, key principles and understanding are built, and impacts and results are monitored and assessed. *Component 2 :Governance and Regulatory regimes* – support for policy and governance structures and strengthening of management institutions leading to (a) strengthening tree tenure and carbon rights, (b) Improvement of law enforcement and protection of existing reserves and (c) Support for effective decentralization and support for community and private sector engagement for sustainable protected area management *Component 3: Ecological Networks and Biodiversity Conservation* – ensure that sustainable forest management is not undermined by fragmentation and	

	degradation as a result of agriculture and wildfires. Ecological networks would be piloted between blocks of protected and unprotected forests. The ecological networks intervention would lead to abatement through (a) reduced deforestation and degradation, plus enhancement of carbon stocks and (b) biodiversity conservation and other ecosystem services. *Component 4: Management of Forest Resources* – Private sector involvement in forest resources management.
	Project 2: Enhancement of carbon stocks *Component 1: Rehabilitation of degraded natural forests*– Enrichment planting in degraded compartments in collaboration of with communities and the private sector, preferable where REDD+ pilots are being developed and in GSBAs that are under threat. *Component 2: Plantation development*– Create enabling environment for results based (REDD+/CDM) private sector plantation development with a strong focus on livelihoods and income generation for communities *Component 3: Sustainable wood fuel production* – Savanna and Forest Savanna Transition Zone. - Promotion of more sustainable production systems would not only contribute to the biomass energy requirements, but also reduce pressure on indigenous woodlands in the savanna and the forest-savanna transition zone, and enhance incomes in a region where there are few non-agriculture income opportunities.
	Project 3: Climate smart Agriculture and Watershed Services *Component 1: Promote Climate-Smart Cocoa Landscapes* – Working in collaboration with farmers, community leaders, the cocoa private sector, and financial or risk reduction institutions to: (a) reduce emissions from conversion of forests to cocoa or loss of trees in cocoa farms, and where appropriate enhance trees in the system or landscape; (b) support private sector engagement and prioritization of climate-smart practices and (c) link increased productivity to a reduction/limit of the cocoa footprint. *Component 2: Promote Climate-Smart Agriculture (food crops*) – climate and livelihood benefits can be achieved through the introduction and adoption of a combination of practices, including: (a) Increased productivity from improved varieties, access to inputs, information, (b) Conservation or sequestration of soil carbon stocks through reduced tilling, no burn methods and other practices; (c) Integration of trees into the farming system for carbon stock enhancement and livelihood benefits (NTFPs, nitrogen fixing), or soil conservation (green belts); and (b) community land use planning to reduce conversion of forest to farming

	landscapes. *Promote Watershed Services* – This component will focus on the design of an innovative system(s) to incentivize communities farming and living within important watersheds to protect and rehabilitate the landscape so as to support a sustainable and clean water supply. The Atewa Range and Kakum National Park are examples of critical watersheds that could benefit from such an initiative.
Objectives assessment	The objectives is to understand what GHG and non-GHG effect can occur during and implementation of the programme
Defining project assessment boundary	*Primary effect* – CO_2 reduction resulting from the carbon stock enhancement through planting or restoring trees on lands that are considered degraded forest. Additional savings will come from avoided deforestation or forest degradation in the cocoa landscape. *Significant secondary effect* – the following were identified as the potential secondary effects associated with the plantation activities: (a) CO_2 emissions from fossil fuel use: in site preparation, e.g., on-site mechanical clearing of vegetation and planting preparation, Nursery production of seedlings, (b) Transportation - Products, employees, and herbicides are transported to and from the plantation, resulting in CO_2 emissions from the combustion of fossil fuels.
GHG emission abatement opportunities in FIP	The emission reduction potentials that are associated with the FIP have been presented according to projects. Although some of the activities under the project components may not directly lead to emission reduction because they focus on removing barriers that will allow for effective implementation of measures that address drivers of land use change. At this stage of the programme, not much baseline data have been collected from the project site. So the baseline and emission reduction potential of the programme have been estimated based on available data from literature and the project document submitted to the World Bank. The emission abatement potentials of FIP have been provided below. The emission reduction opportunities have been provided for those components of the programme that have certain level of data available from literature. Again based on the type of actions; ie. Those that (a) address governance-related challenges; (b) aimed at improving forest management practices; and (c) on the ground activities aimed at ameliorating deforestation and forest degradation trends. Specific interventions that will directly contribute to GHG abatement under the three broad actions include: Project 1: Securing the integrity of natural forests and woodland resources Component 1: Research, Capacity Building, and Monitoring – indirect contribution to emission reduction. *Component 2: Governance and Regulatory regimes* – indirect contribution to

emission reduction.

Component 3: Ecological Networks and Biodiversity Conservation – The ecological networks intervention would lead to abatement through: (a) reduced deforestation and degradation, plus enhancement of carbon stocks and (b) biodiversity conservation and other ecosystem services.

Component 4: Management of Forest Resources – this would lead to reduced emissions from deforestation and degradation.

Project 2: Enhancement of carbon stocks

Component 1: Rehabilitation of degraded natural forests – This component has an estimated emission reduction potential of 4million tCO_2-e, calculated in a hypothetical 30, 000 ha reserve over a period of 20 years at a 2% deforestation rate.

Component 2: Plantation development – Abatement potential could be realized through a mixed species indigenous plantations which would yield a sequestered carbon value of around 500 t/ha CO_2-e, based on a 20 year felling cycle, with 20% of basal area removed at each felling. This approach is expected to maintain continuous forest cover and lead to a full recovery of the original high forest vegetation through natural regeneration. Alternately, planting of a teak plantation which is managed on an 18 year clear felling basis is estimated to yield 200 t/ha CO_2-e.

Component 3: Sustainable wood fuel production – The abatement potential of this component could include: 1) Community benefits through the planting of trees, improved charcoal production systems, and wood for local uses from an 8 year rotation and could sequester carbon of 410 t/ha CO_2-e. Managed on a clear felling basis with uniform age class distribution (equal area of each age), average sequestered carbon would be 162t/ha CO_2-e40; 2) In terms of improved efficiency of charcoal production in the traditional kiln system, 438, 000 tCO_2e emissions reduction could be achieved per kiln through chimney installation for methane flaring and efficient wood packing.

Project 3: Climate smart Agriculture and Watershed Services

Component 1: Promote Climate-Smart Cocoa Landscapes – This project could deliver 8.9 million tCO2 over 20 years (annual average of 440,000 tCO2) in 110,000 ha cocoa landscape that includes forest reserve.

Component 2: Promote Climate-Smart Agriculture (food crops) – Will promote climate smart agriculture in food production systems that could include cassava, plantain, maize, yam, ground-nuts, millet, or sorghum. Climate benefits would result from: 1) enhancement of above ground carbon stocks by planting agroforestry trees on-farm or within the farming landscape that also furnish NTFPs

		for subsistence and markets; 2) conservation or enhancement of soil carbon from the prudent use of fertilizers or planting of nitrogen fixing trees, use of no-burn farming practice and/or adoption of low impact tilling; and 3) avoiding emissions from deforestation associated with clearing forest land for food crop production through community-based land use planning. Promote Watershed Services - The abatement potential of this component will stem from reducing emissions from deforestation/degradation and enhancement of carbon stocks. It will provide adaptation benefits to predicted changes in the climate, and development of a payment for watershed services scheme could also create strong incentives and livelihood benefits.
Non-GHG Effects		Co-benefits will be significant, particularly in terms of biodiversity outcomes (ecological networks and corridors), livelihood and development benefits to forest populations (testing out new policies, rights regimes, management responsibilities, and benefit sharing options), and provision of other ecosystem services. Additional co-benefits are likely to result from the increase yields and thus income (poverty alleviation), diversify production systems and enhance food security (livelihoods), increase or maintain biodiversity in the agricultural landscape, provide watershed services, furnish emissions reductions or removals, and make agricultural systems more resilient.
Funding	Cost	Estimated Amount ($) – 50 million Donors: World Bank, AfDB = 41.5 million Project 1: Securing the integrity of natural forests and woodland resources – 20 million Project 2: Enhancement of carbon stocks – 10 million Project 3: Climate smart Agriculture and Watershed Services – 11.5 million
	Sources	GoG (17%) - 8.5million co-finance
		Private sector – 0%
		Donor - 83% Donor Channel - Multilateral fund (GEF) – World Bank, Africa Development Bank, Financing type – Grant and Concessional Loan
Source of information		Ghana Forest Investment Programme Project document - April,2012

REDD+ Avoided deforestation and Forest Degradation (Result Based Payment Programme)		
General information	Name of action	Cocoa Forest REDD+ Program
	Sector	AFOLU
	REDD+ Stage	Performance based emissions reductions payments
	Scale	Sub-national - High Forest Zone (Cocoa Landscape) covering 5.9million ha. (4.3million ha off-reserve area) and (1.6 million ha on -reserve)
	Gas	CO_2
	Status	Planned (Pipeline)
	Start Year	2016
	End Year	2036
	Phases	Preparation and Design Phase (2014-2015): Early Implementation, Monitoring, and Payments Phase (2016-2020) Performance Based Payments (2020-2036):
Implementation information	Implementing entities	Ministry of Lands and Natural Resources (MLNR) - MLNR will serve on the program's Coordination and Management Committee to ensure integration with FIP projects and related activities. MLNR play a major role in coordinating, managing and implementing the program
		Forestry Commission (FC) - In partnership with Ghana's Cocoa Board, the FC will take responsibility for this program, including its design, management, and implementation.
		Ghana Cocoa Board - Cocoa Board will serve as a co-chair, with the Forestry Commission, of a coordination and management committee to be constituted to lead in the design and implementation of the program.
Objective of Action	Ghana's Cocoa Forest REDD+ Program aims to enable and facilitate a transition to a climate smart Cocoa production system, while concurrently reducing emissions in the landscape. The primary objective of the program is to significantly reduce emissions across the HFZ that are driven by cocoa farming and other key drivers in a manner that will secure the future of Ghana's forests, significantly improve livelihoods opportunities for farmers and forest users, and establish a results-based planning and implementation framework through which the government, the private sector, civil society, and local communities can collaborate..	
Strategy options	Seven strategy options have been identified to tackle the main drivers of degradation and deforestation in the ER Program landscape. These include: Improve quality of multi-stakeholder dialogue and decision-making Clarify right regime Address unsustainable timber harvesting	

	Mitigate effects of agricultural expansion (particularly cocoa in the HFZ) Strengthen local decentralized management of natural resources Expansion of high biomass agroforestry /tree crops systems Improve regulation of mining activities
Objectives assessment	The objectives are: (1) to understand what effect would occur during implementation of the programme; and (2) to track and report on the effectiveness of the Cocoa Emission Reduction Program.
Defining project assessment boundary	*Primary effect* – CO_2 reduction from the avoided emissions from deforestation and forest degradation. This will be achieve by tackling the drivers of deforestation inside and outside forest reserves. The emission reduction will be attained from the reduction in the rate of deforestation and carbon stock enhancement. *Significant secondary effect* – emissions from leakage and domestic displacement are potential secondary effects associated with the Cocoa REDD+ Program.
Identify effects and mapping the causal chain	Reduction in rates of deforestation and forest degradation will lead to avoided emissions from land use change at the cocoa landscape. Additional potential emissions from leakage and domestic displacement may arise from the activities people who are affected by the implementation of the REDD+ program.
Define the GHG assessment boundary	The CO_2 emission reduction from the avoided deforestation and forest degradation is expected to be significant, so they are included in the GHG assessment boundary. The emission from domestic displacement and leakage are excluded because the risk of additional emission is very low.
Forest Reference Level	The ER program REL/FL will be based on an accounting area that is significant in scale, covering more than 5 million hectares and including five (5) eco-zones within which the main cocoa growing areas of Ghana exist. The FRL approach follows the UNFCC guidance as well as the Methodological Framework of the FCPF. The start-date for the Reference Period is 2000 which is 10 years before the end-date, noting that the end date will change to a more recent date as the data becomes available. To arrive at GHG equivalent (tCO_2e) results, the ER Program will use standardized allometric approaches that comply at least with Tier 2 level under the IPCC 2006 guidelines. Projected deforestation and projected reforestation rates for the next 20 years have been modelled using a 10 year historical approach covering 2000-2010. The FRL has been developed based upon a ten year historical average of deforestation—conversion of forest land to crop land. The historical rates of forest cover change were established from available wall-to-wall classified images for the years 2000 and 2010. During this time period land use change classified as deforestation to cropland (the classification of Cocoa under low- / no-shade, as well as other food crops) within the accounting area was determined

to be 14%, equivalent to 1.4% per year. A reforestation rate has not been included in this FRL because it was found to be almost negligible, but this decision will be revisited during the Design Phase.

Emissions from forest degradation have not yet been quantified, although it is estimated from canopy cover analysis in 2010 that activities on approximately 3.1 million hectares or 67% of the forest land within the ER Program area is subject to gradual carbon stock loss.

Data on aboveground biomass and belowground biomass have been divided into three (3) strata with varying carbon stock in the above ground biomass pool:

Closed forest (Intact forest) 155 t C/ha (568 tCO2e)

Open forest (Degraded forest and shaded cocoa farms) 87 t C/ha (319 tCO2e)

Cropland (Deforested landscape containing no-shade cocoa or food crops) is 15 tC/ha (54 tCO2e)

Below ground biomass was estimated using IPCC default values for tropical dry forest of R = 0.28

For reforestation, national data on above-ground carbon increment have been adjusted to apply to

shade cocoa stocking levels and multiplied by a UNFCCC default root-to-shoot ratio to estimate belowground biomass. The preliminary estimate of the average deforestation rate (closed and open canopy forest land to Cropland in the program area (1.4%/year) is equivalent to the loss of 28.5 MtCO2e per year. Over the course of the next 20 years the preliminary FRL analysis suggests that the emissions from deforestation within the program area would be more than 541 MtCO2e due to cocoa farming expansion and practices, as well as other drivers causing conversion of forests.

Year	Total area of deforestation (ha)	Area of deforestation in closed forest (ha)	Area of deforestation in open forest (ha)	Emissions deforestation in open forest (tCO2e)	Emissions deforestation in closed forest (tCO2e)	Emissions deforestation in closed & open forest (tCO_2e)	Residual carbon stock (tCO_2e)	Total emissions from deforestation (tCO_2e)
2016	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2017	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2018	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2019	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2020	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2021	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2022	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2023	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2024	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2025	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2026	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2027	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2028	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942

2029	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2030	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2031	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2032	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2033	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2034	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2035	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
2036	82,168	26,932	55,236	15,306,408	17,640,520	32,946,928	4,458,986	28,487,942
						Total Emissions ($MtCO_2e$)		598.25

Emission Reduction Scenario and Estimated Emission Reductions (ERs)

The ERs were calculated as follows:

Anticipated ERs = [((Area of Deforestation by Forest Type x Emission Factor by Forest Type) – Residual Carbon Stock) x ER Program effectiveness factor]

The ER Program is being designed to cover a period of 20 years, while recognizing the 2020 limitation on the Carbon Fund. The estimate of total expected emissions reductions, based on a conservative estimate of successfully reducing the rate of deforestation by 45% over the lifetime of the program, less a 15% risk buffer, and not including any reduction in forest degradation or increase in reforestation over the 20 year lifetime, is 216,7 $MtCO_2e$.

Over the course of the ER Program design phase, the estimate of total expected emissions reductions will be refined based on more detailed implementation plans including the broadening of the scope of activities. During the first 5 years of the program (2016-2020), the total estimated emissions reductions would come to an emission reduction of 18.5 $MtCO_2e$ compared to the CF's desired goal of 20 million tCO_2e by 2020. It is expected that the long-term volumes would be significant—255 $MtCO_2e$.

Large share of the ERs will be designated to the Carbon Fund. Other potential buyers from the private sector or even carbon market will be considered in the distribution of the emission reductions.

Year	Total emissions from deforestation (tCO_2e)	Programme Effectiveness	Anticipated ERs ($MtCO_2e$)
2016	28487942	0.1	1.4
2017	28487942	0.1	2.8
2018	28487942	0.1	2.8
2019	28487942	0.2	5.7
2020	28487942	0.2	5.7
2021	28487942	0.2	5.7

	2022	28487942	0.3	8.5
	2023	28487942	0.3	8.5
	2024	28487942	0.4	11.4
	2025	28487942	0.4	11.4
	2026	28487942	0.4	11.4
	2027	28487942	0.5	14.2
	2028	28487942	0.5	14.2
	2029	28487942	0.6	17.1
	2030	28487942	0.6	17.1
	2031	28487942	0.6	17.1
	2032	28487942	0.7	19.9
	2033	28487942	0.7	19.9
	2034	28487942	0.7	19.9
	2035	28487942	0.7	19.1
	2036	28487941	0.7	19.11
	Total Emissions ($MtCO_2e$)	598.25		254.5
	Average effectiveness		0.43	
	Buffer Allocation (15% withheld)			38.18
	Net Reductions			216.33
Monitoring Performance over time	The ER Program monitoring system will follow the same design as the national forest monitoring system and will be part of the National MRV system which has specific defined roles for the local people. ER Program will include the collection of ground data to support the Program as well as contributing to the National Forest MRV system. Specifically, the ER Programme will assist in the collection of the relevant ground based data such as biomass inventory, management information and any other information necessary for the ground truthing of remote sensing data within the ER Program Area. The monitoring will also include impact on livelihood and governance.			
Methodology	Methods and Guidance Document (MDG) developed by the Global Forest Observation Initiative (GFOI)			
Assumptions	Emissions from forest degradation have not yet been quantified, although it is estimated from canopy cover analysis in 2010 that activities on approximately 3.1 million hectares or 67% of the forest land within the ER Program area is subject to gradual carbon stock loss.			

	During this time period land use change classified as deforestation to cropland (the classification of Cocoa under low- / no-shade, as well as other food crops) within the accounting area was determined to be 14%, equivalent to 1.4% per year. A reforestation rate has not been included in this FRL because it was found to be almost negligible, but this decision will be revisited during the Design Phase. Emissions from forest degradation have not yet been quantified, although it is estimated from canopy cover analysis in 2010 that activities on approximately 3.1 million hectares or 67% of the forest land within the ER Program area is subject to gradual carbon stock loss. Conservative estimate of successfully reducing the rate of deforestation by 45% over the lifetime of the program, less a 15% risk buffer	
Non-GHG Effects	Farmers' livelihood: One of the main pillars of the program is to substantially increase cocoa farmer incomes by doubling the average yield per ha, and in doing so double income. Doubling yield per hectare, assuming an average production of 400 kg/ha, would result in an additional annual income of $650/ha. Over a 10 year time frame, if the program enabled 20,000 farmers per year to double their yields and then maintain the yield increase over time, then it would result in more than USD 4.3 billion in additional revenue. It is anticipated that this surpasses any potential individual carbon benefit. Biodiversity: Ghana sits within the Guinean Forest Biodiversity Hotspot and is home to many globally important threatened and endangered species. In reducing deforestation and degradation, the program will help to maintain and conserve the biodiversity that is found within the cocoa-forest landscape.	
Funding	Cost	Program Development Cost ($) FCPF - 12.6 million
		Estimated Implementation Cost ($) – 578 million
		Total estimated cost ($) – 590.6 million
	Sources	GoG - 10 million (1.7%) by to 2023 Financing type – Joint investment by Ghana Cocoa board and Forestry commission
		Private sector – 284 million (48.1%)
		Dutch Government - 7 million (1.2%) - Cocoa Rehabilitation and Intensification Programme World Bank Carbon Fund – 50 million (8.5%) - payment for emission reduction Unknown source – 227 million (37.3%) - payment for emission reduction
Source of information	Ghana's Emission Reductions Program for the Cocoa Forest Mosaic Landscape (Cocoa Forest REDD+ Program), 2014.	

Forest Management and Land Use Management		
General information	Name of action	Sustainable Land and Water Management Project (SLMP, SFM and RLM)
	Sector	AFOLU
	Scale	Sub-national – landscape approach in Upper Ghana's savanna
	Gas	CO_2
	Status	On-going (upscaling)
	Start Year	2010
	End Year	2018
	Phases	Additional financing phase – upscaling
Implementation information	Implementing entities	Ministry of Environment, Science, Technology and Innovation (MESTI) – provides overall project management and coordination leadership.
		Environmental Protection Agency (EPA) – Leads the PES and monitoring aspect of SLWM.
		Forestry Commission (FC) - Forest Services Division - implements the newly added sustainable forest management activities
		Forestry Commission (FC) - Wildlife Division - leads planning and implementation of SLWM through biodiversity management in non-agricultural landscapes.
		Ministry of Food and Agriculture (MoFA) – leads the watershed planning and implementation of actual SLWM activities in agricultural landscape
Project targets	Land area where sustainable land and water management practices have been adopted as a result of the project. [2014 = 144.42ha, 2015 = 2,000ha, 2016 = 4,000ha, 2017 = 5,000ha and 2018=6,000ha]. Land users adopting sustainable land management practices as a result of the project. Area reforested within target forest reserves. [2014 = 0ha, 2015 = 300ha, 2016 = 600ha, 2017 = 600ha and 2018=600ha]. Carbon stored in forest ecosystems and emissions avoided from deforestation and forest degradation. [2014 = 0 tCO2/ha, 2015 = 0 tCO2/ha, 2016 = 5.8 tCO2/ha, 2017 =13.3 tCO2/ha and 2018= 26.6tCO2/ha]. Forest area brought under management plans. [2014 = 0ha, 2015 = 56,607ha, 2016 = 126,234ha, 2017 = 172,222ha and 2018=172,222ha].	

Objective of Action	The project supports a comprehensive landscape approach to sustainable land and watershed management at the community level with planning activities at the regional and district levels.
Project Components	Component 1: Capacity building for integrated spatial planning This component provides integrated spatial planning tools (for mapping, analysis, monitoring and evaluation) to strengthen the capacity of SADA to guide and undertake decision-making for land and water related investments across the Northern Savannah region. Spatial planning takes into account ecological units such as watershed and is expected to result in the identification of both large-scale water and flood management infrastructure investments. The component finances establishment of a small spatial planning unit within SADA, mapping and spatial planning exercises, and two pre-feasibility studies of investments identified in the Integrated Water Resources and Flood Management Plan (at the Kambai river basin located on the Black Volta in Lawra district of the Upper West Region and at the Tembe river basin on the White Volta in the Garu district of the Upper East Region). The outputs of Component 1 will guide future water investments in Northern Ghana. *Component 2: Land and Water Management* - This component will scale up support for community flood and land management at the micro-watershed level, including both management of agricultural land and ecological infrastructure through the adoption of SLWM technologies in two additional districts and 88 more communities with stronger focus on rangeland management as one set of SLWM options. The Component will also include new SFM activities in gazetted forest reserves (from GEF SFM funds) aimed at reducing pressures on protected forest estate in Northern Ghana and creating a contiguous management zone of the forests between Gbele Resource Reserve and Mole National Park. Target forest reserves are: Ambalara and Kulpawn Tributaries Forest Reserves where new FMPs will be prepared and key SFM activities implemented. *Systems, capacity and monitoring for sustainable land and water management* - This subcomponent supports strengthening capacities of districts and rural communities for micro-watershed and land use planning; promotion of SLWM practices; and performance monitoring and verification of SLWM activities under subproject agreements. *Implementation of sustainable land and water management in micro-watersheds (subprojects)* - This component will finance SLWM subprojects in agricultural lands and rangelands, including upfront expenditures on provision of inputs and payment of output incentives based on the developed environmental indices linking SLWM technologies. the Sub-Component activities will include: (a) Establishment of community rangelands, including provision of veterinary services; (b) Development of fodder banks for dry season feeding of livestock and watering points; and (c) Support under SLWM agreements (including input and output incentives). *National Sustainable Land Management and Payment for Environmental* –this subcomponent will continue to finance monitoring and evaluation of programs that link local activities to national SLWM objectives, to strengthen their broader impact and replicability. This includes the

	monitoring of environmental services generated in the project area, including vegetation, soil carbon, surface and ground water, through the implementation of the environmental indices linked to the SLWM technologies to support the wider adoption of SLWM and impact of project activities. The Component will continue supporting operation of the GIS based Monitoring and Evaluation system. M*anagement of riparian and other biological corridors* - Specific activities under this subcomponent will include: Implementation of Corridor Management Plan in the Western Biodiversity Corridor, support to Gbele Resource Reserve (GRR) Management, including construction of game viewing platforms and water points within GRR as originally planned and production of maps of GRR and Sustainable Forest Management (SFM). The SFM support reduction of pressures on the forest reserves within the Western Biological Corridor through the following: assessment and diagnostic studies and preparation of forest management plans for effective management of the eight target forest reserves within the project area (Mawbia, Kulpawn Tributaries, and Ambalara (in year 2015), Pudo Hills, Chiana Hills, and Bepona (in year 2016), and Sissili Central and Sissili North (in 2017); assessment of carbon stock above and below ground; and enrichment planting (a total of 600 ha in Ambalara and Kulpawn Tributaries FRs) and natural regeneration in degraded areas (in the remaining six FRs), including watershed and riverine areas; wild fire management training and awareness creation for the FR staff and surrounding communities; establishment of green fire breaks (with a total area of 40 ha) and fire rides along the forest reserves boundaries (the fire rides will be 40 meters wide, as a rule, and will have a cumulative length of 350 km).
Objectives assessment	The objectives are: (1) to understand what effect would occur during implementation of the up-scaling of the project through the additional funding; and (2) to track and report on the effectiveness of the SLWMP.
Defining project assessment boundary	*Primary effect* – CO_2 reduction from forest burning and forest carbon stock enhancement through enrichment planting. *Significant secondary effect* — the following were identified as the potential secondary effects associated with the project activities: (a) CO_2 emissions from fossil fuel use: in site preparation, e.g., on-site mechanical clearing of vegetation and planting preparation, Nursery production of seedlings, (b) Transportation - Products, employees, and herbicides are transported to and from the plantation, resulting in CO2 emissions from the combustion of fossil fuels..
Identify effects and mapping the causal chain	Reduction of emissions through increasing carbon stocks through enrichment planting, SFM, SLM technologies and avoided forest burning will result from improvement of biomass stocks. In addition, erosion control and improved cropping system, fodder management and will add carbon stock to the soil and reduce enteric fermentation through improved animal feed. Site preparation, transportation and nursery production activities that use fossil fuel will produce CO_2 emissions as part of the project implementation.
Define the GHG assessment	The CO_2 emission reduction from the avoided deforestation and carbon stock enhancement is

boundary	expected to be significant, so they are included in the GHG assessment boundary. The emission associated with fossil fuel and chemical use that are associated with the project are included in the assessment boundary
Ex-ante emission reduction estimation	Information on land status and input investment Land information Areas under conservation and enhancement of carbon in non-forest land included degraded lands= 1,333ha Areas under afforestation/reforestation = 1,100ha Areas where SLM technologies have been introduced and adopted = 6,000ha Areas where No burning is practiced due to the project = 2,667ha Livestock information Other cattle - 2,000 Sheep – 8,500 Goats – 7,500 Inputs (Liming, fertilizers, pesticides etc) Urea use due to the project (tonnes of N per year) = 2 Other fertilizers use due to the project (tonnes of N per year) = 170 Compost due to the project (tonnes per year) = 20 Insecticides (tonnes of active ingredients per year)= 0.09 Energy consumption Diesel consumption due to the project = 54.7m3/yr The result of the calculation is in the table below:

Name of the project	Ghana SLWMP		Climate	Tropical (Dry)			Duration (yr)	4			
Continent	Africa		Soil	LAC Soils			Total area (ha)	5244			
Component of	Gross fluxes			Share per GHG of the Balance				Results per year			
the project	Without	With	Balance	Result per GHG				with out	with	Balance	
	All GHG in tCO_2eq			CO_2			N_2O	CH_4			

	Positive = source / negative = sink			Biomass	Soil	Other					
Land Use Changes				CO2-Biomass	CO2-Soil	CO2-Other	N2O	CH_4			
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	-446,319	-446,319	-401,445	-45,426		317	235	0	-111,580	-111,580
Other	0	0	0	0	0		0	0	0	0	0
Agriculture											
Annual	6,247	-15,135	-21,382	0	-18,036		-926	-2,420	1,562	-3,784	-5,345
Perennial	0	0	0	0	0		0	0	0	0	0
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestock											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestock	26,309	26,015	-294				-167	-127	6,577	6,504	-73
Degradation	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	3,042	4,812	1,770			883	887		760	1,203	443
Total	35,598	-430,626	-466,225	-401,445	-63,462	883	111	-2,312	8,900	-107,657	-116,556
Per hectare	7	-82	-89	-76.4	-12.1	0.0	-0.4	0.0			
Per hectare per year	1.7	-20.5	-22.2	-19.1	-3.0	0.0	-0.1	0.0	1.7	-20.5	-22.2
Year 1											-24,200
Year 2											-29,236
Year 3											-53,436
Year 4											-115,368

Monitoring Performance over time

The project has identified the following monitoring indicators in the annual and biannual performance evaluation

Land area where sustainable land and water management practices have been adopted as a

		result of the project Land users adopting sustainable land management practices as a result of the project Area reforested within target forest reserves Carbon stored in forest ecosystems and emissions avoided from deforestation and forest degradation Forest area brought under management plans
Methodology		FAO Ex-ante Carbon Balance tool (standard Edition)
Assumptions		• Project fall within LAC regional soil classifications and dry tropical forest/climate • Growth rate above ground biomass in afforestation/reforestation system up to 20 years = 13tC/ha (country specific) • Growth rate above ground biomass in afforestation/reforestation system after 20 years = 9.8tC/ha (country specific). • Growth rate below ground biomass in afforestation/reforestation system up to 20 years = 7.25tC/ha (country specific) • Growth rate above ground biomass in afforestation/reforestation system after 20 years = 5.4tC/ha (country specific). • Growth rate litter in afforestation/reforestation system after 20 years = 1.7tC/ha (country specific). • Growth rate dead wood in afforestation/reforestation system after 20 years = 3.8tC/ha (country specific). • Growth rate soil carbon in afforestation/reforestation system after 20 years = 76tC/ha (country specific). • Default Rate of soil carbon sequestration (tCO_2/ha/yr) = 1.54 • Residues/Biomass available for burning (t dry matter per ha) = 10 • Default enteric fermentation (kg CH4 per head/year) = other cattle (31), Sheep (5) and Goats (5) • Pasture range and paddock system = other cattle (95%), Sheep (100%) and Goats (100%)
Non-GHG Effects		Expected social benefits include, but are not limited to: enhancement of livelihood sources, job creation, induced development, and the strengthening of local community ownership of sustainable land management investments
Funding	Cost	GEF Grant ($) – 8.75 million

		Total estimated cost ($) – 13.25 million
	Sources	GoG - 4.5 million (34%) Financing type – in kind
		Private sector – 0%
		Donor – GEF Amount – 8.75 million (66%) Financing type – Grant
Source of information		SLWM Project document.