Republic of Botswana

BOTSWANA'S FIRST BIENNIAL UPDATE REPORT (BUR) TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

OCTOBER 2019

Prepared by: Ministry of Environment, Natural Resources Conservation and Tourism

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PREFACE

Botswana’s first BIENNIAL Update Report was compiled by the Ministry of Environment, Natural Resources Conservation and Tourism as part of Botswana’s obligations to the United Nations Framework Convention on Climate Change. The report is prepared in accordance with the United Nations Framework Convention on Climate Change (UNFCCC) Biennial Update Reporting guidelines.

FOREWORD

I am pleased to present to you Botswana's First Biennial Update Report (BUR) under the United Nations Framework Convention on Climate Change (UNFCCC). Climate change negative impact on natural ecosystems is already felt resulting in significant declines in livestock and arable agriculture production impacting millions of people all over the world. Botswana strives towards mainstreaming environmental issues into development planning to minimise climate change impacts.

This report provides an update on information contained in Botswana's Third National Communication (NC3) that will be submitted to the UNFCCC in 2019. The BUR contains information on national greenhouse gas inventory for 2015, ongoing and planned Nationally Appropriate Mitigation Measures (NAMAs); as well as on support received and required.

The Report presents projections of the climate change mitigation measures and their impact assessment up to 2030 taking into account the country's development priorities, objectives and capacities.

Honourable Onkokame Kitso Mokaila

Minister of Environment, Natural Resources Conservation and Tourism

ACKNOWLEDGEMENTS

Botswana's BUR would not have been possible without the cooperation and commitment of numerous experts and stakeholders and the contributions of valuable data from government ministries, agencies, industries, and universities. My sincere thanks also go to the National Climate Change Committee (NCCC), for their hard work and dedication in making this report possible. I would also like to take this opportunity to thank the Global Environment Facility (GEF) and United Nations Development Programme (UNDP) for providing the funds for this report, Special appreciation also goes to the invaluable contribution of the UNDP country office.

Thato Raphaka

Permanent Secretary

Ministry of Environment, Natural Resources Conservation and Tourism

List of Acronyms

ALU	Agriculture and Land Use National Greenhouse Gas Inventory Software Program
BAU	Business-as-usual
BITRI	Botswana Institute for Technology, Research and Innovation
BPC	Botswana Power Corporation
BURS	Biennial Update Reports
CBA	Calculation Based Approach
CFLs	Compact Fluorescent Lamp
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e/CO_2eq	Carbon dioxide equivalent
COP	Conference of Parties
CSO	Central Statistics Office
DFRR	Department of Forestry and Rangeland Resources
DoE	Department of Energy
DMS	Department of Meteorological Services
DTRS	Department of Transport Roads and Safety
DWMCP	Department of Waste Management and Pollution Control
Eq.	Equivalence
FAO	Food Agricultural Organisation
GDP	Gross Domestic Product
GIZ	Deutsche Gesellscraft fur Internationale Zusammenarbeit
Gg	Giga gram
GHG	Greenhouse Gases
GoB	Government of Botswana
GEF	Global Environment Facility
GHG	Greenhouse Gas
GWP	Global Warming Potential

GDP	Gross Domestic Product
ITP	Integrated Transport Policy
Ha	Hectares
HFCs	Hydro-fluorocarbons
HH	Household
IPCC	Inter Panel Convention on Climate Change
IPPs	Independent Power Producers
LEAP	Long Range Energy Alternative Planning
LED	Light Emitting Diode
LFG	Landfill Gas
LPG	Liquid Petroleum Gas
LULUCF	Land Use, Land Use Change and Forestry
MBA	Measurement Based Approach
MENT	Ministry of Environment, Natural Resources Conservation and Tourism
MJ	Mega Joules
MRV	Monitoring, Reporting and Verification
MW	Mega Watt
NAMAs	Nationally Appropriate Mitigation Actions
NA1	Non Annex 1 (Developing country parties to the UNFCCC)
N2O	Nitrous oxide
NC	National Communications
NCCC	National Climate Change Committee
NPV	Net Present Value
PFCs	Per-fluorocarbons
PV	Photovoltaic
QA	Quality Assurance

QC	Quality Control
RE	Renewable Energy
REFIT	Renewable Feed In Tariff
SB	Statistics Botswana
SF6	Sulphur hexafluoride
UB	University of Botswana
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention for Climate Change
WUC	Water Utilities Corporations
GSP	Global Support Program
SNC	Second National Communications
IPPU	Industrial Processes and Product Use

EXECUTIVE SUMMARY

The information provided on national circumstances is an update since submission of the second national communication. Botswana is a landlocked country located in Southern Africa. The country extends between latitudes 22.3285° South longitudes 24.6849° east.

Population
The national population increased from 1,680,863 in 2001 to 2,038,228 in 2011, with an annual growth rate of about 1.9% (Gwebu et al. 2014; Statistics Botswana 2014).

Climate
Botswana's climate is semi-arid. The country is landlocked and has a subtropical desert climate characterized by great differences in day and night temperatures and overall low humidity

Economy
Botswana is an upper middle income country with total Gross Domestic Product (GDP) of 15.68 billion US dollars in 2011. Real GDP growth was an estimated 4.2% in 2018, up from 2.4% in 2017, boosted largely by the recovery in mining and broad-based expansion of non-mining activities.

Energy
The current maximum demand for Botswana is estimated at 681MW and is expected to grow by 336MW to 1017MW by 2025. The current available capacity is estimated at 495MW (300MW from Morupule B, 90MW from Orapa Power Plant and 105 MW from Matshelagabedi). In 2011, the installed capacity supplied a little over 12% of the country's demands while 88% sourced was imported from its neighbours (www.mmewr.gov.bw); (Ofetotse & Essah, 2012).

Transport
Botswana has a newly formulated Integrated Transport Policy (ITP) draft aimed at improving the transportation system in the country. The ITP calls for reduced dependence on road transport. The policy proposes the integration of road, aviation, rail, riverine and other alternative modes of transport such as pipelines. Botswana's road traffic volumes grow daily and this could be avoided through integrated transport planning with other sectors.

Forests
Forest area (% of Land area) in Botswana was last measured at 19.72 in 2011, according to the World Bank. About 11 5351.00ha of Botswana is forested. Botswana's forests contain 646million metric tons of carbon in living forest biomass. Between 1990 and 2010, Botswana lost an average of 118 350ha or 0.86 per year. In total between 1990 and 2010, Botswana lost 17.3% of its forest cover or around 2,367,000ha, (FAO).

Greenhouse Gas Inventories

Botswana GHG inventory for the year 2015 is presented as an update of GHG inventory contained in the Third National Communication for the year 2014. The gases covered are namely carbon dioxide (CO2), methane (CH4), nitrous oxide (N2 O) and sectors covered are Energy, Industrial Processes, Agriculture, Land Use and Land Use Change and Waste.

Table1: Greenhouse gas emissions, by sectors, for Botswana in 2015, Gg

	CO2 emission	CO2 removal	CH4	N2 O	NOx	CO	HFCs
TOTAL without LULUCF (Gg)							
TOTAL with LULUCF (Gg)	6714.08	- 2803.005	147.86	1.45	15.23	253.89	0.548
ENERGY	8295.95		40.47	0.53			
IPPU	1221.139						0.548
AFOLU		- 2803.005	75.830	0.847	15.234	253.892	
WASTE			31.563	0.0745			
INTERNATIONAL BUNKERS	37.8378						
CO2 EMISSIONS FROM BIOMASS	9157.075						
GWP indexed multipliers of CH4, N2 O, SF6 are 21, 310, 23900 respectively.							

Mitigation

Mitigation actions were identified from across all emission sectors mainly land use change and forestry, energy that include stationary and transport, agriculture, and waste. Additionally, the emission potential of the identified mitigation actions were also quantified together with their implementation costs. Specifically, the following are the identified feasible mitigation action;

- Solar Power station
- Solar geysers

- Improved public transport system
- Waste to energy biogas
- Efficient appliances e.g. CFLs and LEDs and fridges
- Solar street lamps
- Improved veldt fire management systems to reduce deforestation

CHAPTER 1

National Circumstances

1.1 Geographic and geological profile

Botswana is a landlocked country located in Southern Africa. The country extends between latitudes 22.3285° South longitudes 24.6849° east. Botswana is topographically flat. It is bordered by South Africa to the south and southeast, Namibia to the west and north, and Zimbabwe to the northeast and with Zambia to the north. A mid-sized country of 581,739km2, Botswana is one of the most sparsely populated nations in the world with a population of just over 2 million people. Around 10 percent of the population lives in the capital and largest city, Gaborone.

1.2 Drainage systems and water resources

Botswana is a water scarce country, with varied rainfall and is highly susceptible to drought. Much of the country depend on groundwater resources to meet the water demand for various sectors of the economy. Groundwater resources are mostly fossil type and caution is exercised in its exploitation to avoid their depletion. However, most of these resources are saline leading to heavy dependence on surface water resources and other alternatives sources such as effluent n and Trans-boundary water transfer schemes.

Surface water resources consists of 7 reservoirs created by major dams, rivers and the wetlands of the Okavango Delta. All of these resources in exception of the Okavango Delta, are vulnerable to periodic drying as a result increasing water demand and variation in spatial and temporal water run off patterns. A very insignificant portion of the total surface area of Botswana is occupied by the surface water resources.

1.3 Demographic

1.3.1 Population and Demographic Profile

Botswana's population increased from 596,900 in 1971 to 1,680,863 in 2001. The national population then further increased from 1,680,863 in 2001 to 2,038,228 in 2011, with an annual growth rate of about 1.9% (Gwebu et al. 2014 (Figure 1); Statistics Botswana, 2014).

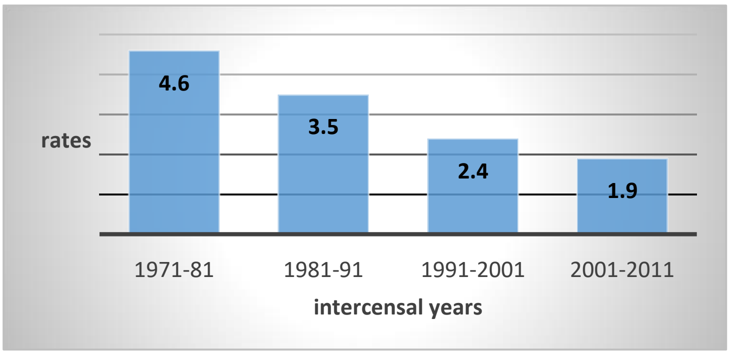


Figure 1. Intercensal Population Growth Rates Source: Gwebu et al, 2014:

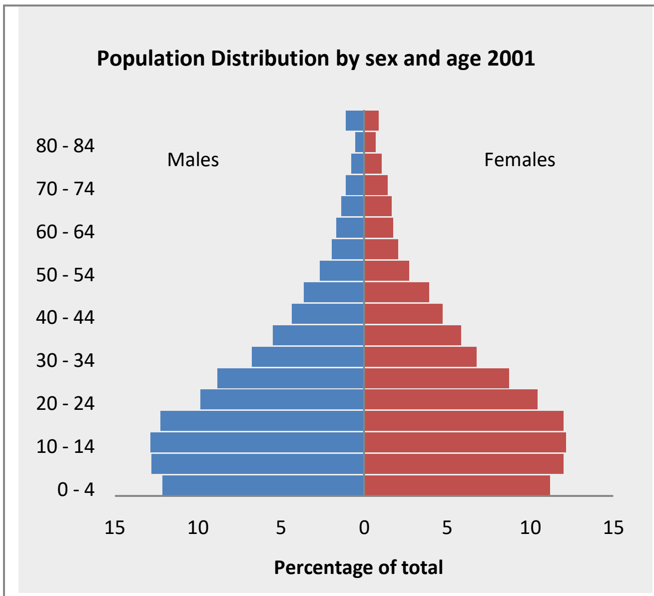
During the 1971 and 2001 inter-censal period, urban population increased significantly, partly due to the reclassification in the 1990s of some settlement areas as urban. In 1971, only about 9.0% of the population were regarded as urban. By 2001 the urban population constituted more than 54.0% of the country's population, while in 2011 about 64.1% of the population were urban (Statistics Botswana, 2014).

The dependency ratio decreased from 71.5 reported in 2001 to 56.7 recorded in 2011, an 8.0% decline (Statistics Botswana, 2014). This might have been attributable to the increase in the size of the economically active population, as well as the decline in the number of children and the elderly.

Trends in the general fertility rate recorded during 1971, 2001 and 2011 censuses reveal that general fertility rate for women aged 15-49 dropped from 189 in 1971 to nearly 107 in 2001, then further dropped from 107 in 2001 to 92 in 2011.

There was a significant decline in Infant Mortality Rate between 2001 and 2011, from 56 to 17. Under-five Mortality Rate saw a decline from 74 in 2001 to 28 in 2011 (Statistics Botswana, 2014). Life expectancy, also, dropped from 65.3 years in 1991 to 55.6 years in 2001. However, in 2011 the country saw an increase in life expectancy at birth, from 55.6 years in 2001 to 68 years in 2011 (Statistics Botswana, 2014).

Botswana's age-sex structure for 2001 shows a typical triangle shaped population pyramid of a country with a relatively high population growth rate, except for the narrowing base (age groups 0-4 and 5-9), which also accounts for the increase in the median age, from 15.7 years in 1971 to 20.1 years in 2001 (CSO, 2004). Comparing the 2001 and 2011 age-sex population pyramids, it is evident from Figure 2 that in 2011 there was resurgence of population in the 0 – 4 age group.



Population Distribution by age 2011

Males Females

80 - 84 70 - 74 60 - 64 50 - 54 40 - 44 30 - 34 20 - 24

10 - 14 0 - 4

20 10 0 10 20

Percentage of total

Figure 2: Botswana's age-sex population pyramids for 2001 & 2011

Source: Gwebu et al. 2014: 7

The distribution of the national population by Planning Regions over the 2001-2011 period shows that the percentage of population residing in each Region increased except for the Eastern Region; this could have been due to net migration from the latter Region to the South eastern Region which recorded the highest net increase (Gwebu, 2014: 12) (Figure 3)

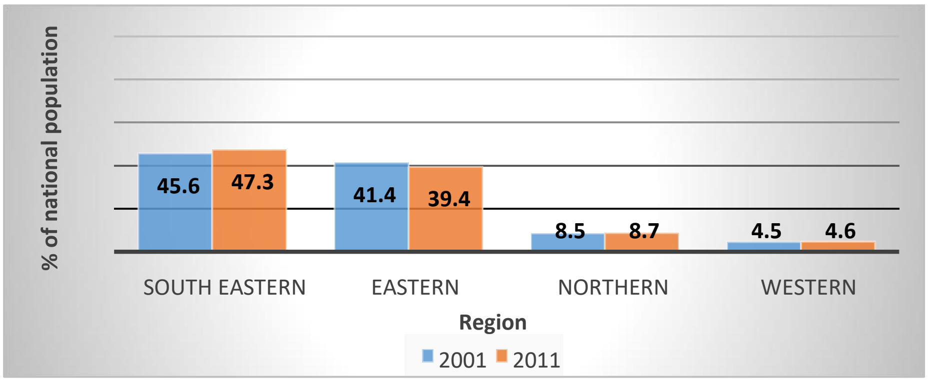


Figure 3: Population Distribution by Planning Area in Botswana, 2011

Source: Gwebu et al. 2014: 13

During the 1971 – 2011 intercensal period, urban population experienced an increase while the rural population suffered a decline. According to Gwebu (2014) the urban population as a percentage of total population was on the increase throughout the census years 1971, 1981, 1991, 2001, and 2011, with 9.1, 17.7, 45.2, 54.1 and 64, respectively.

1.4 Climate

Botswana's climate is semi-arid. The country is landlocked and has a subtropical desert climate characterized by great differences in day and night temperatures and overall low humidity. Though it is hot and dry for much of the year, there is a rainy season which runs through the summer months of October to March. There is little to no rain during the entire winter and humidity is low, typically 20-40%.

Rainfall tends to be erratic, unpredictable and highly spatially variable. The southwest experience the least average annual rainfall of less than 220mmwhile the northeast of the country receives the highest rainfall of approximately 500mm (Figure 6). An analysis of annual rainfall trend for Botswana for the period 1970/71 to 2013/14 for 13 stations across Botswana indicate a general decline.

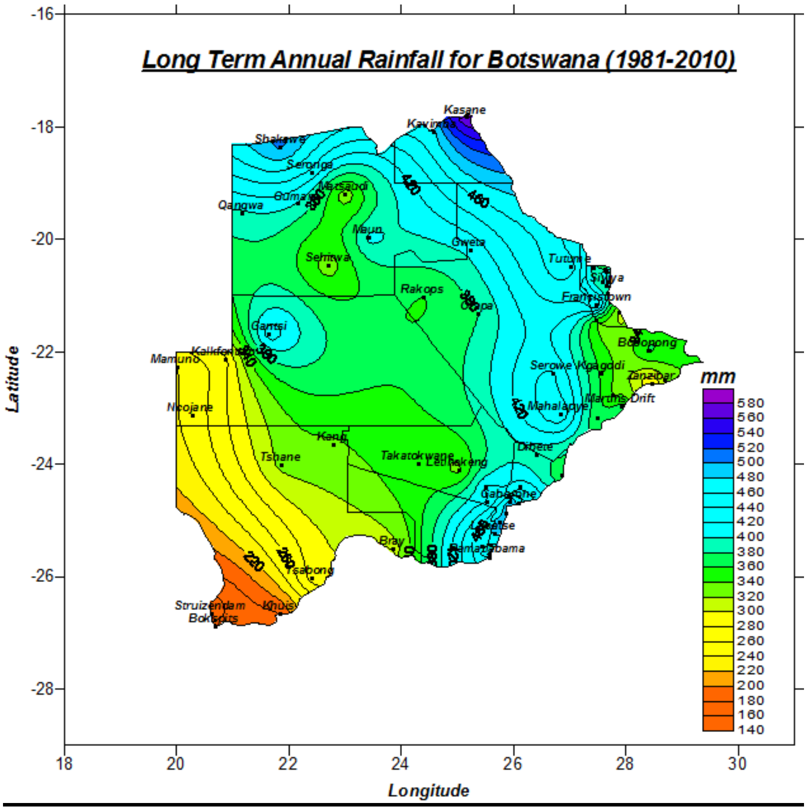


Figure 4: Botswana Annual average rainfall 1981– 2010 (Source: Department of Meteorological Services)

The day time air temperatures during summer months are on average warm to hot due to high insolation, leading to potential evapotranspiration exceeding precipitation rates. The mean monthly maximum temperatures in summer months (October to February) for the past 30 years (1981 – 2010) range from 31˚C to 34˚C (Figure 4). Summer mean monthly minimum temperatures are warm and range from 16 ˚C to 20.5 ˚C for period 1981-2010.

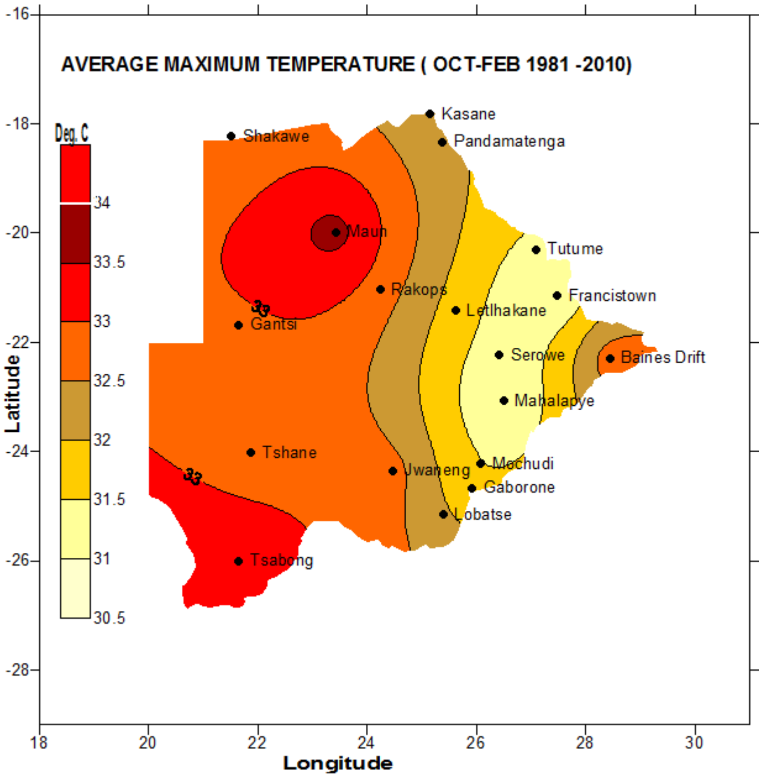


Figure 5: Mean monthly maximum temperature for 30years (1981-2010) (Source: Department of Meteorological Services)

The winter season starting in May to August, has average monthly maximum temperatures range from 22˚C to 29˚C (for the period (1981 – 2010). The season has cool minimum temperatures, indicating between 2.8 to 10.6˚C for the same period (Figure 5). The south western part of the country is colder than the other parts due to its vicinity to the cold dry air from the Benguela current.

The temperature trend is generally increasing in Botswana with minimum temperatures showing a slightly higher increase of 1°C and maximum temperature with an increase of 0.8°C for the period of 1970/71 to 2012/13.

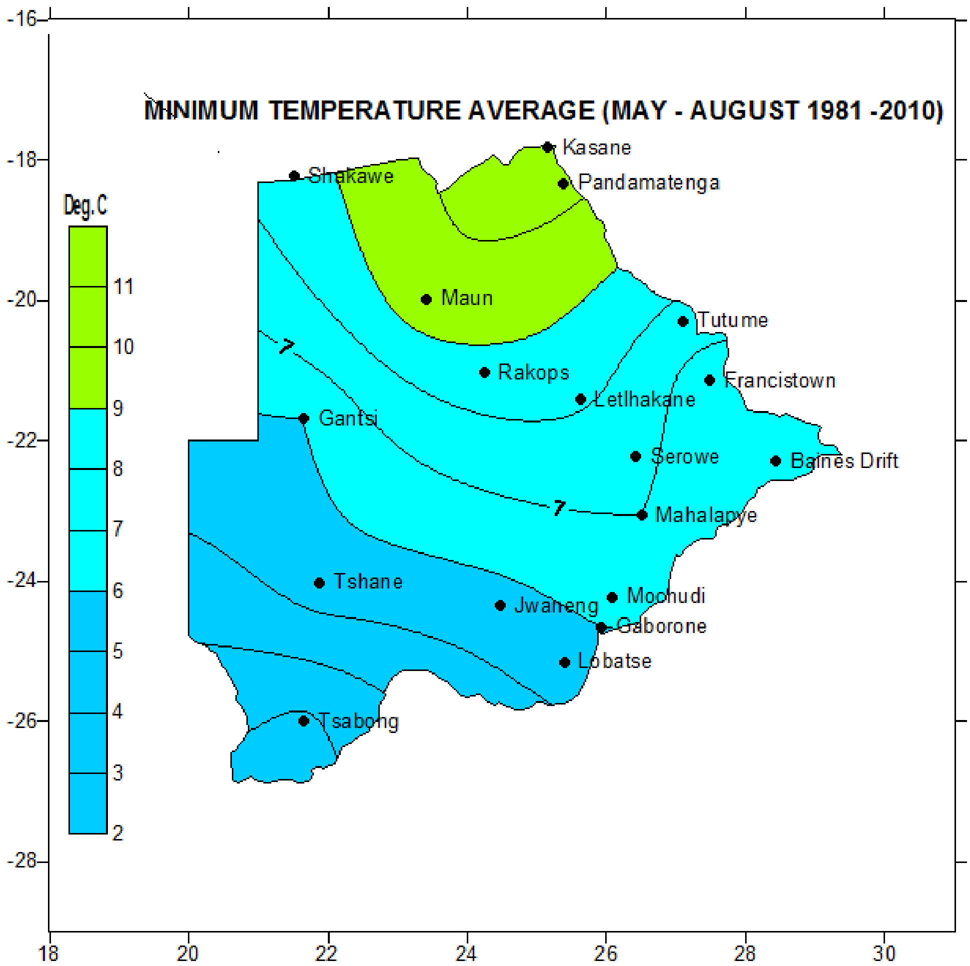


Figure 6: Mean monthly minimum temperature for 30years (1981-2010) (Source: Department of Meteorological Services)

Droughts are recurrent in Botswana. The country experienced moderate to severe droughts in the seasons 1984/85, 1985/86, 1991/92, 2002/03, 2006/07, 2011/12, 2012/13, 2014/15 and 2015/16 which had standardized precipitation indices (SPIs) from -1.0 or below (Figure 9). Conversely, the highest rainfall was experienced during the season 1999/2000 followed by 1973/1974. The diagram also depicts decreasing rainfall trend with large inter-annual variability.

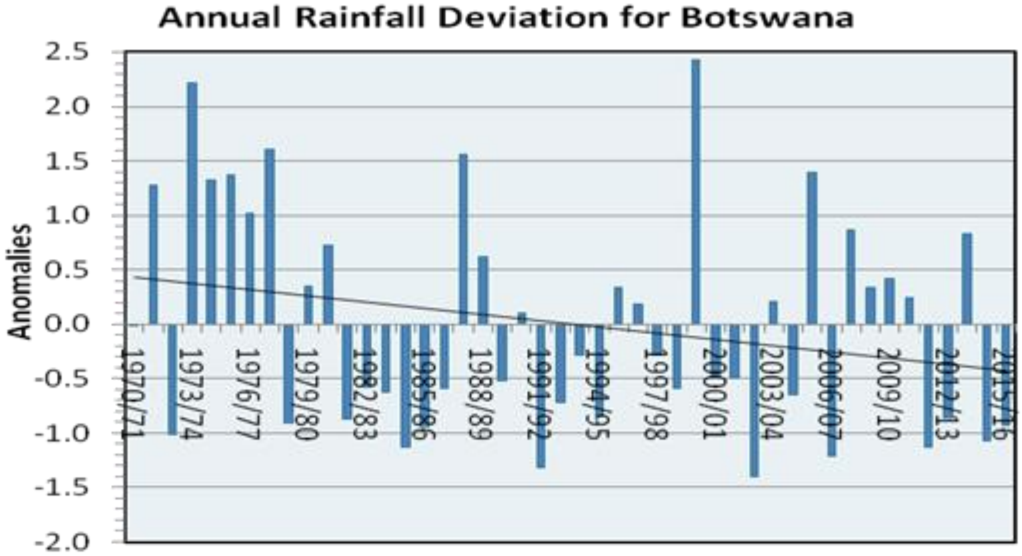


Figure 7: Annual rainfall anomalies (standardized precipitation indices) for aggregated rainfall for the 13 stations (Source: Department of Meteorological Services)

1.5 Agriculture, Forestry and Land Use

1.5.1 Livestock and rangelands

Rangeland covers approximately over 70% of Botswana surface land and its vastness provide a great opportunity for carbon sequestration. Currently, rangeland stores about 0.88 giga tonnes of soil organic carbon (Dintwe et al 2011) and may be further enhanced by increased cover of bushy plants (C3) being observed across the country and also projected to increase in response to climate change. However, degradation of 97 831 km2 of rangeland (Bai et al 2008) in Botswana due to unsustainable management increase the risks of loss of carbon through soil erosion and wildfires. The rangeland productivity is highly depended on rainfall and decline strongly (30 %) in response to drought (Setshwaelo 2003). Maintaining a healthy rangeland ecosystem therefore has multiple benefits including mitigation and adaptation to climate change.

Rangeland ecosystems support livestock production and livelihoods of communities in Botswana. Livestock sector contribute about 65 % of Agricultural GDP, but highly vulnerable to climate change. Currently, livestock is a major emitter of greenhouse gases (GHG) in particular methane through enteric fermentation. High livestock numbers especially ruminants (Figure 8) leads to high emission and low carbon sequestration as more plant biomass is grazed. The costs and emissions from fossil fuels used to pump water are likely to increase due to climate change and Botswana can improve its carbon footprints by switching to clean energy (Solar and windmill). Use of breeds adapted to local environment and improved livestock diets could therefore contribute significantly towards reduced emissions.

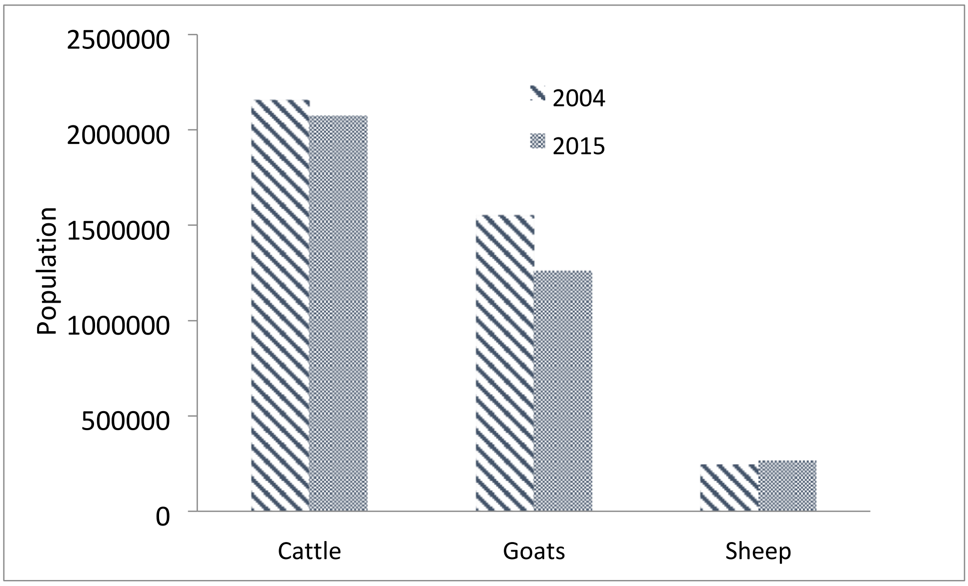


Figure 8: Livestock numbers in Botswana

1.6.2 Forest

Forest area (% of Land area) in Botswana was last measured at 19.72 in 2011, according to the World Bank. Forest area is land under natural or planted stands of trees of at least 5 metres in situ, whether productive or not, and excludes tree stands in agricultural production system and trees in urban parks and gardens.

About 11 5351.00ha of Botswana is forested. Botswana's forests contain 646million metric tons of carbon in living forest biomass. Biodiversity and protected areas; Botswana has some 900 known species of amphibians, birds, mammals and reptiles according to figures from the World Conservation Monitoring Centre, Of these, 0.8% are endemic meaning they exist in no other country, and 1.7% are threatened. Botswana is home to at least 2151 species of vascular plants, of which 0.8% are endemic. 18.1% of Botswana is protected area under IUCN categories I-V.

Botswana vegetation types are closely related with climate. The hardwood forests of the north of the country represent a valuable resource. Over 60% of Botswana land area is covered by sparse savannah woodland and shrub formations. Forests in Botswana are still a versatile renewable resources, simultaneously providing a wide range of economic, social and environmental benefits & services. Derivation of products from forest resources continue to be under great pressure due to human activities; particularly wood, which contributes significantly to fuel energy used in the country. The Botswana Forest Distribution Map (BFDM) has been developed in 2015. According to the BFDM 2015 findings, the forest area in Botswana currently stands at 157,279 km2 (28%), which constitutes Typical Forest: 36, 517 km2 (1%), Riparian Forest: 1, 552km2 (8%) and Woodland: 119, 210 km2 (19%).

1.7 Energy

The country produces 80% of its electricity needs through a state-owned entity, Botswana Power Corporation (BPC). The rest comes mainly from Eskom in South Africa supplemented by EDM in Mozambique and occasionally the rest of the Southern African Power Pool.

The current maximum demand for Botswana is estimated at 681MW and is expected to grow by 336MW to 1017MW by 2025.The country's installed generating capacity stands at 892MW, of which 132MW is under care and maintenance and is currently being refurbished and expected to return to service by the end of 2017. The current available capacity is estimated at 495MW (300MW from Morupule B, 90MW from Orapa Power Plant and 105 MW from Matshelagabedi). In an effort to ensure security of supply and for export additional generation capacity is planned to be developed through independent power producers comprising of 2 x 300MW coal fired plants, one to be located at Morupule B and the other at a site to be determined.

As at September 2016 national access to electricity was 76% and it is expected to increase to 100% by 2030.

Botswana consumes about 1.1 billion litres of liquid fuels (petrol, diesel and illuminating paraffin) and 18 million litres of aviation fuels per annum. The annual average rate of increase in petroleum products demand currently stands at approximately 5%.

Botswana's coal resources are estimated to be over 200 billion tonnes. These abundant coal resources are not yet significantly monetized although coal presents significant development opportunities for Botswana. As at June 2016 there were only 2 measured (proven) coal reserves, namely Morupule and Mmamabula coal basins with capacity of 7.2 billion tonnes. The coal consumption (raw coal) of Botswana is around 1.6 million tonnes per annum (Mtpa) to date. However, in optimal setting, when top three coal consumers (BPC, BCL, Soda Ash) are taking all their allocations, total local raw coal requirements rises to 2.55Mtpa (0.5 Mtpa for Morupule A; 1.8 Mtpa for Morupule B; and 0.25 Mtpa for local consumption). There is only 1 operating coal mine, the Morupule Coal Mine with a total production capacity of about 3.2 million tonnes, but currently at 2.8 million tonnes of production. About 75% of the mined coal is used for power generation and the rest is used in various industries including export. Very little coal is used for household purposes.

The gas industry in Botswana is at its infancy. However, the development of the industry presents an opportunity for the supply of clean thermal energy solutions to households, the hospitality and the manufacturing sectors.

Botswana is endowed with Coal Bed Methane (CBM) resources estimated at 196 trillion cubic feet (tcf) of gas; of which 60 tcf is located in the Kalahari Karoo Basin and 136 tcf in associated carboniferous shales. The exploration of natural gas is ongoing and commercial availability of gas is still to be proven. Woodfuel, in the form of firewood, continues to be a major source of energy for rural and low income urban communities. It is mainly used for cooking, space heating and lighting in rural households.

1.8 Mining

Botswana has several important mineral deposits. Diamonds were first discovered in Botswana in 1967 and are currently mined at Orapa, Letlhakane, Damtshaa, Jwaneng, Karowe, Lerala, Ghagoo and Monarch Ventures mines. The output in 1996 was 17.7 million carats. The diamond mining industry was a key factor in the rapid economic and social development of the country. In the period between 1980 and 1995, diamond exports contributed between 50% and 70% of foreign exchange earnings. Coppernickel reserves have been exploited at Selibe Phikwe since 1973. Since 1984 production has been relatively constant at 49 000 tons of matte. Sale of copper-nickel contributed between 5% and 9% of total exports. Extensive reserves of salt and soda ash are found at Sowa Pan; production in 1995 was 208 and 211 thousand tons of each. Botash, the sole producer of soda ash in the region and supported by substantial government investment, produced 265,000 tons of soda ash in 2005.

Other minerals are known to occur, including gold, manganese and semiprecious stones, but are not mined in significant quantities. Gold is mined by Galane Gold mine near Francistown.

Crushed stone, sand and clay are quarried for construction purposes; the level of production depends on the building industry and large infrastructure projects. The mining sector dominated the economy in 1994 (36% of the GDP) and continues to do so at present.

In 2007, diamonds accounted for 67% of total exports (down from a high of 84% in 2003/2004) and 28% of GDP

Coal reserves in Botswana are estimated to amount to 212.8 billion tons. Exploitation of vast coal resources is on-going with coal having been mined at Morupule Coal Mine since 1976, with 900 778 tons extracted in 1994. African

Energy Resources has recently been given a mining license. Coal-Bed Methane (CBM) gas has been discovered in the north-eastern part of the country, estimated by the developers at a commercially viable quantity of 12 trillion cubic feet. Development of the gas fields has been slow.

1.9 Transport and industry

1.9.1 Railways and roads and airport networks

Roads are currently the predominant mode of transport for Botswana carrying over 90 percent of freight and passenger traffic. Botswana's railway, a 100 percent government owned parastatal, consists of a single main line of 900 km with three short branch lines. It links with the South Africa railway to the south and the Zimbabwe railway to the northeast. Its major business activities are freight traffic of soda ash - export, and raw materials for the textile industry – import. Market access to air transport is quite restrictive in comparison with road transport. Restrictions exist, in particular, for scheduled domestic and international air transport services. The bilateral agreement with South Africa has an important influence on access, frequencies, and prices to Botswana. In addition, improved airport facilities, management, and operation efficiency have become important and urgent issues for the air transport sub-sector.

1.10 Waste

1.10.1 Waste disposal in Botswana

The solid waste generated in Botswana can be classified into five categories. General waste, garden waste, soil, clinical waste and construction waste. The general waste can be primarily classified into two sub-categories, organic and inorganic. The organic waste consists of food waste, garden waste, papers and cardboards, wood and other organic materials. The inorganic waste consists of bottles, cans, plastic, glass, electronic waste, metals and other kinds of waste. The waste is generally not separated but the different types of waste are mixed up by the individual and then thrown into the waste bins. Most of this type of waste is disposed either in landfills or dumping sites and most of the clinical waste is incinerated.

Liquid waste or waste water from both domestic and industries end up in waste water treatment plants and ponds. This is another sources for greenhouse gas emissions where bio-degradation generates methane gas. Wastewater treatment may account for another 10 per cent of anthropogenic CH_4 emissions, both from domestic and industrial waste sources. During biodegradation waste produces methane which is a greenhouse gas. The waste sector contributes to 1% of total Botswana's emissions.

CHAPTER 2

2.1 GREENHOUSE GAS INVENTORY

2.1.1 Introduction

Botswana GHG inventory for the year 2011 is presented as an update of GHG inventory contained in the Second National Communication for the year 2000. The gases covered are namely carbon dioxide (CO2), methane (CH4), nitrous oxide (N2 O), The inventory of gases with indirect greenhouse effect - CO, NOx, SO2, and the emissions of HFCs, PFCs, SF6 compounds were not identified. The estimation of gases such as CO, NOx, SO2 from direct fuel combustion require detailed process information such as combustion conditions of the different types of fuels, size and age of the different engine types and the engine maintenance and operational practices which are currently not available. Include information on other non-direct GHGs: hydro fluorocarbons (HFCs), Perfluorocarbons (PFCs) and sulphur hexafluoride SF6 as well as CO, NOx, SOx and NMVOCs by sources and their removal by sinks, for the year 2011. Sectors covered;

- Energy
- Industrial Processes
- Agriculture o Land Use and Land Use Change
- Waste

Estimation and reporting of GHG inventory are in accordance with the guidelines for the preparation of National Communications UNFCCC decision 17/CP.8 is used for reporting National Communications from Non-Annex I Parties using relevant IPCC guidelines.

2.1.2 Institutional Arrangement for GHG Inventory

The Department of Meteorological Services which is the Climate Change Focal Point, assigned the following institutions to carry out the inventory preparation exercise.

- MENT - Ministry of Environment, Natural Resources Conservation and Tourism
- DMS - Department of meteorological Services
- UB - University of Botswana
- BPC - Botswana Power Corporation
- DWMPC - Department of Waste Management and Pollution Control
- BITRI - Botswana Institute for Technology, Research and Innovation
- SB - Statistics Botswana
- DFRR - Department of Forestry and Range Resources

- BPC - Botswana Power Corporation

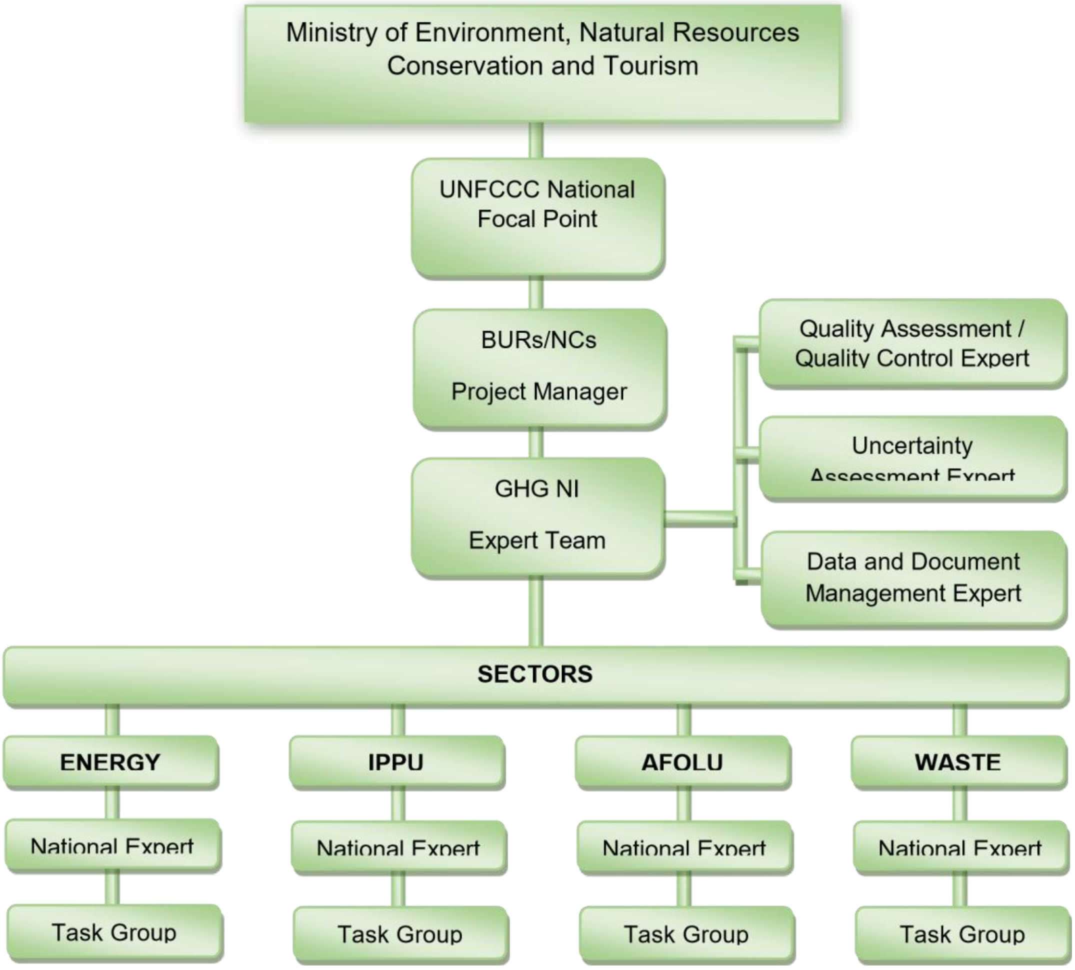


Figure 9: Organisational Chart of the GHG system

2.2 Methodology for GHG Inventory Preparation

The 2015 GHG inventory was compiled using the IPCC 2006 Guidelines Inventory Software Version 2.54 for data entry, emission calculation, results and analysis, for all sectors and the UNFCCC software was used for reporting the GHG inventory trend analysis. Good Practice Guidelines and Uncertainty Management in National GHG Inventories in response to the request from the United Nations Framework Convention on Climate Change (UNFCCC) for the Intergovernmental Panel on Climate Change (IPCC) were also used during preparation of this report.

The 100-year time horizon global warming potentials (GWP) relative to CO_2 adapted from the Second Assessment Report (SAR) were used to convert the estimated CH_4, N_2O and HFCs emissions to CO_2 equivalents. The national inventory has considered three direct GHGs such as CO_2, CH_4 and N_2O. Aggregated GHG emissions and removals expressed in CO_2 equivalent have been provided too. The data used for this GHG inventory were obtained from the stakeholders within the public and private sectors of the economy and Statistics Botswana (SB) provided some other data. . In cases where activity data was not available, the process of estimating the values was through expert knowledge. The default emissions factors and IPCC Tier 1 methodology were used in line with Decision 17/CP.8 of UNFCCC Conference of Parties (COP) 8. Table (2) presents the summary of methodological choices for estimating emissions and removal of greenhouse gases from different sectors.

Botswana's National GHG Inventory is, mostly, a complete inventory of the following direct greenhouse gases: CO2, CH4, N2O and HFCs, and also the indirect GHGs: CO and NOx. Despite the effort to cover all existing sources and sinks, the inventory still has some gaps, most being determined by lack of activity data needed to estimate certain emissions and removals, such as SF6 (Sulphur hexafluoride), PFCs (Perfluorocarbons), NMVOC (Non-Methane Volatile Organic Compounds) and SO2 due to lack of public reporting on their use. In terms of geographical coverage, the reported inventories cover all the administrative districts of Botswana.

The assessment of completeness of the inventory conducted in the report, following the IPCC guidelines, within each source category is summarized in Table 2 below

Table 2: GHG emissions by source category

Greenhouse gas source and sink categories	**CO2**		**CH4**		**N2 O**		**NOx**		**CO**		**NM VO Cs**		**SO2**		**PFC**		**HF C**	
	M	**EF**	**M**	**EF**	**M**	**EF**	**M**	**EF**	**M**	**EF**	**M**	**EF**	**M**	**EF**	**M**	**EF**	**M**	**EF**
1 - Energy	T1	D	T1	D	T1	D	T1	D	NE		NE		NE					
1A - Fuel Combustion Activities	T1	D	T1	D	T1	D	T1	D	NE		NE		NE					
1B - Fugitive Emissions from Fuels	T1	D	T1	D	T1	D	NO		NO		NE		NE					
2 - Industrial Processes and Product Use	T1	D	NO		NO		NA		NA		NA		NA		NE		T1	D

2A - Mineral Products	T1	D	NO				NO		NE		NE		NE					
2B - Chemical Industry	T1	D	NO				NO		NE		NE		NE					
2C – Product Use and Substitutes of Ozone Depleting Substances	NO						NO		NE		NE		NE		NA		T1	D
3 – Agriculture, Forestry and Other Land Use	T1	D	T1	D	T1	D	T1	D	T1	D	NE		NE					
3A - Livestock			T1	D			NE		NE		NE		NE					
3B - Land	T1	D			T1	D	NE		NE		NE		NE					
3C – Aggregate Sources and non-CO2 Sources on Land	T1	D	T1	D	T1	D	T1	D	T1	D	NE		NE					
3D - Other	T1	D	NE		NO		NE		NE		NE		NE					
4 - Waste	NA		T1	D	T1	D	NE		NE		NE		NE					
4A - Solid Waste Disposal			T1	D	NA		NE		NE		NE		NE					
4D – Waste Treatment and Discharge			T1	D	T1	D	NE		NE		NE		NE					

Table 2: Summary of methods and emission factors

T1 = Tier 1

D = IPCC Default values

NA = Not Applicable

NO = Not Occurring

NE = Not Estimated

BOTSWANA NATIONAL GREENHOUSE GAS INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF ALL GREENHOUSE GASES NOT CONTROLLED BY THE MONTREAL PROTOCAL AND GREENHOUSE GAS PRECURSORS

Summary report for GHG emissions inventory

Table 3: GHG inventory - summary report for national GHG Inventory Year: 2015

Greenhouse gas source and sink categories	CO2 Emissions (Gg)	CO2 Removals (Gg)	CH4 (Gg)	N2O (Gg)	CO Gg	NOx (Gg)	NMVOCs (Gg)	SOx (Gg)
Total National Emissions and Removals	30924.74607	51026.3098	188.3880538	40.15672961	140.4853504	8.42793358	0	0
1 - Energy	6894.49287		0	0	0	0	0	0
1A - Fuel Combustion Activities	6878.207216		0	0	0	0	0	0
1A1 - Energy Industries	3657.592822		0	0	0	0	0	0
1A2 - Manufacturing Industries and Construction (ISIC)	1235.518877		0	0	0	0	0	0
1A3 - Transport	1985.096517		0	0	0	0	0	0
1B - Fugitive Emissions from Fuels	16.28565367		0	0	0	0	0	0

1B1 - Solid Fuels	16.28565367		0	0	0	0	0	0
2 - Industrial Processes	540.7236182		0	0	0	0	0	0
2A - Mineral Products	7.67243724		0	0	0	0	0	0
2B - Chemical Industry	533.051181		0	0	0	0	0	0
4 - Agriculture			188.3880538	40.15672961	140.4853504	8.42793358	0	0
4A - Enteric Fermentation			96.877734		0	0	0	0
4B - Manure Management			0	29.9963358	0	0	0	0
4D - Agricultural Soils				9.706582	0	0	0	0
4E - Prescribed Burning of Savannas			91.5103198	0.453811808	140.4655597	8.42793358	0	0
4F - Field Burning of Agricultural Residues			0.000580815	1.50582E-05	0.019790718	0.000537791	0	0
5 - Land-Use Change & Forestry	23505.81524	51026.3098		0	0	0	0	0
5A - Changes in Forest and Other Woody Biomass Stocks	23505.81524				0	0	0	0
5B - Forest and Grassland Conversion		46186.19971			0	0	0	0

5E - Other (please specify)		4840.110092			0	0	0	0
6 - Waste	0		5.288968195	0.085632386	0	0	0	0
6A - Solid Waste Disposal on Land			1.147096485		0	0	0	0
6B - Wastewater Handling			4.141871709	0.085632386	0	0	0	0

2.2.1 Quality Assurance and Quality Control (QA/QC)

The Quality Assurance and Quality Control procedures as defined in the IPCC 2006 Guidelines have been implemented during the preparation of the inventory. Whenever there were inconsistencies or possible transcription errors, the responsible institution was queried and the problem discussed and solved.

Processes implemented for quality control for all sectors included:

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

The quality assurance process was performed after completion of the national inventory calculations by independent reviewers who were not involved with the preparation of the inventory, the main objectives being to review the activity data and emission factors adopted within each source category and check the calculation steps in the software to ensure accuracy

2.2.2 Implementation of QC Procedures

The Tier 1 level of trend assessment as recommended by the 2003 IPCC Good Practice Guidance followed these procedures:

- Emission data were reported in manners consistent with calculation tables for ease of transference to BURS (Biennial Update Reports) and National Communications;
- Confirmation that the total GHG emissions equalled the sum of individual sectorial emissions;
- IPCC software and Agriculture and Land Use National Greenhouse Gas Inventory Software Program (ALU), were used independently for computations of national greenhouse gas inventories for the Agriculture and Land Use, Land Use Change and Forestry sectors for the purposes of ensuring consistency and accuracy;
- Assurance that data in sectorial inventory tables are consistent with text entries in the report;
- Creation of back-ups for all documentations in both hard and soft copies;
- Selection and application of estimation methods are consistent with 2006 IPCC Inventory Software.

2.2.3 Internal and External Review Processes

The GHG Team constituted itself into an internal review party for all sectorial inventory reports. In addition, the Botswana National Climate Change Committee (NCCC) made elaborate inputs into the inventory report at its meetings scheduled for the purpose. In addition to these, the report was subjected to external review by the NCCC secretariat. The external reviewers were from the office of the UNDP (United Nations Development Programme) Global Support Program for National Communications and Biennial Update Reports.

2.2.4 Uncertainty Assessment

Most of the activity data were from primary sources in all categories of the study. This is one of such unique instances for a Non-Annex 1 country. In virtually all instances, therefore, the study had access to uncertainty ranges. In the few instances where the primary source could not be corroborated independently, expert judgement was used to eliminate inherent uncertainties.

2.2.5 National Greenhouse Gas Inventory in 2015

Botswana's GHG emissions in 2015 were 8336.95 Gg CO2 eq from Energy, IPPU 1221.69 Gg CO2 eq, Waste 31.66 Gg CO2 eq AFOLU-2803.005 Gg CO2 eq sectors. The net emission after accounting for the removal was 7131.07 Gg CO2 eq,. GHG emissions according to gases and sectors for 2015 inventory are provided in Table below;

Table 4: GHG emissions according to gases and sectors for 2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 Emissions / removals	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x	HFCs	PFCs*	SF_6*	Other fluorinated
	(Gg)			(Gg)				CO₂ equivalent (Gg)			
Total National Emissions and Removals											

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 Emissions / removals	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x	HFCs	PFCs*	SF_6*	Other fluorinated
	(Gg)			(Gg)				CO_2 equivalent (Gg)			
1. Energy	8295.95	40.47	0.53								
1A. Fuel Combustion Activities (Sectoral Approach)	8292.93	25.38	0.53								
1A1. Energy Industries	5088.82	0.05									
1A3. Transport	2379.60	0.66	0.12								
1A4. Other Sectors	824.50	24.67	0.34								
1B. Fugitive Emissions from Fuels	3.02	15.09									
1B1. Solid Fuels		15.09									
2. Industrial Processes and Product Use	1221.139							0.548			
2A. Mineral Industry	126.418										
2A1. Cement Production	126.418										

2B. Chemical Industry	1094.721										
2B7. Soda Ash Production	1094.721										
2F. Product Uses as Substitutes for Ozone Depleting Substance									0.548		
2F1. Refrigeration and Air Conditioning									0.548		
3. Agriculture , Forestry and other Land Use (AFOLU)	-2803.005	75.830	0.847	253.892	15.234	0	0				
3A. Livestock		66.847									
3A1. Enteric Fermentation		63.682									
3A2. Manure Management		3.165									
3B. Land	-2792.161		0.018								

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 Emissions / removals	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x	HFCs	PFCs*	SF_6*	Other fluorinated
	(Gg)			(Gg)				CO_2 equivalent (Gg)			
3B1. Forest Land	-18019.600										
3B2. Cropland	0.026										
3B3. Grassland	15198.916										
3B4. Wetlands	28.068		0.018								
3B5. Settlements	0.325										
3B6. Other Land	0.104										
3C. Aggregate Sources and Non-CO_2 Emissions Sources on Land	0.243	8.984	0.829	253.892	15.234						
3C1. Biomass Burning	0	8.984	0.829	253.892	15.234						
3C2. Liming	0.091										
3C3. Urea Application	0.153										
3D. Other	-11.087										
3D1. Harvested Wood Products	-11.087										

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 Emissions / removals	CH_4	N_2O	CO	NO_x	NMVOCs	SO_x	HFCs	PFCs*	SF_6*	Other fluorinated
4. Waste		31.5 63	0.07 45	0	0	0	0				
	(Gg)			(Gg)				CO_2 equivalent (Gg)			
4A. Solid Waste Disposal		27.813	0	0	0	0	0				
4D. Wastewater Treatment and Discharge		3.75 1	0.0745	0	0	0	0				
Memo items											
International bunkers	37.8378	0.0003	0.00 1								
International Aviation	37.8378	0.0003	0.00 1								
CO_2 Emissions from Biomass	9157.07 5										

Notes:
** Optional for Level 1 and Level 2 reporting*
Note: Shaded cells are not applicable. Cells to report emissions of NOx, CO, NMVOC and SO2 have not been shaded although the physical potential for emissions is lacking for some categories.
Source: Table 1 and Table 2 in the annex to UNFCCC decision 17/CP.8, Table A.15 in Ellis et al. 2011 and Table A Summary Table of IPCC 2006 GL, Vol. 1 Ch. 8 Annex 8A.2

Table 5:

Table 5: Summary of GHG Emission from All Sectors

Sectors	Emissions CO_2 eq (Gg)	Sink CO_2 eq (Gg)
Energy	8336.95	
Industrial Processes	1221.69	
AFOLU		-2803.005
Waste	31.66	
Total emissions	7131.07	

2.2.7 Share of Sectors and Gases

Energy sector dominates by accounting for 87%, followed by IPPU 13% and Waste and AFOLU account for 0%.

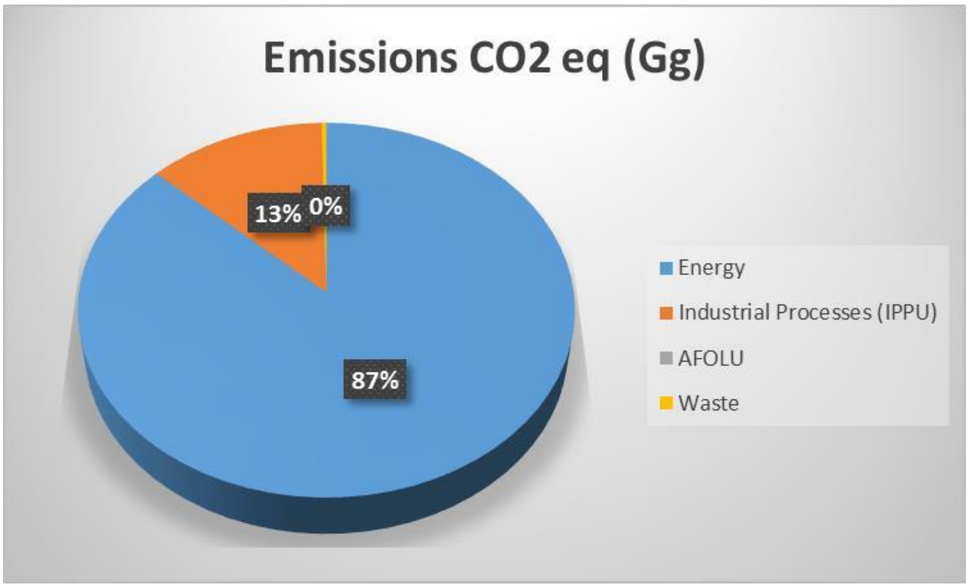


Figure 10: GHG emissions by sector

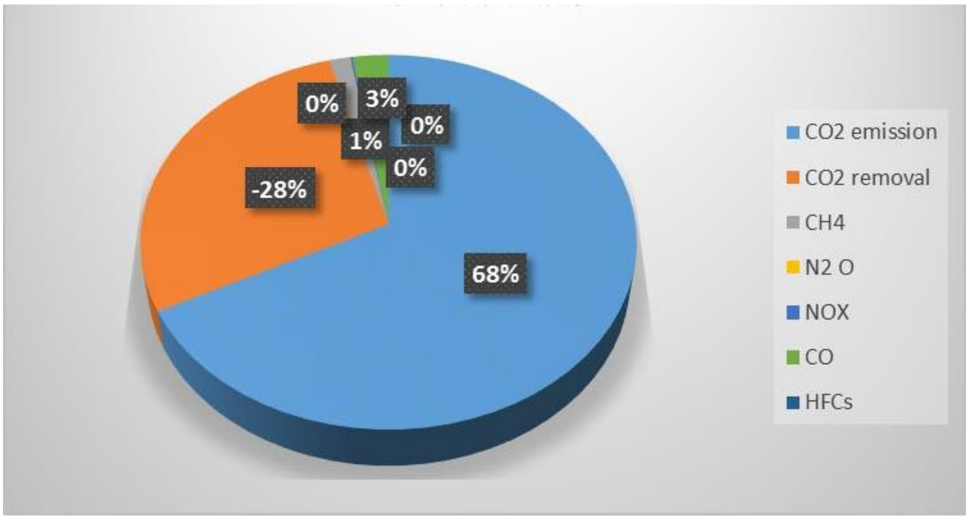


Figure 11: GHG emissions by gases

GHG emissions according to gases for 2015 inventory are provided in Figure 8. From figure 11 it can be observed that CO2 emissions dominate the total GHG emissions by accounting for 68%, followed by CO with 3%, and CH4 with 1% and N_2O, NOX and HFCs with 0%.

2.3 Sectoral Description

Energy

Botswana's energy sources consist primarily of electricity, fuel wood, and Liquefied petroleum gas (LPG), petrol, diesel and aviation gas. Solar, biogas and biodiesel constitute a small proportion, about 1%. Fuel wood usage has been declining over the years while LPG and electricity consumption has been on the rise. This is mainly attributed to the rising level of affluence as well as the increased access to electricity. Fuel wood continues to play a significant role as an energy source for many households, especially in rural areas. It is the principal energy source used for cooking in 46% of the households nationally; and in 77% of households located in rural areas. This represents a decline from around 90% in 1981 but still significant enough to attract policy attention. Peak power demand is set to increase from 578 MW in 2012 to 902 MW by 2020, a 56% increase.

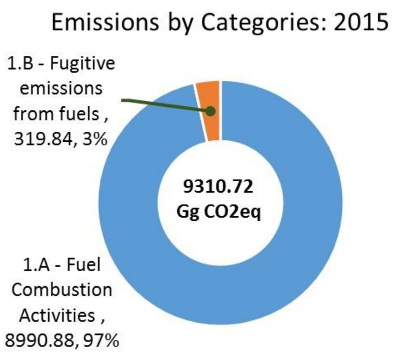
The major energy consumers in Botswana are residential, transport and industry at 42, 27 and 23% respectively (SNC, 2011). This sector provides estimates of GHG emissions resulting from electricity and heat production activities, and fuel combustion for energy generation purposes for the base year 2015, the percentage of wood-fuel and petroleum products will be accounted for under the land-use change and forestry sector. It is estimated that wood-fuel accounts for as much as 34% of the country's total energy consumption, while petroleum products account for about 45%.

In 2015, Energy Sector accounted for approximately 73.8% of total national direct GHG emissions (without LUCF). This sector is the major source of GHG emissions at the national level. Energy Sector was also a significant source of

CO_2 and N_2O emissions, accounting for approximately 87.2%, and 87.7%, respectively, of total CO_2 and N_2O (in Gg CO_2-eq) emissions registered at the national level. Methane contributed to about 29.1% emission to the 2015 national CH_4 emissions.

Table 6 Summary of GHG emissions from the energy sector for 2015

GHG Categories	Emissions							
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOCs**	**SO2**	**TOTAL**
Unit	**Gg CO2eq**			**Gg**				**Gg CO2eq**
1 - Energy	**8295.95**	**849.81**	**164.96**					**9310.72**
1.A - Fuel Combustion Activities	8292.93	533.00	164.96					8990.88
1.B - Fugitive emissions from fuels	3.02	316.81	0.0 0					319.84



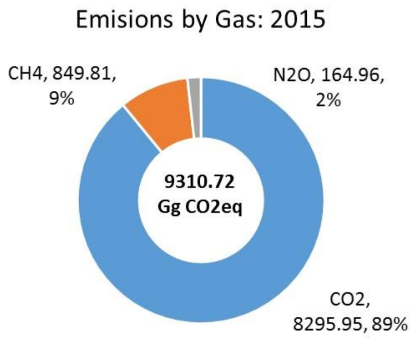


Figure 12: Proportions of the GHG Emissions by Energy Categories and by Gas: 2015 Table: Energy sector CO_2 emissions estimated by reference approach and Sectoral approach for 2015

In 2015, the total emission under this sector was 9310.72 Gg CO2eq. A large proportion of the GHG emissions within the energy sector arose from the Fuel Consumption Activities–1.A (8990.88 Gg CO2eq; a 96.6% contribution to the total energy sector) with emissions from Energy Industries–1.A.1 (5114.96 Gg CO2eq; a 56.9% contribution to the Fuel Consumption Activities), from the Main Activity Electricity and Heat Production–1.A.1.a subcategory. Contribution of Energy Industries to the Energy Sector are 100% entirely from the Electricity Generation–1.A.1.a.i.

Emissions from the Transport–1.A.3 subcategory were 2429.52 Gg CO2eq (27.0% contribution to the Fuel Consumption Activities). A large proportion of emissions from the transport subsector comes from Road Transportation–1.A.3.b (specifically

Cars–1.A.3.b.i), which accounted for 2401.14 Gg CO2 eq (98.8%) whereas the rest arose from Civil Aviation–1.A.3.a, under the Domestic Aviation–1.A.3.ii subsection with 69.44 Gg CO2eq (1.2%).

The “Other Sectors”, which include; Commercial / Institutional–1.A.4.a (738.94 Gg CO2eq; 51.1% contribution to the “Other Sectors”), Residential–1.A.4.b (662.56 Gg

CO2eq; 45.8% contribution to the “Other Sectors”) and Agriculture / Forestry /Fishing / Fish Farms–1.A.4.c, specifically from Stationary–1.A.4.c.i subcategory (44.90 Gg CO2eq; 3.1% contribution to the “Other Sectors”) contributed to about 1446.40 Gg CO2eq (which is a contribution of 16.1% to the Fuel Consumption Activities).

The Fugitive Emission from Fuels–1.B emitted only 319.84 Gg CO2eq, about 3.4% of total GHG emissions from the 2014 energy sector. Greenhouse emissions under this sector emanate almost entirely (292.17 Gg CO2eq; 91.3%) from Coal Mining and Handling–1.B.1.a; under the Underground Mines–1.B.1.a.i specifically the Mining– 1.B.1.a.i.1 subsector, with Post-mining Seam Gas Emission contributing to 27.67 Gg CO2eq (8.7%) to the Fugitive Emission from Fuels.

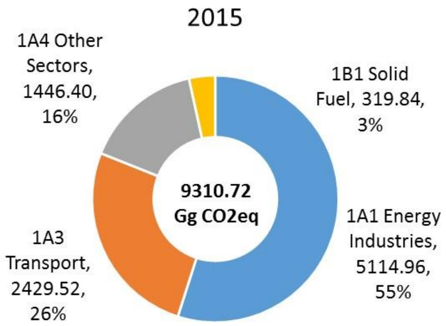


Figure 13: Proportions of the Energy GHG Emissions by Categories for 2015

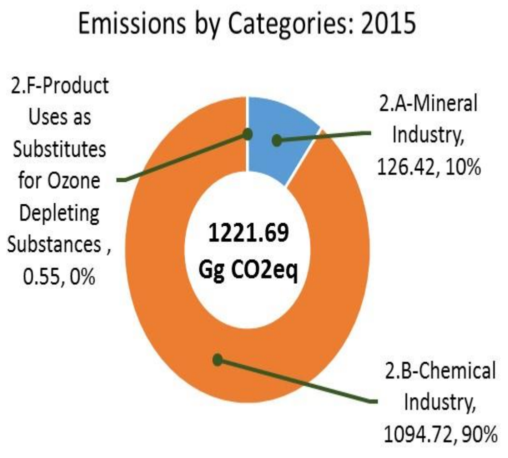
Industrial Processes and Product use (IPPU)

Botswana is not heavily industrialised, there are only a limited number of industries that produce and use of solvents there are two main industrial processes in Botswana that contribute meaningfully to the national GHG inventory, soda ash production plant and production of cement. This sector provides estimates of GHG emissions resulting from two main subcategories: Cement Production (2.A.1; under the Mineral Industry Category–2.A) and Soda Ash Production (2.B.7; under the Chemical Industry Category–2.B). In addition, Botswana reports, in this document, GHG emissions under the Product Uses as Substitutes for Ozone Depleting Substances–2.F Category, specifically, the Refrigeration and Stationary Air Conditioning–2.F.1.a Subcategory.

The IPPU Sector Emissions

In the year 2015, IPPU Sector accounted for approximately 9.7% of total national direct GHG emissions (without LUCF). This sector ranks at number three (3) source of GHG emissions at the national level. The sector is a source of CO2 and HFC emissions, accounting for approximately 12.8%, and 100%, respectively, of total CO2 and HFC (in Gg CO2-eq) emissions registered at the national level.

Percentage contributions by major categories and by gas within the IPPU sector are given in Figure 3-13, respectively



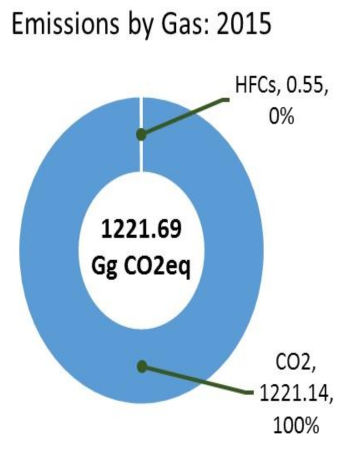


Figure 14: Proportions of the GHG Emissions by IPPU Categories and by Gas: 2015

In 2015, the total emission under this sector was 1221.69 Gg CO2eq. A large proportion of the GHG emissions within the IPPU sector arose from the 2.B-Chemical Industry– 2.B (094.73 Gg CO2eq; about 89.6% contribution to the total IPPU sector) with Soda Ash Production– 2.B.7 providing a 100% CO2 contribution to the subcategory.

Emissions from the Mineral Industry–2.A subcategory were 126.42 Gg CO2eq (about 10.3% contribution to the sector) with Cement production–2.A.1 providing a 100% CO2 contribution to the subcategory.

Greenhouse gas emissions from the Product Uses as Substitutes for Ozone Depleting Substances–2.F (0.55 Gg CO2eq; just under 0.05% contribution to the total IPPU sector) category comes from Refrigeration and Air Conditioning–2.F.1 (specifically from the Refrigeration and Stationary Air Conditioning 2.F.1.a) and emits HFC-152a (CH3CHF2) at a 100% contribution to the HFCs in Gg CO2-eq.

Details of GHG emissions from the IPPU sector by gas type and source in 2015are presented in Table 3-16 and Figure 3-15, respectively.

Table 7: GHG emissions from the IPPU sector by gas type and source in 2015

GHG Categories	**Emissions**							
	CO2	**CH4**	**HFC**	**NOx**	**CO**	**NMVOCs**	**SO2**	**TOTAL**
Unit	**Gg CO2eq**			**Gg**				**Gg CO2 eq**
2 - Industrial Processes and Product Use	**1293.44**		**0.55**					**1221.69**
2.A - Mineral Industry	126.42		0.00					126.4 2
2.A.1 - Cement production	126.42							126.4 2
2.B - Chemical Industry	1094.72		0.00					1094.72
2.B.7 - Soda Ash Production	1094.72							1094.72
2.F - Product Uses as Substitutes for Ozone Depleting Substances			0.55					0.55
2.F.1 - Refrigeration and Air Conditioning			0.55					0.55
2.F.1.a - Refrigeration and			0.55					0.55

Stationary Air Conditioning								

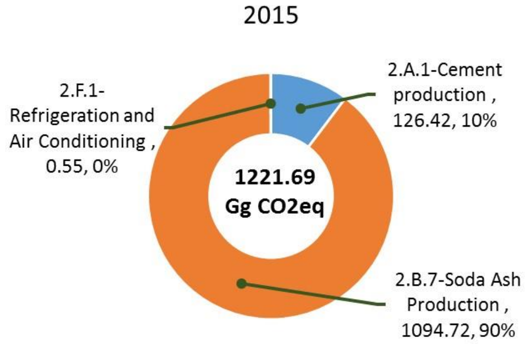


Figure 15: Proportions of the IPPU GHG Emissions by Categories for 2015

Waste

This sector provides estimates of GHG emissions resulting from two main categories: Solid Waste Disposal–and Wastewater Treatment and Discharge, particularly Domestic Wastewater Treatment and Discharge subsector.

In the year 2015, Waste Sector accounted for approximately 5.4% of total national direct GHG emissions (without LUCF). This sector is the least source of GHG emissions at the national level. Gases emitted under this sector are CH4 and N2O. Methane accounts for approximately 21.3%, of total methane (in Gg CO2-eq) emissions registered at the national level, whereas N2O registered 12.3%.

Percentage contributions by major categories and by gas within the waste sector are given in Table 3-33 and Figure 3-28, respectively.

Table 8: Summary of GHG emissions from the waste sector for 2015

GHG Categories	**Emissions**							
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOCs**	**SO2**	**TOTAL**
Unit	**Gg CO2eq**			**Gg**				**Gg CO2eq**
4 - Waste		**621.33**	**23.09**					**685.92**
4.A - Solid Waste Disposal		543.99						584.07
4.D - Wastewater Treatment and Discharge		77.3 4	23.09					101.85

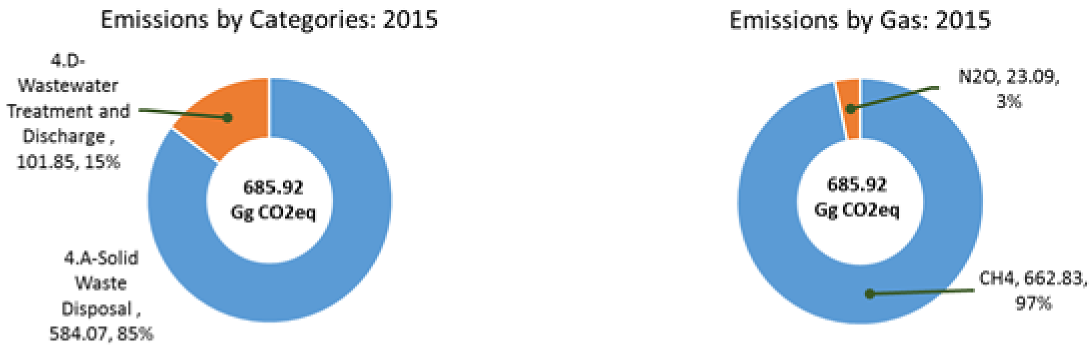


Figure 16: Proportions of the GHG Emissions by Waste Categories and by Gas: 2015

Details of GHG emissions from the Waste sector by gas type and source in 2015 are presented in Table 3-35.

Table 9: GHG emissions from the Waste sector by gas type and source in 2015

GHG Categories	**Emissions**							
	CO 2	**CH4**	**N2 O**	**NO x**	**C O**	**NMV OCs**	**S O2**	**TOTAL**
Unit	**Gg CO2eq**			**Gg**				**Gg CO2eq**
4 - Waste		**662.83**	**23.09**					**685.92**
4.A - Solid Waste Disposal		584.07	0.0 0					584.07
4.D - Wastewater Treatment and Discharge		78.7 6	23.09					101.85
4.D.1 - Domestic Wastewater Treatment and Discharge		78.7 6	23.09					101.85

Table 10: Botswana's Key Categories Identified under the Waste Sector: 2015

IPCC Category		GHG	Identification Criteria
Code	Description		
4.A	Solid Waste Disposal	CH4	L

L = Level Assessment; T = Trend Assessment

The AFOLU Sector

This sector provides estimates of GHG emissions as follows:

Agriculture, Forestry, and Other Land Use (AFOLU), based on four clusters: Livestock–Land Aggregate sources and non-CO2 emissions sources on land– and Other Harvested Wood Products. Each category was further disaggregated into activities that contributed to emissions /removals.

In the year 2015, AFOLU accounted for approximately –2803.00 Gg net CO2 emissions. Greenhouse gas emissions from CH4 and N2O were 1592.44 Gg CO2eq and 262.62 Gg CO2eq, respectively. Without LUCF, AFOLU accounted for 1403.78 Gg CO2eq, that's is, approximately 11.1% of total national GHG emissions. This sector is the second major source of GHG emissions at the national level. Emissions and removals of GHG are given in Table 11, Figure 17.

Table 11**:** Summary of GHG emissions from the AFOLU sector for 2015

GHG Categories	**Emissions**					
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**TOTAL**
Unit	**Gg CO2eq**			**Gg**		**Gg CO2eq**
3 - Agriculture, Forestry, and Other Land Use	-2803.00	1592.44	262.62	262.62	262.62	-947.94
3.A - Livestock	0.00	1403.78				1403.78
3.B - Land	-2792.16		5.55	5.55	5.55	-2786.61
3.C - Aggregate sources and non-CO2 emissions sources on land	0.24	188.66	257.07	257.07	257.07	445.98
3.D - Other	-11.09					-11.09

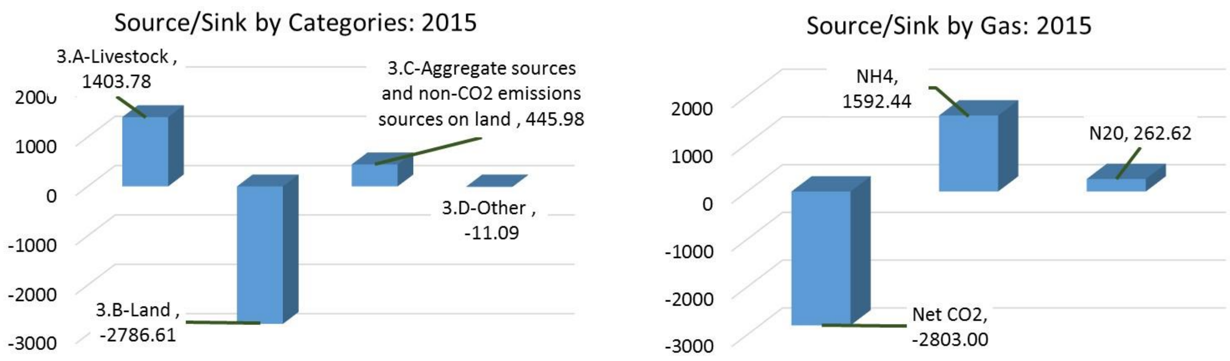


Figure.17: GHG Source and Sink from AFOLU Sector by Categories and by Gas: 2015

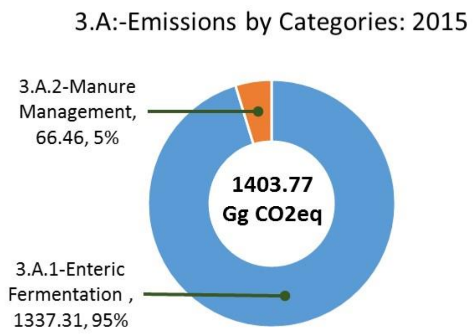


Figure.18: GHG Emissions from Livestock Categories: 2015

AFOLU Sector Key Sources for 2014 and 2015

Key category assessment under the AFOLU sector was performed following the 2006 IPCC Tier 1 approach. Information on the sector's identified key categories (by level and trend assessment) is presented in Table 12 for 2015,

Table 12: Botswana's Key Categories Identified under the AFOLU Sector: 2015

IPCC Category		GHG	Identification Criteria
Code	Description		
3.A.1	Enteric Fermentation	CH_4	L,T
3.B.1.a	Forest land Remaining Forest land	CO_2	L,T
3.B.1.b	Land Converted to Forest land	CO_2	L,T
3.B.3.b	Land Converted to Grassland	CO_2	L,T

L = Level Assessment; T = Trend Assessment

CHAPTER 3

3.1 MITIGATION ACTIONS AND THEIR EFFECTS

3.1.1 Mitigation measure and their potential emission reduction

The chapter details the feasible and cost-effective mitigation actions that Government of Botswana can implement without necessarily impeding economic growth and development. Mitigation actions were identified from across all emission sectors mainly land use change and forestry, energy which include stationary and transport, agriculture, and waste. Additionally, the emission potential of the identified mitigation actions were also quantified and their implementation costs.

3.2 Methodology

Desktop review was undertaken to identify suitable GHG inventory methods, baseline GHG emissions and mitigation projects. Documents such as First and Second National Communications, Energy annual reports, were also reviewed to identify mitigation measures, their GHG emission reduction potential and implementation status. Long Range Energy Alternatives planning system (LEAP): LEAP a computer-based model that calculates the country's energy balance (supply and demand) and the corresponding GHGs emissions over a defined time slice was used. Expert review was also used to identify mitigation actions.

Assumptions

- Economic growth- in projecting GHG emission under both business as usual and improved technological advancement it is assumed that the economy will grow at 2% up to 2030.
- Population growth rate- it is also assumed that population will growth at annual rate of 3% for the entire duration the simulation period. This population growth is based on observed growth of 3% annually.
- An enabling environment for mitigation projects – for the low emission pathway, it was assumed that a conducive environment will be created to encourage investment into mitigation projects by both the private (farmers, households, businesses etc) and the public sector. The conducive environment included removal of subsidies for fossil fuels (coal and petroleum products) and at the same time introduction of subsidies for RE projects, and tax rebates for smart and energy sustainable building.
- Improved energy policies: it is also assumed that households and small scale solar energy generator will be able to sell excess electricity to Botswana Power

Corporation. This will encourage the private sector to invest in solar systems.

- Sufficient funding for the mitigation projects- under the improved technological advancement which will coincide with the GHG emission low pathway, it is assumed that there will be sufficient funding for implementation of the identified mitigation projects. In addition, the funding will be able to sustain the operations and maintenance of the identified mitigation projects
- Technological advancement- the country will embrace technological on mitigation projects particularly RE, transportation and retrofit innovative solutions for energy efficiency.

Specifically, the following are the identified feasible mitigation action;

- **Solar Power station:** This is one of the feasible and viable mitigation actions. According to the draft Energy Policy, the proposed goal for renewable sources of energy is to maximise their potential in meeting the socio-economic needs of the country. Moreover, GoB has set a target to increase the use of renewable energy to 25% by 2030. Through the amendment of the Electricity Supply Act in 2007, Independent Power Producers (IPPs) are now permitted to participate in the sector. The objectives of investing in PV power plants include the following:
  - To contribute to economic growth through provision of reliable energy at the rural sector and thus support rural economic sector
  - To diverse the energy sector and reduce national reliance on coal powered energy generation
  - To achieve energy national reliance and energy security with less dependence on energy imports.
  - To achieve environmental sustainable through promotion of green growth strategies which have low ecological footprint with emphasis on RE
  - To contribute to global effort of reducing GHG emissions and thus achieving the global target of limiting the increase in the earth's global average surface temperature to 2°C (3.6°F) above the preindustrial level
- **Solar appliances** include solar water pumps for groundwater pumping, solar streetlights, solar geysers at household and institutional houses. Implementation of the solar appliances will effectively reduce consumption of coal generated electricity. The objectives of government emphasis on solar electricity appliances are as follows:

- Reduce the cost of operation for the farming sectors and hence increase profitability of the beef and water utility sector
- Reduce dependency on unsustainable coal fire powered stations
- Reduce petroleum imports and corresponding high import bills from both electricity and petroleum imports
- Reduce GHG emissions and control to the global efforts of achieve the Paris Agreement target of keeping global temperature from rising above dangerous levels
- Ensure that villages that are not connected to the national electricity grid system have reliable streetlights

• **Improved public transport system:** The Transport sector falls under the energy sector and classified as mobile sources. It can be categorised as rail, road, water and air. The Draft Energy Policy indicates that the sector relies on imported petroleum fuels (well over 800 million litres per annum) and is the major consumer of petroleum products in Botswana (38%), of which more than 90% of the petroleum is being used on road transport. All rail traction is diesel powered and accounts for some 3 % of diesel usage in the transport sector. Road and air transport and associated transport fuels are consumed primarily as intermediates and benefit from petroleum products being regulated where appropriate. The objectives of this mitigation action are as follows:

- to improve the public transport systems which will encourage the public to use public transport systems
- to reduce high import bill from petroleum imports to reduce traffic congestion in the capital city
- Reduce GHG emission and contribute to global efforts of achieve the Paris Agreement target of keeping global temperature from rising above dangerous levels

• **Waste to energy biogas** Energy provision is generally about innovating around and exploiting the country's indigenous and locally generated raw materials. Thus methane capture is another innovative feasible and highly viable mitigation measure as all landfills constructed in the country require construction of gas capture systems to avoid landfill gas build-up and potential explosion of the landfills. The objectives of capturing methane for energy use include:

- To diverse the energy sector and reduce national reliance on coal powered energy generation
- To achieve environmental sustainable through promotion of green growth strategies which have low ecological footprint with emphasis on Renewable Energy.

- To contribute to global effort of reducing GHG emissions and thus achieving the global target of limiting the increase in the earth's global average surface temperature to 2°C (3.6°F) above the preindustrial level

- **Efficient appliances** e.g. CFLs and LEDs and fridges Energy efficient appliances is activity pursued by the Government of Botswana as evident from replacement of energy efficient lighting and encouraging other efficient appliances. The objectives of replacement inefficient appliances with efficient appliances are as follows:
  - To reduce national electricity consumption and corresponding generation to sustainable levels
  - Reduce importation of electricity and associated electricity import bills which affect the government trade imbalances
  - To achieve cost effectiveness at both the household and business sectors and hence achieve international competitiveness

- **Improved veldt fire management systems to reduce deforestation**: The most contributing factor to Land use change and forestry is deforestation mainly from veldt fire which contributes approximately 50% of the land use change and forestry. Therefore, the feasible mitigation measures include improved fire management in the country to reduce the veldt fires and pasture management to reduce deforestation and improved access to rural electrification and lastly, enhance natural reforestation of the degraded rangelands. The objectives of these mitigation actions under the smart agriculture and improved land management are as follows:
  - Increase agricultural productivity and reduce agriculture vulnerability to climate change
  - Increase land use productivity and reduce current agriculture land use which is mostly idle and can lie fallow for many years
  - Minimise the impacts of fire on rangeland productivity and ecosystems services
  - Maintain the ecosystem integrity and productivity by engaging in sustainable agricultural production processes.

Table 13 depicts a summary of the mitigation actions, their GHGs emissions reduction impacts, co-benefits and policy instruments required for optimal performance of the measures and estimated costs.

Mitigation Action	Status	Specific Objectives	Description Type of action	Coordination and Management	Estimated Emissions Reduction Potential	Co benefits	Recommended facilitation policy	Type of Support anticipate d	Cost of preparation and implementation	Assumption
Switch to energy efficient lighting	On-going	To reduce electricity consumption by 25% and 50% for CFLs and LEDs respectively	Replacing incandescent light bulbs with efficient CFLs and LEDs at household and commercial level	BPC DoE DMS	5% reduction in GHG emissions	Electricity saving; Avoided pollution from reduced electricity demand	Tax Put an inefficient appliances (incandescent bulbs)	Government	Average of P200 million per annum to 2030	By 2030 all light bulbs are LEDs and no incandescent bulbs in the market. There is sufficient funds to support

										the programme.
Introduction of efficient refrigeration	On-going	To reduce demand for electricity	Reduce electricity demand at household levels by limiting the demand for electricity and correspond ing GHG emissions	BPC DoE DMS	0.5% of GHGs emission from Electricity generation.	Electricity saving; Avoided pollution from reduced electricity demand	Tax inefficient refrigeration	Government	Average BWP 50 million per annum	By 2030 all household have energy efficient refrigeration and no sale of inefficient refrigeration.
Introduction of solar geysers	On-going	To replace conventi on al geysers	Reduce electricity demand at	DoE DMS	Will contribute	Improved environmental quality Increase	Introduce subsidies on solar equipment	Domestically funded	Average of 1716 million per annum to 2030	By 2030 25% of urban and rural

		with solar geysers	household and institutional sector		87.7 Gg of CO2eq. emission reductions	the country energy security Reduce energy supply deficits				household have solar geysers.
Introduction of solar electrical appliances	On-going	To switch from diesel powered pumps to solar electrical pumps	Major users of the fossil fuels mainly diesel is groundwater pumping by both the state owned parastatals and private cattle owners	WUC MoA DoE	10 Gg CO2 eq. emission reduction	Reduction of use of fossil fuels	Introduce subsidies on solar equipment	Government and external funding	P50 million annually	By 2030 50% of the farmers have switch to solar electricity pumps.
Replacement of electric	On-going	To replace	Replacement of electric	DoE Local	38 Gg CO2 eq.	Reduction of use	Introduce subsidies	Government and	P230 million annually	By 2030 all street

streetlight s with solar streetlight s		electricity powered street lights with solar street lamps	streetlights with solar streetlights especially in the big town and cities	councils BITRI	emission reduction	of fossil fuels	on solar equipment	external funding		lights are solar powered.
Improved land use management	On-going	To improve fire management hence reducing the veldt fires and pasture Management. To reduce deforestation and improved access to rural	Identification on of additional fire breakers to be constructed .Development of management plans. Acquire fire Surveillance	MoA MLGL	16000 Gg CO2 eq. emission reduction	Avoided land Degradation and increase ecosystems functions and services. Increased wildlife population. Reduced vulnerability of rural	Introduction of carrying capacity quotas and livestock tax on exceeded numbers. Introduce optimal charges that discourage torching. Introduce	International funding and local funding	Difficult to estimate given time constraints	

		electrification. To enhance natural reforestation of the degraded rangelands	system and equipment. Construct fire stations at areas prone to veldt fires. Introduce agro-ecological zoning. Encourage afforestation.			communities to climatic variability.	adequate allowances for voluntary community firefighting exercises.			
Exploitation of landfill gas	Proposed	To capture methane from landfills	Construction of LFG facility at selected landfills in the country which can be	DWMPC	Reduce GHG emissions by 2% from waste sector	Revenue generated from sale of methane as a fuel for the vehicle or as	Increase energy self-reliance. Reduce country import bill from	Government and external funding	P70 million	By 2030 90% of methane generated is captured and used for

			used to generate use the electricity or captured gas for domestic use			cooking gas	energy imports. Employment creation			domestic use.
Bioelectricity generation	Proposed	To capture methane from sewerage ponds and generate electricity	Construction of the shed for bio generator, installation of the pipe system to transport methane from digesters to generators	DWMPC	Reduced emission by approximately 73 Gg CO2 eq. per year	Revenue generation from waste sector, increase energy security and reduction of emission	Introduce Feed In Tariffs for renewable energy	External funding	P8 million	By 2030, 90% of the gas from sewerage ponds is captured and used for electricity generation.

Introduction of efficient transport system	Planned	To encourage the general public to use public transport and reduce GHGs emissions for the transport sector	The high use of private vehicles as opposed to public transportation has fuelled the demand for private vehicles	DTRS	Emissions reduction of 1350 Gg of CO2 eq.	Reduce traffic congestion Improve ambient air quality Reduce consumption of petroleum and reduce import bill	Introduce tax on petroleum products Introduce parking fees and control parking on empty spaces	External funding	P2 billion	By 2030, there is efficient urban public transport system and 50% of the population use public transport to work.
Development of solar power plants	Planned	To produce 328.5 MWh of electricity from (2) 50 MW solar power plants	Construction of two 50 MW solar power plants to supply the mines and	DoE	761 Gg CO2 eq., which translates into 9% emissions reduction	Improve energy self-sufficient and reduce imports Improved ambient air quality	Removal of subsidies on Coal Electricity Introduce Feed In	Government and external funding	P165 Billion	By 2030, the country generate 328.5 MWh of electricity

			economy in the country is on the cards			Improve health of The communities in the proximity of the power plants	Tariffs for renewable energy			
Based on these mitigation actions, total GHGs emissions reduction for the country is projected at 15% by 2030 based on 2010 as the baseline year.									167 billion	

3.2.1 Low GHG emission

Based on the proposed mitigation actions, it is projected that the country would achieve reduced GHG emissions in the region of approximately 15% taking the year 2010 as the base year. Figure 16 depicts GHG emission under BAU and mitigation measures.

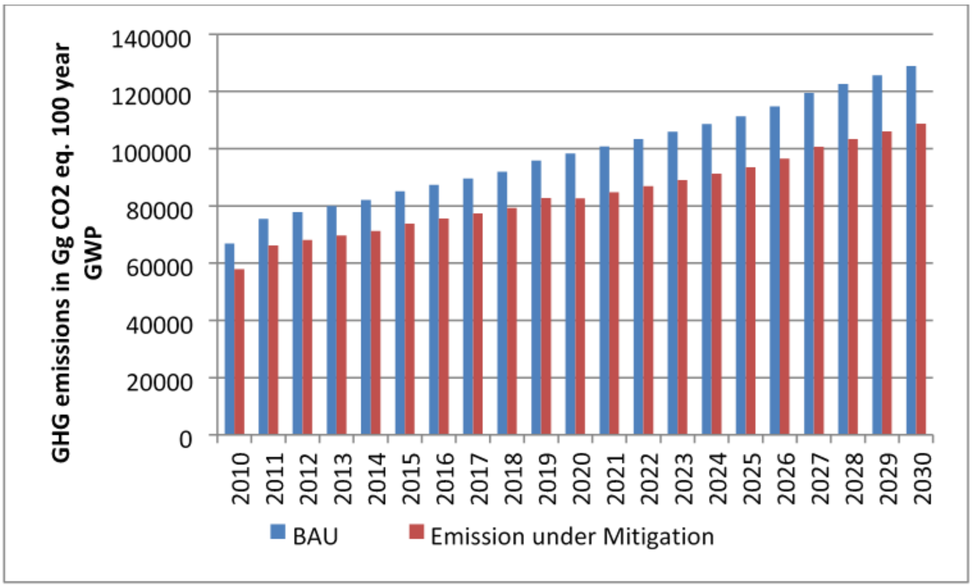


Figure 19: Low GHG emissions for the country over time

3.2.2 Policy and economic instruments for NAMAs functioning

Optimal implementation and operations of the identified climate mitigation actions would require a conducive and enabling environment. Simply, this would involve policy instrument implementation which will spontaneously remove the existing barriers to financing climate mitigation projects. These instruments include taxes, subsidies, grants, concessional loans and guarantees. Below is a highlight of the instruments and policies that are proposed for implementation in the country to ensure that optimal conditions for climate mitigation projects are created.

Table 14: Summary of policy instruments for investing in climate mitigation projects

Policy instrument	Its impact
Removal of subsidies on coal power electrical generation	• Increase the market price of electricity for solar electricity to be competitive and viable • Internalise the externalities associated with coal fired electricity and reflect the true cost of producing coal fired electricity
Introduce REFIT	Encourages and promotes electricity generation from renewable energy resources Ensures that producers of electricity from renewable sources have a guaranteed market and a reasonable rate of return Ensures that RE is a sound long-term investment for investors Encourages foreign direct investment
Introduce subsidies on solar electricity	Reflect the benefits associated with solar electricity Lower the unit cost of solar electricity to increase demand
Introduce tax on petroleum products	Increase the cost of using private vehicle Discourage individual to use large engine vehicles
Introduce parking fees and control parking on empty spaces	Increase the cost of using private vehicles
Introduce subsidies on solar appliances	Encourage use of solar appliance mainly solar geysers

Tax exemptions on environmentally friendly houses	- Encourage individual to invest in solar energy and environmentally friendly houses
Government as guarantor on climate loans	- Reduce country risks for foreign direct investment

3.3 Conclusion

Most of the identified mitigation actions have a positive net return on investment over a defined time period. The proposed mitigation actions include energy efficiency with specific focus on efficient lighting, efficient appliances such as refrigeration, switch to solar appliances mainly solar geysers, increase share of renewable energy, improved public transport system, the landfill gas capture and improved land used change with emphasis on veldt fire management systems. It is projected that implementation of this projects would potentially reduce the country total GHGs emissions by 15% by year 2030 based on 2010 base baseline. This emission reduction is based on the country generating its electricity with neither imports nor exports.

In order for the emission reduction target to be achieved, there is a need to have an enabling and conducive environment for the mitigation actions to work optimally. This would entail implementation of instruments such as removal of subsidies on coal based electricity generation, removal of subsidies on petroleum products, introduction of REFIT and subsidies on solar electricity generation.

CHAPTER 4

4.1 Domestic Measurement Reporting and Verification

4.1.1 Introduction

Parties to the UNFCCC have agreed that the NAMA proposals must be accompanied by Monitoring, Reporting and Verification (hereinafter MRV) section. MRV is an important component of the NAMAs as it facilitates trust, transparency and facilitates decision making. Consequently, the ultimate goal of MRV is to ensure that intended emission reduction targets are attained through continuously improving on implementation of the mitigation measures and their effectiveness. According to GIZ (2014) the key purposes of the MRV are as follows:

- To ensure and enhance transparency, accuracy and comparability of information with regard to climate change in order to identify good practice and also allow for international benchmarking,
- To track both progress and the impacts of the mitigation measures that have been identified by the partner countries
- To assess the impacts of policy instruments on the functioning of the identified and implemented mitigation measure
- To track international support flow into implementation of the mitigation measures

To improve access to the international public and private financial support this section to develop the MRV for emission, mitigation measures implementation and international support. The outputs of the section are templates which will be employed to monitor, report and verify emissions; NAMAs and international support. Additionally, the output of the section is a monitoring plan which details instructions to the emitters on how-to collect and analyse the data for monitoring purposes. They entail the following parameters: aspects to be monitored, frequency of monitoring, instruments for data collection and responsible agent for monitoring and structure for reporting.

4.1.2 MRV Scope

As per IPCC guidelines, it is important that MRV is undertaken for three activities being GHG emission, Mitigation action implementation and International assistance (finance and capacity building).

MRV comprises of two aspects being monitoring plan and the development of the template which are instruments for monitoring, reporting and verification. MRV is a cycle as depicted in Figure 20 below. It involves monitoring which entail data collection through measuring, data analysis, reporting of the results and verifying the results through sampling and spot- check.

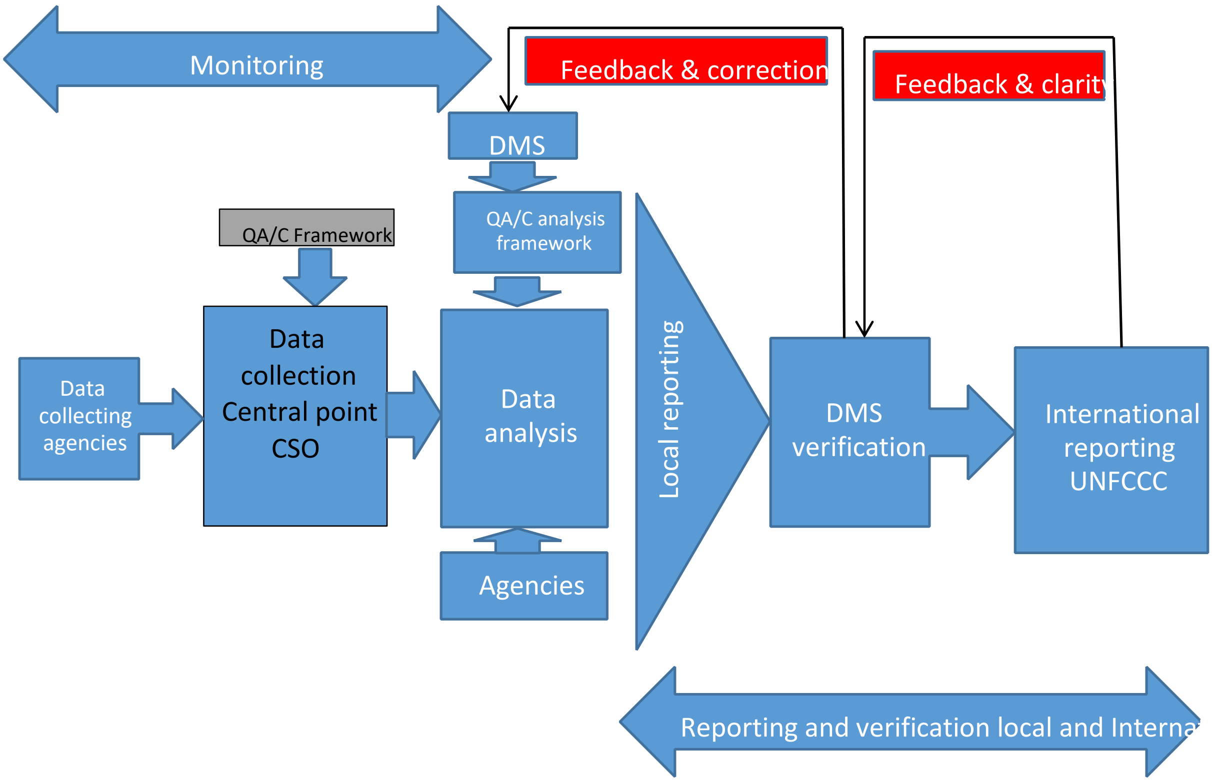


Figure 20: MRV scope

4.1.3 MRV processes

It is important that audits and spot checks should be emphasised in the MRV processes. Additionally, dependent verifiers must be engaged for verification purposes.

4.1.4 MRV instruments

It is important that MRV instruments in the form of templates are developed and consistently used to ensure consistency and accuracy. Thus, the main report has detailed MRV instruments.

It is also important that MRV is undertaken for GHGs emissions, mitigation projects implementation and international assistances in terms of financial flows and technical skill transfers.

4.1.5 MRV for emissions

MRV for emissions entail data collection on GHGs emission by sector for purposes of determining the performance of the parties in attaining their emission reduction targets. Scope of the MRV emissions can be undertaken at four levels being:

- National
- Sub-national
- Sectorial, and; Facility levels.

For this assignment, the MRV for emission is developed at the Sectoral level and the results harmonised at the national level.

MRV comprises of two aspects being monitoring plan and the development of the template which are instruments for monitoring, reporting and verification. The next section, thus discusses the monitoring plan for MRV section. MRV is a cycle as depicted in Figure 20 below. It involves monitoring which entail data collection through measuring, data analysis, reporting of the results and verifying the results through sampling and spot- check.

4.2 Monitoring plan

Central to the success of the MRV is a robust and sound monitoring plan. A monitoring plan guides the monitoring processes for GHG emissions. The plan details, methods of measurement or quantification for the GHG for the various sectors, instruments to be used for data collection, parameters to be collected and monitored, frequency of data collection, and analyses of the results. In the main, a monitoring plan gives guidelines on monitoring processes for GHGs emissions.

The monitoring approach for the country is developed based on the concept of cost-effective while at the same time emphasising on accuracy in GHGs emissions measuring. Therefore, point sources which are generally the highest emitters should be monitored accurately to ensure that GHGs emissions in the country are not underestimated. Therefore, measurement based approach (hereinafter MBA) is recommended for high emitters such as industrial production and energy transformation sources while for low emitters such as mobile sources calculation based approach (hereinafter CBA) is recommended.

Monitoring for the GHGs emissions should be done at the Sectoral level and this should be compiled to produce national GHG emissions inventories.

4.3 Sector for GHG monitoring

It is recommended that GHG monitoring should be undertaken for the major emitters being: Energy (include transport, waste), Land use change, Agriculture and industrial processes. The energy sector should be categorised into stationary and mobile sources where the stationary source include electricity transformation such as Coal fired power plants and household energy demands. The mobile source includes the transportation sectors (road, air, rail and water). The agricultural sector should be categorised into crop production (fertiliser utilisation) and livestock sectors where emission is generally through enteric fermentation. The industrial sector should cover the processing sectors mainly cement production and smelters.

4.4 Parameters to be monitored

For all the economic sectors of the country, the three major GHGs being CO_2, CH_4 and N_2O should be monitored. The three GHGs must be converted to CO_2 eq. 100 years Global Warming Potential (hereafter GWP) based on the

IPCCC guidelines for converting GHGs. The parameters to be collected for monitoring should include GHG emissions in Giga grams (hereinafter Gg), activity data on the following:

- Consumption of all fuel fossil by type (coal, petroleum products) in appropriate units such as litres and tonnes
- Fuel-wood in tonnes
- Fertilisers in tonnes
- Amount of waste deposited at the landfills also known as managed waste in tonnes and percentage of carbon/biogradable
- Land use and land cover changes from grassland, dryland forests to ploughing field and settlements
- Number of livestock by type and age (cattle, sheep, goats, etc)
- Number of vehicles by type and activity (private, commercial and freight)
- Number of boats, trains etc by engine size
- Scale of industrial processes mainly cement and smelters in tons

The data collected should be used for measuring/estimating the GHGs emissions and subsequently for tracking (monitoring) the GHGs emissions over a defined time scale. Additionally, the information will also be used by the Verifier for verification purposes.

4.5 Methods of data collected

Data collection methods vary significantly by sector depending on various factors such as cost-effectiveness, point and non-points sources and number of emitters. Therefore, these factors determine the appropriate method for GHGs emissions data collection. Generally, there are three (3) main types of data collection methods being. Below is the description of the recommended methods, approaches and equations for collecting data for the GHGs for the respective sectors. These methods are based on the IPCCC guidelines and regulation for GHGs inventory.

Energy sector

Energy sector is one of the major GHG emitters in the country and it comprises of stationary and mobile sources. For the stationary sources mainly electricity transformation/generation from coal fired power stations, it is recommended that MBA should be used for collecting data. The instruments that are recommended are the flow meters. On the other hand, for the mobile source (non-point sources) mainly transport sector, Calculation Based Approaches should be employed. Total fuel consumption must be estimated based on the fuel imports by type. The activity data must be multiplied by the country default emissions to determine the GHG emission by fuel type.

Waste sector

As landfills are categorised as point source, it is thus recommended that the flow meters be installed for collection of GHG emission data.

Agriculture sector

The sector emits GHGs from land use change and livestock sector, CBA is recommended as a method for data collection. Activity data should be obtained from the Land Surveys and livestock census conducted by Ministry of Agriculture and Central Statistics Office (hereinafter CSO).

Industrial processes

These activities are point-sources, it is thus appropriate to employ the MBA for monitoring purposes. Therefore, it is recommended that the flow meters be installed at the point source to measure the emissions.

Table 8 below depicts a summary of the recommended data collection methods for the various sectors.

Table 15: Emissions estimation approaches

sector	Methods
1.0. Energy	
1.1. Mobile	CBA
1.2. Stationary	MBA
2.0. Waste	MBA
3.0. Agriculture	CBA
4.0. Industrial process	MBA

4.6 Frequency of data collection

For all the identified economic sectors, it is recommended that data should be collected on bi-ennial basis for monitoring purposes.

4.7 Responsible agents

The various economic sectors would require multiple players for data collection and analysis. Below is a list of the economic sectors and the responsible agents for data collection and monitoring.

Table 16: Responsible agents for monitoring GHG emissions

Sector	**Responsible agent**
Energy (stationary)	BPC
Households	DOE
Transport	DTRS
Waste	DWMPC
Land use change	MOA, DFRR
Industrial processes	BCL and Cement Sector

Table 17 summarises the monitoring plan for the GHGs emissions monitoring for the country

Table 17: Monitoring plan for GHG emissions

Sectors	**GHG to be monitored**	**Parameters**	**Method of measurement**	**Instruments**	**Method of analysis**	**Responsible agents**
Energy	CO_2, CH_4, N_2O	emissions, energy demand, consumption of fossil fuel, activity data	measurement based approach and calculation based approaches	Flow meters	statistical analysis	DOE, BPC
Waste	CO_2, CH_4, N_2O	emissions, waste generation, percentage of carbon content in waste, percentage of managed waste to landfills	measurement based approach and calculation based approaches	Flow meters	statistical analysis	DWMPC

Agriculture	CO_2, CH_4, N_2O	land use change, soil carbon content, fertiliser utilisation, number of livestock and growth rates	calculation based approaches	Non	statistical analysis	MOA
Land use change	CO_2, CH_4, N_2O	land use change, emission factors	calculation based approaches	Non	statistical analysis	DLS
Industrial processes	CO_2, CH_4, N_2O	scale of operation for selected industries (cements and copper nickel smelter)	measurement based approach	Flow meters	statistical analysis	Private sector

4.8 Monitoring framework

Having defined the monitoring plan, it is critical that a GHGs monitoring template is developed which will be employed and adopted by the country. Typically, a monitoring framework template is an active excel spread-sheet that can be implemented by the monitors who are also defined as responsible agents. The monitoring framework is divided between monitoring for activities that require measuring and those that involve calculation based approaches.

4.9 Monitoring for measurement based approach

Activities that require measurement based approach should use table 7 monitoring template to monitor GHGs emissions over time

Table 18: Monitoring template for Measurement based approach sectors

Sector					
Name of authority					
Name of responsible official					
Date of data collection					
GHG	**previous reading (a)**	**current reading (b)**	**actual emissions (b-a)**	**baseline emission**	**GHG emission threshold target**
CO_2					
CH_4					
N_2O					
Remarks					

The results obtained above should be crossed checked based on calculation based approach using table 8 below.

Table 19: Calculation Based Approach for cross checking measurement based approach

Scale of production				
Current production	**Previous production**	**Input in production (a)**	**Emission factor (b)**	**Total emissions (a*b)**
			CO_2	
			CH_4	

			N_2O	
Remarks				

4.10 Monitoring for calculation based approach

As highlighted some emissions sources particularly non-point sources would require CBA to estimate and monitor Sectoral and national emissions. Calculation based estimation require activity data and emission factors to enable quantification of the emissions. Templates below should be used to estimate emissions from the various sectors.

Table 20: Fuelwood Monitoring template

Date											
Name of authority											
Name of responsible official											
HH number	HH connected to National Grid	HH not connected to Grid	% of connected HH using f/wood	average f/wood consumption by connected HH	average f/wood by HH not connected	% of institutions using f/Wood	Average f/wood consumption per capita at institution	Total f/wood consumption	f/wood emission factor	GHG emission (Gg CO_2 eq.)
									CO_2	
									CH_4	
									N_2O	
Baseline emission										
Emission reduction target										
Remarks										

Table 21: Monitoring template for transport

Date									
Name of authority									
Name of official									
Total Vehicle numbers	Number of vehicles using diesel	Number of vehicles using petrol	Average mileage diesel	Average mileage petrol	Total fuel used diesel	Total fuel used Petrol	Diesel emission factors	Petrol emissions factors	Total emissions
							CO_2 factor	CO_2 factor	
							N_2O factor	N_2O factor	
							CH_4 factor	CH_4 factor	
Baseline									
Emission reduction target									
Remarks									

Table 22: Monitoring template for land use change

Date							
Name of authority							
Name of official							
grassland Savannah coverage (h)	grassland converted to arable (h)	grassland converted to pastoral	grassland converted to settlements	emission factor arable	emission factor pastoral	emission factor settlement	total emissions
				CO2	CO2	CO2	
				CH4	CH4	CH4	
Baseline				N2O	N2O	N2O	
Emission reduction targets							
Remarks							

Table 23: Monitoring template for fertilisers

Date					
Name of Authority					
Name of Official					
Type of fertiliser	Quantity ordered	Quantity used by commercial	Quantity used by subsistence	Emission factors	Total emissions
				CO_2	
				CH_4	
				N_2O	
Baseline					
Emission reduction target					
Remarks					

4.11 Reporting

Reporting is another important component of the MRV and it entails production of GHGs emissions reports that comprehensively depicts GHGs emission dynamics. The report structure must entail the following information: data collection methods, data analysis methods, emissions estimated and measured for all the GHGs (CO_2, CH_4, and N2O). The report should be a maximum of 4 pages. The report must be compiled by the authorities responsible such as DOE, DFRR; BPC, DTRS and DWMPC. The compiled report must be submitted to the DMS. Table 13 depicts the proposed GHGs emissions reporting standards for the country.

Table 24: Proposed Reporting Structure for GHG emissions

Reporting institution	**Enter name of authority**
Sector category	Enter name of sector and specify e.g. energy mobile sector
GHGs reporting	Enter gases monitored
Methods of data collection	Describe methods of data collection used
Methods of data analysis	Statistical analysis
Results on GHGs emissions	Brief description of the results by way of numbers and figures
Conclusions on GHGs emissions and targets	Brief description of the findings and compare them to baseline and emission reduction targets

i. Verification

Verification is an important component of the MRV as it enables independent analysis of the GHG emissions. This thus enhances transparency and reliability of the results. Verification can be undertaken at both domestic and international levels. At the domestic level, it is recommended that the DMS should take the responsibility of being a domestic verifier. For international verification purposes, DMS should engage a UNFCCC expert to verify the compiled GHGs emissions. As the funders are the affected stakeholders, it is recommended that the funder(s) select an independent verifier for the assessment.

ii. Techniques for Verification

Verification techniques include internal quality checks, inventory inter-comparison, and comparison of intensity indicators, comparison with atmospheric concentrations and source measurements, and modelling studies. In all cases, comparisons of the systems for which data are available and the processes of data acquisition should be considered along with the results of the studies. These techniques, and their applicability at the national and international level, are discussed below. Additionally, other methods are inclusive of evaluation of emissions estimates and trends, as part of the UNFCCC review of emissions inventories. Another approach entails an evaluation of aggregate inventories on a global or regional basis, with the objective of providing further scientific insight. The following activities must be undertaken for verification purposes of the GHGs emission at both the national and international levels.

Compliance to Monitoring plan

It is important that the verifier assesses the extent to which the monitoring plan has adhered to collecting GHGs emissions data. This can be done through inspecting the monitoring templates to determine the extent to which they have been applied and populated. Therefore, all the templates that were used by the responsible authority should be availed to the verifier.

Instruments calibration check
As it has been highlighted under data collection, some sectors would require MBA while other will require CBA methods. For those sectors which require measurement instruments, the verifier should access the instruments and check the calibration based on the manufacturers specifications. The instruments must be checked in terms of reliability and accuracy. It is recommended that another instrument should be used to corroborate the results.

Check data collected
Another procedure for verifying the results obtained is to check the data that has been used in the GHGs inventory. The data should be checked for consistency mainly in terms of out-layers and extreme values. This should be corroborated with socioeconomic activities such as economic growth, population growth and climatic data. This verification exercise should give the verifier a clear picture of the data used in terms of accuracy and reliability. It is recommended that trendlines should be used to check the data and all abnormal fluctuations should be explained and corroborated.

Analyse the calculations
The verifier must access all the spreadsheets that have been used in calculating the GHGs emissions and checked for mathematical errors and consistencies. All emission factors and activity data should be checked by the verifier. It is critical that the emission factors are consistent with the IPCCC guidelines. Therefore the verifier must cross-check with IPCCC guidelines.

Verification report
Based on the results from the verification exercise, the verifier must compile a report detailing their findings on monitoring plan compliance, instruments measurement accuracy, quality of data collected and used for GHG inventory, precision and accuracy in data analysis and calculations, amongst other things. It is recommended that the report should be a maximum of 5 pages.

iii. MRV for NAMAs
Similar to monitoring GHG, it is also vital that MRV for NAMAs be undertaken. Monitoring for NAMAs entails tracking implementation progress of the mitigation actions, their impacts on GHGs emissions, and associated co-benefits. Essentially, it is critical that a scorecard be used to track (monitor) the implementation progress and impacts of the mitigation project on GHGs emissions over time.

iv. MRV for NAMAs Monitoring plan

In order to undertake a comprehensive monitoring for the mitigation measure progress and their impact, it is fundamental that a monitoring plan be prepared. Correspondingly, to the monitoring plan for the GHGs emissions, the plan details parameters to be collected, responsible agent, frequency of monitoring, methods of data collection and analysis. Table 14 depicts the monitoring plan for the NAMAs MRV.

Table 25: Monitoring plan for NAMAs

Sectors	Mitigation measure	Parameters	Method of monitoring	Instruments	Method of analysis	Responsible agents
Energy	Efficient lighting	• percentage penetration of CFL and LED • percentage of number of household replacing incandescent bulbs with CFLs and LED	Household survey	Questionnaire	Statistical analysis	BPC
	Efficient refrigeration	• percentage penetration of efficient fridges • percentage of household replacing less efficient fridges with efficient ones	Household survey	Questionnaire	Statistical analysis	BPC
	Increase share of renewable energy	Percentage share of renewable solar electricity to coal fired electricity generation	MBA	Flow meters	Statistical analysis	BPC
	Improved use of public transport	• Replacement of minibuses with buses • Number of households using public transport • Reduced petroleum imports	Transport and infrastructural survey	Questionnaire	Statistical analysis	DRTS

		• Introduction of bus lanes				
Waste	Capture of LFG	• Landfill gas captured	MBA	Flow meters	Statistical analysis	DWMPC

Monitoring for NAMAs involve tracking implementation progress, performance of the mitigation measures in terms of reducing GHGs emissions to the targets and also evaluating the co-benefits of the mitigation measures. The convenient method to monitor the mitigation measure is the implementation scorecard. Table 15 depicts the scorecard for monitoring mitigation measures that should be used by the responsible agent for monitoring.

Table 26: Proposed scorecard for monitoring NAMAs

Name of mitigation measure					
	preparation stage (1)	developmental stage (2)	completed (3)	submitted for funding (4)	
Development of proposal for funding					
	Rejected (0)	conditional approved (1)	Approved (2)	Funds disbursed (3)	
Status of submitted proposal					
	preparation stage (1)	construction of infrastructure (2)	constructed at advanced stage (3)	construction completed (4)	operational phase (5)
Implementation of mitigation measure					
	no change in emissions (0)	Below target (1)	At target (2)	Above target (3)	
Impacts of the mitigation on emission					
Description of all mitigation co-benefits					

Co-benefits performance	No co-benefit (0)	Below target (1)	At target (2)	Above target (3)
Co-benefits 1				
Co-benefit 2				

NAMAs Reporting

Similarly to the GHGs emissions, NAMAs implementation should be reported. The report structure for the NAMAs must include: proposed mitigation measure by sector, implementation process, impact of the implemented measure on GHGs emissions, cobenefits over time. The report should be a maximum of 5 pages and should be compiled by the implementation authorities such as BPC, DOE, DTRS and DWMPC. The compiled report must be submitted to the DMS. Table 27 depicts the proposed GHGs emissions reporting standards for the country.

Table 27: Proposed Reporting Structure for Mitigation Actions

Reporting institution	**Enter name of authority**
Sector category	Enter name of sector and specify e.g. energy mobile sector
Mitigation measure reported	Enter gases monitored
Implementation status of the mitigation	Describe the state at which the mitigation measure is at (preparation, being implemented, operation etc)
Impact of the mitigation on GHG	Describe the impacts of the mitigation measure on GHG emissions and compare with the projects emission reduction target
Co-benefits	List all possible co-benefits and describe them and where possible quantify them

vi. Verification of the mitigation actions

It is proposed that verification for the NAMA implementation be undertaken at both domestic and international v. Consequently, verification should be done by an independent agent and it is recommended that DMS should be responsible for verification of the mitigation measures. Verification should be done on annual basis for effective monitoring of implementation of mitigation and at the same time avoid implementation lapses and regressions. Implementation audits must be undertaken to verify the results from the implementation scorecard. The verifier from DMS should physically visit the sites of operation and inspect facility. For operational facilities, flow meters must be used to verify outputs for solar power plants and Landfill facility. For transportation sector, annual survey should be conducted to determine public transportation utilisation. Additionally, fuel consumption should also be used to establish the linkage between public transport and reduction in petroleum products use. Table 16 should be used by the verifying agent based on audits for consistence with the findings from the monitoring stage of the NAMAs. Where there are inconsistencies, the verifier must highlight and seek clarify from the monitoring institutions.

vii. MRV for international assistance

Mitigation measures that fall under NAMAs can either be domestically or internationally financed depending on the country's financial ability and readiness. Additional to being legible to international financing/funding, developing countries are also legible to international technological transfer. Thus, as much as MRV is undertaken for GHGs emissions and for mitigation measures, it is also imperative that international flows (finance and technical assistance) are monitored, reported and verified. This will ensure that international aid for mitigating GHGs emissions are tracked for transparency and accountability. Monitoring for international flow should be the responsibility of DMS and all proposals for international assistance should be routed through DMS. Monitoring for international assistance (financial and technical) should be monitored by sector based on table 28 below.

Table 28: monitoring framework for international assistance

Sector	**Financial assistance**				
		Proposal submitted	**Approvals**	**Amount**	**Amount disbursed**	**Source of funding/country**
Energy	efficient lighting					
	Refrigeration					
	solar power plant					
	solar geysers					
	transport					
Waste	landfill gas facility					
	Technical Assistance					
		Technical transfer	Type	Number of personnel trained		Source of assistance
Energy	efficient lighting					
	refrigeration					
	solar power plant					
	solar geyser					
	transport					
Waste	landfill gas facility					

viii. Reporting

It is proposed that reporting on international assistance flow (financial and technological) should be the responsibility of DMS which is the liaison/contact departments for climate change. Thus, based on the findings from the monitoring template as depicted in table 18, a report of a maximum of 5 pages should be produced detailing key aspects as in table 29 below.

Table 29: Reporting structure for International assistance for NAMAs

Reporting institution	Enter name of authority
Source of funding by sector	Describe source of funding for each sector
Amount by source	Describe amount of funding per sector
Total amount of funding	Calculate total amount of funds received
Technological transfer by sector	Describe technological transfer by source and sector
Skill transfer by sector	Describe training undertaken by sector in terms of numbers
Source of technological transfer	Describe source of technological transfer per year

ix. Verification for technical assistance

Verification should be done by international verifiers appointed by UNFCCC. It is recommended that financial and skills audit be conducted to verify the reported results on technical assistance. The verification should immediately follow the monitoring results. The verifier must have access to all financial accounts for the auditing purposes.

4.12 Conclusions

The report details the feasible and cost-effective mitigation actions that GoB can implement without necessarily impeding economic growth and development. In fact, the identified mitigation actions have a positive net return on investment over a defined time period. The proposed mitigation actions include energy efficiency with specific focus on efficient lighting, efficient appliances such as refrigeration, switch to solar appliances mainly solar geysers, increase share of renewable energy, improved public transport system and the landfill gas capture. It is projected that implementation of this projects would potentially reduce the country total GHGs emissions by 15% by year 2030 based on 2010 base baseline. This emission reduction is based on the country generating its electricity with no imports.

In order for the emission reduction target to be achieved, there is a need to have an enabling and conducive environment for the mitigation actions to work optimally. This would entail implementation of instruments such as removal of subsidies on coal based electricity generation, removal of subsidies on petroleum products, introduction of REFIT and subsidies on solar electricity generation.

It is also important that MRV is undertaken for GHGs emissions, mitigation projects implementation and international assistances in terms of financial flows and technical skill transfers

CHAPTER 5

5.1 Support Received

Most of the financial support received by Botswana was from Global Environmental Facility (GEF) for capacity building, technical to enable the country to fulfil its obligations under the Convention and to implement measures that address the impacts of climate change. Financial support reported was obtained through requests from institutions and from the websites of funding institutions.

5.2 Funding Sources

Table 30: Funding sources to address climate change impacts

Project	Type	Description of support	Country	Start	End	Implementing Agency	Amount	Implementing Institution	Status
Renewable Energy Based Rural Electrification Project for Botswana (RE BOTSWANA)	Grant	Supporting financial mechanism for uptake of RE Systems in rural electrification	Botswana	2008	2015	United Nations Development Programme	USD (790,000)	DoE	Project officially closed. Funding to be used for 21 village off grid electrification
Load assessment in 20 villages through	Grant	Off grid Electricity needs assessment study	Botswana	May 2016	June 2017	United Nations Development Programme	USD (12,000)	DoE/BPC	Load Assessment Study completed

Global Fuel Economy Initiative	Grant	Baseline study and policy formulation for fuel efficiency	Botswana	2016	2017	United Nations Environment Programme	USD (83 000)	DoE	Baseline study completed and approved by UNEP. 2nd phase of policy formulation due to begin by October 2017
Jatropha research project	Grant	5 years Research on Jatropha feedstock suitable for local conditions	Botswana	2016	2017	JICA	JPY (97 Million)	DoE/Dept of Aricultural Research/ University of Botswana	Research Study completed in 2017

Renewable Energy & Energy Efficiency Strategy development	Grant	Strategy formulation with detailed roadmap for Botswana	Botswana	2015	2017	World Bank	USD (870 000)	DoE	Road map completed and presented to stakeholders in Feb 2017
Bankability study for 200MW CSTP power plant	Loan		Botswana	2011	2013	World Bank	USD (1 Million)	DoE	Completed
Bankability study for 200MW CSTP power plant	Grant		Botswana	2011	2013	African Development Bank	USD (1 Million)	DoE	Completed

Action Agenda and Investment Prospectus	Grant	Development of Botswana's high level Action Plan and targets for Energy Efficiency, Renewable Energy and Energy Access	Botswana	2016	2017	African Development Bank		DoE	Due for completion in August 2017
1MW Solar Plant	Grant	Design and build a 1MW	Botswana	2010	2012	JICA	USD (10 Million)	Department of Energy / Botswana Power Corporation	Commissioned in 2012
1 Million incandescent bulbs	Bulk buying through SAPP	Electricity Demand Side Management	Botswana	2009	2010	Phillips Lighting		Botswana Power Corporation	40MW savings were achieved in 2012

500 Solar Panels	Grant	Donation for off grid RE application	Botswana	2014	2015	Government of China through Local Embassy		Department of Energy	Panels donated to various government departments

Supply and Installation of photovoltaic panels in selected Primary Schools	Grant	Supply and Installation of photovoltaic panels in selected Primary Schools in remote villages in the country where Botswana Power Corporation has not yet extended the grid and are also not among the electrification project	Botswana	2010	2012	JICA	(USD 3,4 Million) P34 828 267.00	Ministry of Education	completed
BIOFIN	Grant	Facilitation of increased investment in biodiversity		2014.	2017	GIZ	USD 530 000		Extended to May 2018

		y conservation and ecosystem management through building of a sound business case							
SLM Ngamiland	Grant	To mainstream Sustainable Land Management in rangeland areas		2014	2019	GEF	USD 3 million	Department of Forestry Range Resources	On going
SLM Makgadikgadi	Grant	To strengthen the capacity of local communities in arable farming, livestock managem		2013	2017	GEF	USD 1 million	Department of Forestry Range Resources	On going

		ent and livelihoods support system							
Response to Climate change	Grant	Development of Climate Change Response Policy, Strategy and Action Plan		2015	2017	UNDP	USD 112,000	Ministry of Environment Natural Resources and Tourism/Department of Meteorological Services	On going
Environmental Coordination	Grant	Development of National Strategy on Sustainable dev		2013	2016	UNDP	USD 545,000	Department of Environmental Affairs	Extended to 2017

Bio-Chobe		To strengthen management effectiveness of the National Protected Areas system to conserve globally significant biodiversity and		2014	2017	GEF	USD 1.8 Million	Department of Forestry Range Resources	On going
		maintain healthy and resilient ecosystems							

Kalahari Namib project		to support communiti es and policy makers in Botswana, Namibia and South Africa to effectively implement and upscale sustainable land manageme nt (SLM) in the MolopoNossob basin area and thereby contribute to	Botswana	2010	2017	UNEP	US$ 976,282.00	Department of Forestry Range Resources	Completed

		improved livelihoods and the maintenance of the integrity and functioning of the entire KalahariNamib ecosystem							
Integrated Transport	loan					World Bank	US$ 385.20 million		On going
Enhancing National Forest Monitoring System	Technical			2013	2016	JICA		Department of Forestry and Range Resources (DFRR)	Completed

Table 31: Projects requiring Support

Project	**Status**	**Objective**	**Description Type of action**	**Implementing Institution**	**Estimated Emissions Reduction Potential**		**Amount**
Introduction of efficient transport system	Planned	To encourage the general public to use public transport and reduce GHGs emissions from the transport sector	The high use of private vehicles as opposed to public transportation. has fuelled the demand for private vehicles	Department of Transport Road Safety (DTRS)	Emissions reduction of 1350 Gg of CO2 eq.	External funding	P2 billion
Development of solar power plants	Planned	To produce 328.5 Mwh of electricity from (2) 50 MW solar power plants	Construction of two 50 MW solar power plants to supply the mines and economy in the country is on the cards	Department of Energy (DoE)	761 Gg CO2 eq., which translates into 9% emissions reduction	Government and external funding	P165 Billion

5.3 Constraints Gaps for GHG

Table 32: Gaps and constraints

Gaps and Constraints	Description
Data Organisation	Data scattered in many agencies

Non-availability of relevant data	Data for refining inventory to higher tier levels: AFOLU is a key source greenhouse gases there is lack of data such as harvested wood, manure management. Amount of fertiliser used. • The production of beverages (e.g. alcoholic) under the IPPU sector in the country. This will lead to emission of NMVOCs which was not reported in this NIR, though it is occurring. • Land use conversions between the single years covering the period 2000 to 2015. • The quantity of clinker used during the production of cement in Botswana. • The amount of waste generated in Botswana, disaggregated by waste category (e.g. chemical waste, municipal waste, food waste, paper/plastic, rubber etc.) and by source (e.g. household, industry/construction). • Fuelwood gathering/consumption in Botswana. This led to the use of FAOSTATS data which is for the period 2002 to 2009. Extrapolation method was used to fill in the data gaps, among other methods.

Access to data	Lack of institutional arrangements for data sharing
Technical and institutional capacity needs	Training in data gathering for relevant institutions in GHG inventory methodologies and data formats
Lack of specific country emission factors	Inadequate data for representative emission measurements in the sectors

5.4 Improvement Plans

To strengthen accurate reporting of greenhouse gas emissions in Botswana the following activities need to be undertaken:

- Statistics Botswana and Department of Meteorological Services- UNFCCC Focal Point to liaise with Kgalagadi Breweries in order to source information on the production of beverages in the country at least by mid-2019.

- Department of Meteorological Services- UNFCCC Focal Point to either engage local experts or the Department of Surveys and Mapping to develop land cover/use maps for Botswana for the individual years covering the period 2000 to 2015. Since this is a big project, the focal point should consider starting with the planning process as soon as possible.

- Department of Meteorological Services- UNFCCC Focal Point to sign a MoU with PPC Cement Botswana to facilitate smooth data (cement production/quantities of clinker used) sharing between the two institutions. This activity should be done by at least mid-2019.

- Department of Meteorological Services- UNFCCC Focal Point to sign a MoU with the Department of Waste Management and Pollution Control and Ministry of Local Government and Rural Development (Department of Public Health) to facilitate smooth data (e.g. waste generation from landfills) sharing between the aforesaid institutions. This activity should be done by at least mid-2019 in order to have the activity data ready for the forthcoming GHG Inventories.

- Department of Meteorological Services- UNFCCC Focal Point to launch a system and database to update all activity data required for the GHG inventory on an annual basis which will significantly speed up the inventory process and should allow for annual monitoring of GHG emissions.

- National GHG Inventory Team to examine options of improving activity data used for the GHG inventory so as to minimise uncertainties associated with the inventories and therefore allow for more accurate estimates to be made.

- National GHG Inventory Team to consider exploring possibilities of introducing country-specific emission factors derived from detailed data on carbon contents in different batches of fuels used, or from more detailed information on the combustion technologies applied in the country, so as to reduce the uncertainties and the trends over time be better estimated. The Team will require capacity building in order to perform the aforementioned activities.

5.5 Constraints in NAMAs

- Costs: solar appliances are relatively more expensive compared to conventional appliances
- Existence of externalities: this is another factor that inhibits the use of solar as users of conventional appliances are not forced to internalise the social costs associated with their uses thus lowering the cost of electricity use.
- Electricity subsidies: this results in the cost of electricity to become cheap which does not encourage users to switch to solar energy as a way of saving electricity bill
- Vandalism and theft of electricity appliance: solar appliances are prone to vandalism and theft particularly solar panels and this discourages their uses.
- Financing barriers to climate investment in Botswana
- High investment costs and long term investment nature of the climate Mitigation projects: Most of the mitigation projects that have the potential to significantly reduce the GHG emissions in the country are high investments costs projects with long duration to break-even and start to realise positive return on investment (Berliner et al., 2013). For developing countries with multiple socio-economic challenges, the high investment costs become a hindrance to invest in these mitigation projects. Additionally, even the potential investors are discouraged from investing in these climate mitigation projects.
- Existing subsidies on substitutes of the climate mitigation projects: this is another barrier that inhibits investors from investing on mitigation projects. In many instances these substitutes are highly subsidised both directly and indirectly by the government. The effect of subsidies is to lower the cost of investment for the substitutes to the extent that prices/charged by the providers becomes extremely lower. Incidentally, this results in mitigation projects which have high investment costs to be non-viable projects as the ongoing markets prices results in loss over time. Consequently, economic analysis of the mitigation action results in non-viability based on the market price for the alternatives which effectively creates barriers to the investors. Projects that are highly affected by subsidised alternatives include Solar Power Plants, Private versus Public Transport sector, solar geysers and solar pumps at the cattle post.

- Existence of externalities and public good nature of environment: In addition to existing subsidies, existence of externalities and public good nature of the environment create barriers for investing in climate mitigation projects. Externalities ensure that the producers of environmentally dirty projects such as coal fired electricity generation and private vehicle users do not integrate their cost of operation in economic decision making. Evidently, this results in producers charging lower electricity prices which out-competes and edges out the solar electricity projects out of the market.

- Competing developmental priorities and limited resources: Developing countries have various competing developmental needs coupled with limited financial resources. Therefore issues such as health, access to water, education and poverty take precedence over climate mitigation actions. Consequently, this creates sombre barriers particularly for domestic financing of the mitigation actions. For instance, it is highly unlikely that the developing countries would give priority to solar generated energy over coal fired electric generation, water and health issues due to the high investment costs. Subsequently, the developing country would optimally allocate the scarce financial resources amongst the various competing demand. Automatically, relative cheap projects which would meet the demands will be selected as opposed to expensive projects.

- Stiff Competition for available climate change funds and lack of personnel to develop climate change projects: Climate mitigation action are legible for international financing/funding mainly from Green Climate Fund (hereinafter GCF), Less Developing Country Funds (hereinafter LDCF), Deutsche Gesellschaft fur Internationale Zusammenarbeit (hereinafter GIZ) and Global Environmental Fund (hereinafter GEF) amongst others. One of the barriers of accessing funding from the available global/international financing is stiff competition amongst the legible parties. For countries such as Botswana, other factors that create barriers on accessing funding is lack of skilled personnel to develop proposal for financing. Incidentally, the requirement for application for funding is tedious and demands trained skill manpower.

- Lack of enabling and conducive environment for operation of the mitigation action:
- In order for climate mitigation action to be profitable and attract financial flow both domestically and internationally, there is a need to create an enabling and conducive environment for their operations. This enabling environment is created through legal framework in the form of financial incentives such as tax exemptions, internalisation of externalities amongst others. Lack of enabling and conducive

environment ensure that environmentally clean projects such as public transport are exposed to unfair competition resulting in them being outcompeted by dirty projects.

- Political instability and country risk and lack of loan guarantee: Another factor that inhibits investing in climate change projects in the developing countries including Botswana, is political stability and country risks. In addition to high initial investment costs, investors are generally sceptical and risk averse in investing in the developing countries due to political instabilities and country risks. The political risk is generally compounded by lack of guarantee for climate change project investment loans. Specifically to Botswana, its dependence on diamond as the main source of revenue could possible creates country risk due to its vulnerability to international diamond market fluctuations.
- Absence of economies of scale in the country: Projects in the country are generally small scale due to small population coupled with high investment and transaction costs. This limits opportunities for high investment costs projects to realise declining average costs over time. This thus creates a barrier to enter into climate mitigation measure as the products become continuously expensive and lowers demand over time.

Table 33: Summary of barriers to investing in climate change projects

Barriers to climate change financing	Factor that create barriers
High investment cost and long term investment	• Lack of technology • Lack of existing infrastructure • Lack of skilled manpower
Existing subsidies on climate mitigation project substitutes	Government policies
Existence of the externalities	• Public good nature of the environment • Missing markets • Government policies
Limited resources and competing developmental needs	Developing nature of the country
Stiff competition and lack of trained personnel to develop climate mitigation proposals	Lack of training plans amongst relevant institutions
Lack of enable and conducive environment for operation of climate mitigation projects	Lack of energy policy and appliance guidelines on energy consumption standards
Political instability risk	Location of the country in an African continent
Absence of economies of scale for most climate projects	Small population size of the country

Table 33

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Statistics Botswana: International Merchandise Trade Statistics Digest

ANNEX

Annex: List of Institutions Represented in the NCCC

1. Attorney General's Chambers (International and Commercial Division)
2. Botswana Bureau of Standards
3. Business Botswana
4. Botswana Council of Nongovernmental Organizations (BOCONGO)
5. Botswana Institute for Technology Research and Innovation
6. Botswana Meat Commission
7. Botswana Power Corporation
8. Department of Energy Affairs
9. Department of Mines
10. Department of Water Affairs
11. Department of Environmental Affairs
12. Department of Forestry and Range Resources
13. Department of Meteorological Services
14. Department of Wildlife and National Parks
15. Department of National Museum, Monuments and Art Gallery
16. Department of Tourism
17. Department of Waste Management and Pollution Control
18. Gaborone City Council
19. Ministry of Agricultural Development and Food Security
20. Ministry of Tertiary Education, Research, Science and Technology
21. Ministry of Finance and Economic Development
22. Ministry of Health and Wellness
23. Ministry of Transport and Communications
24. National Disaster Management Office
25. Statistics Botswana
26. United Nations Development Program
27. University of Botswana
28. Water Utilities Corporation
30. Somarelang Tikologo
31. Ministry of Basic Education
32. Department of Gender Affairs
33. Ministry of International Affairs and Cooperation
34. Forestry Conservation Botswana

Table 34: 2015 Key Categories: Level Assessment

A	B	C	D	E	F	G
IPCC Cate gory code	IPCC Category	Greenhouse gas	2014 Ex,t (Gg CO2 Eq)	|Ex,t | (Gg CO2 Eq)	L x, t	Cumul ative Total of Colum n F
3.B.1. b	Land Converted to Forest land	CARBON DIOXIDE (CO2)	-15241.32	15241.32	0.33	0.33
3.B.3. b	Land Converted to Grassland	CARBON DIOXIDE (CO2)	15198.92	15198.92	0.33	0.66
1.A.1	Energy Industries - Solid Fuels	CARBON DIOXIDE (CO2)	5088.82	5088.82	0.11	0.77
3.B.1. a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-2778.28	2778.28	0.06	0.83
1.A.3. b	Road Transportation	CARBON DIOXIDE (CO2)	2351.48	2351.48	0.05	0.88
3.A.1	Enteric Fermentation	METHANE (CH4)	1337.31	1337.31	0.03	0.91
2.B.7	Soda Ash Production	CARBON DIOXIDE (CO2)	1094.72	1094.72	0.02	0.93

1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	624.37	624.37	0.01	0.94
4.A	Solid Waste Disposal	METHANE (CH4)	584.07	584.07	0.01	0.96
1.A.4	Other Sectors - Biomass	METHANE (CH4)	515.09	515.09	0.01	0.97
1.B.1	Solid Fuels	METHANE (CH4)	316.81	316.81	0.01	0.97
3.C.1	Emissions from biomass burning	NITROUS OXIDE (N2O)	254.28	254.28	0.01	0.98
1.A.4	Other Sectors - Solid Fuels	CARBON DIOXIDE (CO2)	200.14	200.14	0.00	0.98
3.C.1	Emissions from biomass burning	METHANE (CH4)	188.66	188.66	0.00	0.99
2.A.1	Cement production	CARBON DIOXIDE (CO2)	126.42	126.42	0.00	0.99
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	101.38	101.38	0.00	0.99
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	78.76	78.76	0.00	0.99
3.A.2	Manure Management	METHANE (CH4)	66.46	66.46	0.00	1.00

1.A.3. b	Road Transportation	NITROUS OXIDE (N2O)	35.84	35.84	0.00	1.00
1.A.3. a	Civil Aviation	CARBON DIOXIDE (CO2)	28.12	28.12	0.00	1.00
3.B.4. a.i	Peatlands remaining peatlands	CARBON DIOXIDE (CO2)	28.07	28.07	0.00	1.00
1.A.1	Energy Industries - Solid Fuels	NITROUS OXIDE (N2O)	25.01	25.01	0.00	1.00
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N2O)	23.09	23.09	0.00	1.00
1.A.3. b	Road Transportation	METHANE (CH4)	13.82	13.82	0.00	1.00
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO2)	- 11.09	11.09	0.00	1.00
3.B.4. a.i	Peatlands remaining peatlands	NITROUS OXIDE (N2O)	5.55	5.55	0.00	1.00
1.B.1	Solid Fuels	CARBON DIOXIDE (CO2)	3.02	3.02	0.00	1.00
3.C.5	Indirect N2O Emissions from managed soils	NITROUS OXIDE (N2O)	2.10	2.10	0.00	1.00
1.A.4	Other Sectors - Liquid Fuels	METHANE (CH4)	1.73	1.73	0.00	1.00
1.A.4	Other Sectors - Liquid Fuels	NITROUS OXIDE (N2O)	1.49	1.49	0.00	1.00

1.A.4	Other Sectors - Solid Fuels	METHANE (CH_4)	1.23	1.23	0.00	1.00
1.A.1	Energy Industries - Solid Fuels	METHANE (CH_4)	1.13	1.13	0.00	1.00
1.A.4	Other Sectors - Solid Fuels	NITROUS OXIDE (N_2O)	0.98	0.98	0.00	1.00
3.C.4	Direct N_2O Emissions from managed soils	NITROUS OXIDE (N_2O)	0.69	0.69	0.00	1.00
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	0.55	0.55	0.00	1.00
3.B.5.a	Settlements Remaining Settlements	CARBON DIOXIDE (CO_2)	0.25	0.25	0.00	1.00
1.A.3.a	Civil Aviation	NITROUS OXIDE (N_2O)	0.25	0.25	0.00	1.00
3.C.3	Urea application	CARBON DIOXIDE (CO_2)	0.15	0.15	0.00	1.00
3.B.6.b	Land Converted to Other land	CARBON DIOXIDE (CO_2)	0.10	0.10	0.00	1.00
3.C.2	Liming	CARBON DIOXIDE (CO_2)	0.09	0.09	0.00	1.00
3.B.5.b	Land Converted to Settlements	CARBON DIOXIDE (CO_2)	0.08	0.08	0.00	1.00
3.B.2.a	Cropland Remaining Cropland	CARBON DIOXIDE (CO_2)	0.03	0.03	0.00	1.00

1.A.3.a	Civil Aviation	METHANE (CH4)	0.00	0.00	0.00	1.00

Table 35: 2015 Energy Sectoral Table

	Emissions (Gg)						
Categories	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
1 - Energy	8295.95	40.47	0.5 3				
1.A - Fuel Combustion Activities	8292.93	25.38	0.5 3				
1.A.1 - Energy Industries	5088.82	0.0 5	0.0 8				
1.A.1.a - Main Activity Electricity and Heat Production	5088.82	0.0 5	0.0 8				
1.A.1.a.i - Electricity Generation	5088.82	0.0 5	0.0 8				
1.A.1.a.ii - Combined Heat and Power Generation (CHP)							
1.A.1.a.iii - Heat Plants							
1.A.1.b - Petroleum Refining							

1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries							
1.A.1.c.i - Manufacture of Solid Fuels							
1.A.1.c.ii - Other Energy Industries							

1.A.2 - Manufacturing Industries and Construction							
1.A.2.a - Iron and Steel							
1.A.2.b - Non-Ferrous Metals							
1.A.2.c - Chemicals							
1.A.2.d - Pulp, Paper and Print							
1.A.2.e - Food Processing, Beverages and Tobacco							
1.A.2.f - Non-Metallic Minerals							
1.A.2.g - Transport Equipment							
1.A.2.h - Machinery							
1.A.2.i - Mining (excluding fuels) and Quarrying							
1.A.2.j - Wood and wood products							
1.A.2.k - Construction							
1.A.2.l - Textile and Leather							
1.A.2.m - Non-specified Industry							

1.A.3 - Transport	2379.60	0.66	0.1 2				
1.A.3.a - Civil Aviation	28.12	0.00	0.00				
1.A.3.a.i - International Aviation (International Bunkers) (1)							
1.A.3.a.ii - Domestic Aviation	28.12	0.00	0.00				
1.A.3.b - Road Transportation	2351.48	0.66	0.12				
1.A.3.b.i - Cars	2351.48	0.66	0.12				
1.A.3.b.i.1 - Passenger cars with 3way catalysts							
1.A.3.b.i.2 - Passenger cars without 3-way catalysts							
1.A.3.b.ii - Light-duty trucks							
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts							
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts							
1.A.3.b.iii - Heavy-duty trucks and buses							
1.A.3.b.iv - Motorcycles							

1.A.3.b.v - Evaporative emissions from vehicles							
1.A.3.b.vi - Urea-based catalysts							
1.A.3.c - Railways							
1.A.3.d - Water-borne Navigation							
1.A.3.d.i - International water-borne navigation (International bunkers) (1)							
1.A.3.d.ii - Domestic Water-borne Navigation							
1.A.3.e - Other Transportation							
1.A.3.e.i - Pipeline Transport							
1.A.3.e.ii - Off-road							
1.A.4 - Other Sectors	824.50	24.67	0.34				
1.A.4.a - Commercial/Institutional	734.72	0.09	0.01				
1.A.4.b - Residential	45.92	24.53	0.33				
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	43.86	0.04	0.00				
1.A.4.c.i - Stationary	43.86	0.04	0.00				
1.A.4.c.ii - Off-road Vehicles and Other Machinery							

1.A.4.c.iii - Fishing (mobile combustion)							
1.A.5 - Non-Specified							
1.A.5.a - Stationary							
1.A.5.b - Mobile							
1.A.5.b.i - Mobile (aviation component)							
1.A.5.b.ii - Mobile (water-borne component)							
1.A.5.b.iii - Mobile (Other)							
1.A.5.c - Multilateral Operations (1)(2)							
1.B - Fugitive emissions from fuels	3.02	15.09					
1.B.1 - Solid Fuels	3.02	15.09					
1.B.1.a - Coal mining and handling	3.02	15.09					
1.B.1.a.i - Underground mines	3.02	15.09					
1.B.1.a.i.1 - Mining	1.51	13.84					
1.B.1.a.i.2 - Post-mining seam gas emissions	1.51	1.25					

1.B.1.a.i.3 - Abandoned underground mines							
1.B.1.a.i.4 - Flaring of drained methane or conversion of methane to CO2	0.00	0.00					
1.B.1.a.ii - Surface mines	0.00	0.00					
1.B.1.a.ii.1 - Mining	0.00	0.00					
1.B.1.a.ii.2 - Post-mining seam gas emissions	0.00	0.00					
1.B.1.b - Uncontrolled combustion and burning coal dumps							
1.B.1.c - Solid fuel transformation							
1.B.2 - Oil and Natural Gas							
1.B.2.a - Oil							
1.B.2.a.i - Venting							
1.B.2.a.ii - Flaring							
1.B.2.a.iii - All Other							
1.B.2.a.iii.1 - Exploration							
1.B.2.a.iii.2 - Production and Upgrading							
1.B.2.a.iii.3 - Transport							
1.B.2.a.iii.4 - Refining							

1.B.2.a.iii.5 - Distribution of oil products							
1.B.2.a.iii.6 - Other							
1.B.2.b - Natural Gas							
1.B.2.b.i - Venting							
1.B.2.b.ii - Flaring							
1.B.2.b.iii - All Other							
1.B.2.b.iii.1 - Exploration							
1.B.2.b.iii.2 - Production							
1.B.2.b.iii.3 - Processing							
1.B.2.b.iii.4 - Transmission and Storage							
1.B.2.b.iii.5 - Distribution							
1.B.2.b.iii.6 - Other							
1.B.3 - Other emissions from Energy Production							
1.C - Carbon dioxide Transport and Storage	0.00						
1.C.1 - Transport of CO2	0.00						
1.C.1.a - Pipelines	0.00						
1.C.1.b - Ships	0.00						
1.C.1.c - Other (please specify)	0.00						
1.C.2 - Injection and Storage	0.00						

1.C.2.a - Injection	0.00						
1.C.2.b - Storage	0.00						
1.C.3 - Other	0.00						

Categories	Emissions (Gg)						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
Memo Items (3)							
International Bunkers	37.8378	0.0003	0.001	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers) (1)	37.8378	0.0003	0.001	0	0	0	0
1.A.3.d.i - International water-borne navigation (International bunkers) (1)				0	0	0	0
1.A.5.c - Multilateral Operations (1)(2)				0	0	0	0
Information Items							
CO2 from Biomass Combustion for Energy Production	9157.075						

Table 36: 2015 IPPU Sectoral Table

Categories	(Gg)			CO2 Equivalents(Gg)				(Gg)				
	C O2	C H 4	N 2 O	H F C s	P F C s	S F 6	Oth er halo gena ted gase	Oth er halo gena ted gase	N O x	C O	N MV OC s	S O 2

							s with CO2 equi vale nt conv ersio n facto rs (1)	s with out CO2 equi vale nt conv ersio n facto rs (2)				

2 - Industrial Processes and Product Use	1221.139	0	0	0.548	0	0	0	0	0	0	0	0
2.A - Mineral Industry	126.418	0	0	0	0	0	0	0	0	0	0	0
2.A.1 - Cement production	126.418								0	0	0	0
2.A.2 - Lime production	0								0	0	0	0
2.A.3 - Glass Production	0								0	0	0	0
2.A.4 - Other Process Uses of Carbonates	0	0	0	0	0	0	0	0	0	0	0	0
2.A.4.a - Ceramics	0								0	0	0	0
2.A.4.b - Other Uses of Soda Ash	0								0	0	0	0
2.A.4.c - Non Metallurgical Magnesia Production	0								0	0	0	0
2.A.4.d - Other (please specify) (3)	0								0	0	0	0

2.A.5 - Other (please specify) (3)									0	0	0	0
2.B - Chemical Industry	1094.	0	0	0	0	0	0	0	0	0	0	0
	721											
2.B.1 - Ammonia Production	0								0	0	0	0
2.B.2 - Nitric Acid Production			0						0	0	0	0
2.B.3 - Adipic Acid Production			0						0	0	0	0
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0						0	0	0	0
2.B.5 - Carbide Production	0	0							0	0	0	0
2.B.6 - Titanium Dioxide Production	0								0	0	0	0
2.B.7 - Soda Ash Production	1094.721								0	0	0	0

2.B.8 - Petrochemical and Carbon Black Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.8.a - Methanol	0	0							0	0	0	0
2.B.8.b - Ethylene	0	0							0	0	0	0
2.B.8.c - Ethylene Dichloride and Vinyl Chloride Monomer	0	0							0	0	0	0
2.B.8.d - Ethylene Oxide	0	0							0	0	0	0
2.B.8.e - Acrylonitrile	0	0							0	0	0	0
2.B.8.f - Carbon Black	0	0							0	0	0	0
2.B.9 - Fluorochemical Production	0	0	0	0	0	0	0	0	0	0	0	0
2.B.9.a - By-product emissions (4)				0					0	0	0	0
2.B.9.b - Fugitive Emissions (4)									0	0	0	0
2.B.10 - Other (Please specify) (3)									0	0	0	0
2.C - Metal Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	0	0							0	0	0	0

2.C.2 - Ferroalloys Production	0	0							0	0	0	0
2.C.3 - Aluminium production	0				0				0	0	0	0
2.C.4 - Magnesium production (5)	0					0			0	0	0	0
2.C.5 - Lead Production	0								0	0	0	0
2.C.6 - Zinc Production	0								0	0	0	0
2.C.7 - Other (please specify) (3)									0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use (6)	0	0	0	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0								0	0	0	0
2.D.2 - Paraffin Wax Use	0								0	0	0	0
2.D.3 - Solvent Use (7)									0	0	0	0
2.D.4 - Other (please specify) (3), (8)									0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor (9)				0	0	0		0	0	0	0	0

2.E.2 - TFT Flat Panel Display (9)					0	0		0	0	0	0	0
2.E.3 - Photovoltaics (9)					0				0	0	0	0
2.E.4 - Heat Transfer Fluid (10)					0				0	0	0	0
2.E.5 - Other (please specify) (3)									0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	0.548	0	0	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning	0	0	0	0.548	0	0	0	0	0	0	0	0
2.F.1.a - Refrigeration and Stationary Air Conditioning				0.548					0	0	0	0
2.F.1.b - Mobile Air Conditioning				0					0	0	0	0
2.F.2 - Foam Blowing Agents				0				0	0	0	0	0

2.F.3 - Fire Protection				0	0				0	0	0	0
2.F.4 - Aerosols				0				0	0	0	0	0
2.F.5 - Solvents				0	0			0	0	0	0	0
2.F.6 - Other Applications (please specify) (3)				0	0			0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment	0	0	0	0	0	0	0	0	0	0	0	0
2.G.1.a - Manufacture of Electrical Equipment					0	0			0	0	0	0
2.G.1.b - Use of Electrical Equipment					0	0			0	0	0	0
2.G.1.c - Disposal of Electrical Equipment					0	0			0	0	0	0
2.G.2 - SF6 and PFCs from Other Product Uses	0	0	0	0	0	0	0	0	0	0	0	0
2.G.2.a - Military Applications					0	0			0	0	0	0
2.G.2.b - Accelerators					0	0			0	0	0	0
2.G.2.c - Other (please specify) (3)					0	0			0	0	0	0

2.G.3 - N2O from Product Uses	0	0	0	0	0	0	0	0	0	0	0	0
2.G.3.a - Medical Applications			0						0	0	0	0
2.G.3.b - Propellant for pressure and aerosol products			0						0	0	0	0
2.G.3.c - Other (Please specify) (3)			0						0	0	0	0
2.G.4 - Other (Please specify) (3)									0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry									0	0	0	0
2.H.2 - Food and Beverages Industry									0	0	0	0
2.H.3 - Other (please specify) (3)									0	0	0	0

Table 37: 2015 AFOLU Sectoral Table

Categories	(Gg)				
	Net CO2 emissi ons / remov als	Emissions			
		CH 4	N2 O	NO x	CO
3 - Agriculture, Forestry, and Other Land Use	-2803.005	75.830	0.847	15.234	253.892
3.A - Livestock	0.000	66.847	0.000	0.000	0.000
3.A.1 - Enteric Fermentation	0.000	63.682	0.000	0.000	0.000
3.A.1.a - Cattle	0.000	54.087	0.000	0.000	0.000
3.A.1.a.i - Dairy Cows		0.054		0.000	0.000

3.A.1.a.ii - Other Cattle		54.033		0.000	0.000
3.A.1.b - Buffalo		0.000		0.000	0.000
3.A.1.c - Sheep		1.210		0.000	0.000
3.A.1.d - Goats		6.025		0.000	0.000
3.A.1.e - Camels		0.000		0.000	0.000
3.A.1.f - Horses		0.576		0.000	0.000
3.A.1.g - Mules and Asses		1.780		0.000	0.000
3.A.1.h - Swine		0.004		0.000	0.000
3.A.1.j - Other (please specify)		0.000		0.000	0.000

3.A.2 - Manure Management (1)	0.000	3.165	0.000	0.000	0.000
3.A.2.a - Cattle	0.000	2.246	0.000	0.000	0.000
3.A.2.a.i - Dairy cows		0.001	0.000	0.000	0.000
3.A.2.a.ii - Other cattle		2.24 5	0.000	0.000	0.000
3.A.2.b - Buffalo		0.000	0.000	0.000	0.000
3.A.2.c - Sheep		0.058	0.000	0.000	0.000
3.A.2.d - Goats		0.363	0.000	0.000	0.000
3.A.2.e - Camels		0.000	0.000	0.000	0.000
3.A.2.f - Horses		0.079	0.000	0.000	0.000
3.A.2.g - Mules and Asses		0.348	0.000	0.000	0.000

3.A.2.h - Swine		0.04 8	0.000	0.000	0.000
3.A.2.i - Poultry		0.023	0.000	0.000	0.000
3.A.2.j - Other (please specify)		0.000	0.000	0.000	0.000
3.B - Land	-2792.161	0.000	0.018	0.000	0.000
3.B.1 - Forest land	-18019.600	0.00 0	0.000	0.000	0.000
3.B.1.a - Forest land Remaining Forest land	-2778.280			0.000	0.000
3.B.1.b - Land Converted to Forest land	-15241.321	0.000	0.000	0.000	0.000
3.B.1.b.i - Cropland converted to Forest Land	0.000			0.000	0.000

3.B.1.b.ii - Grassland converted to Forest Land	-15241.321			0.000	0.000
3.B.1.b.iii - Wetlands converted to Forest Land	0.000			0.000	0.000
3.B.1.b.iv - Settlements converted to Forest Land	0.000			0.000	0.000
3.B.1.b.v - Other Land converted to Forest Land	0.000			0.000	0.000
3.B.2 - Cropland	0.026	0.00 0	0.000	0.000	0.000
3.B.2.a - Cropland Remaining Cropland	0.026			0.000	0.000
3.B.2.b - Land Converted to Cropland	0.000	0.000	0.000	0.000	0.000
3.B.2.b.i - Forest Land converted to Cropland	0.000			0.000	0.000
3.B.2.b.ii - Grassland converted to Cropland	0.000			0.00 0	0.000

3.B.2.b.iii - Wetlands converted to Cropland	0.000			0.000	0.000
3.B.2.b.iv - Settlements converted to Cropland	0.000			0.000	0.000
3.B.2.b.v - Other Land converted to Cropland	0.000			0.000	0.000
3.B.3 - Grassland	15198.916	0.000	0.000	0.000	0.000
3.B.3.a - Grassland Remaining Grassland	0.000			0.000	0.000
3.B.3.b - Land Converted to Grassland	15198.916	0.000	0.000	0.000	0.000
3.B.3.b.i - Forest Land converted to Grassland	15198.916			0.000	0.000
3.B.3.b.ii - Cropland converted to Grassland	0.000			0.000	0.000
3.B.3.b.iii - Wetlands converted to Grassland	0.000			0.000	0.000
3.B.3.b.iv - Settlements converted to Grassland	0.000			0.000	0.000

3.B.3.b.v - Other Land converted to Grassland	0.000			0.000	0.000
3.B.4 - Wetlands	28.068	0.000	0.018	0.000	0.000
3.B.4.a - Wetlands Remaining Wetlands	28.068	0.00 0	0.018	0.000	0.000
3.B.4.a.i - Peatlands remaining peatlands	28.068		0.018	0.000	0.000
3.B.4.a.ii - Flooded land remaining flooded land				0.000	0.000
3.B.4.b - Land Converted to Wetlands	0.000	0.000	0.000	0.000	0.000
3.B.4.b.i - Land converted for peat extraction			0.000	0.000	0.000
3.B.4.b.ii - Land converted to flooded land	0.000			0.000	0.000
3.B.4.b.iii - Land converted to other wetlands				0.000	0.000

3.B.5 - Settlements	0.325	0.00 0	0.000	0.000	0.000
3.B.5.a - Settlements Remaining Settlements	0.246			0.000	0.000
3.B.5.b - Land Converted to Settlements	0.079	0.000	0.000	0.000	0.000
3.B.5.b.i - Forest Land converted to Settlements	0.000			0.000	0.000
3.B.5.b.ii - Cropland converted to Settlements	0.000			0.000	0.000
3.B.5.b.iii - Grassland converted to Settlements	0.000			0.000	0.000
3.B.5.b.iv - Wetlands converted to Settlements	0.035			0.000	0.000
3.B.5.b.v - Other Land converted to Settlements	0.043			0.000	0.000
3.B.6 - Other Land	0.104	0.000	0.000	0.000	0.000
3.B.6.a - Other land Remaining Other land				0.000	0.000

3.B.6.b - Land Converted to Other land	0.104	0.00 0	0.000	0.000	0.000
3.B.6.b.i - Forest Land converted to Other Land	0.000			0.000	0.000
3.B.6.b.ii - Cropland converted to Other Land	0.000			0.000	0.000
3.B.6.b.iii - Grassland converted to Other Land	0.000			0.000	0.000
3.B.6.b.iv - Wetlands converted to Other Land	0.070			0.000	0.000
3.B.6.b.v - Settlements converted to Other Land	0.034			0.00 0	0.000
3.C - Aggregate sources and non-CO2 emissions sources on land (2)	0.243	8.984	0.829	15.234	253.892
3.C.1 - Emissions from biomass burning	0.000	8.984	0.820	15.234	253.892
3.C.1.a - Biomass burning in forest lands		4.080	0.373	6.918	115.304

3.C.1.b - Biomass burning in croplands		0.000	0.000	0.000	0.000
3.C.1.c - Biomass burning in grasslands		4.90 4	0.448	8.315	138.588
3.C.1.d - Biomass burning in all other land		0.00 0	0.000	0.000	0.000
3.C.2 - Liming	0.091			0.000	0.000
3.C.3 - Urea application	0.153			0.000	0.000
3.C.4 - Direct N2O Emissions from managed soils (3)			0.002	0.000	0.000
3.C.5 - Indirect N2O Emissions from managed soils			0.007	0.000	0.000
3.C.6 - Indirect N2O Emissions from manure management			0.000	0.00 0	0.000
3.C.7 - Rice cultivations		0.00 0		0.000	0.000
3.C.8 - Other (please specify)				0.000	0.000

3.D - Other	-11.087	0.000	0.000	0.000	0.000
3.D.1 - Harvested Wood Products	-11.087			0.000	0.000
3.D.2 - Other (please specify)				0.000	0.000

Table 38: 2015 AFOLU Sectoral Table

Categories	Emissions [Gg]						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
4 - Waste	0	31.563	0.0745	0	0	0	0
4.A - Solid Waste Disposal	0	27.813	0	0	0	0	0
4.A.1 - Managed Waste Disposal Sites				0	0	0	0
4.A.2 - Unmanaged Waste Disposal Sites				0	0	0	0
4.A.3 - Uncategorised Waste Disposal Sites				0	0	0	0

4.B - Biological Treatment of Solid Waste		0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0
4.C.1 - Waste Incineration	0	0	0	0	0	0	0
4.C.2 - Open Burning of Waste	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	3.75 1	0.0745	0	0	0	0
4.D.1 - Domestic Wastewaster Treatment and Discharge		3.75 1	0.0745	0	0	0	0
4.D.2 - Industrial Wastewater Treatment and Discharge		0		0	0	0	0
4.E - Other (please specify)				0	0	0	0