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Liberia's First Biennial Update Report to UNFCCC

Liberia EPA

Liberia Government submission to the
United Nations Framework Convention on Climate Change

Liberia's First Biennial Update Report
(October 2020)

In collaboration with

Produced by the Environmental Protection Agency

Foreword

For and on behalf of His Excellency President George Manneh Weah, and the People of the Republic of Liberia, I present Liberia's First Biennial Update Report (BUR1) to the United Nations Framework Convention on Climate Change (UNFCCC) in fulfilment of Articles 4 and 12 of the UNFCCC. The 2018-2023 national development agenda (Poor Agenda for Prosperity and Development - PAPD) outlines the country's vision for achieving middle-income status by 2030 through inclusive and sustained economic development.

Achieving the national vision is a challenge because the economy depends on climate-sensitive sectors. The PAPD aims to bring growth back to the economy by increasing productivity through value chains with emphasis on agricultural processing and market. Among other things, climate-smart agricultural activities and climate-resilient infrastructure are sustainable actions the country is undertaking to adapt to climate change. The forestry sector is highlighted as a significant sector to achieve growth. Despite a significant forest loss over the years, Liberia still has significant forest which makes up about 40% of the remaining West African moist forest (upper Guinea Forest).

As we submit the BUR1, we hope that the whole world will see the progress Liberia has made to align the national policies with the African Union Agenda 2063 and the Sustainable Development Goals (SDGs). Despite Liberia's development challenges, over the years, the country has demonstrated a high commitment to accurately report on Greenhouse Gas (GHG) emissions, implement policy measures to mitigate GHGs and build resilience in the forestry, waste and the energy sectors.

Finally, Liberia through its partners, Conservation International (CI), the European Union (EU), and the United Nations Development Program (UNDP) is developing a roadmap for its Nationally Determined Contribution (NDC), inclusion of nature-based solutions, natural capital accounting, mainstreaming climate change in sectoral national strategies and policies and capacity building training to launch an even more ambitious five-year climate change program and prepare the country for the enhanced transparency framework of the Paris Agreement.

All Liberians and international partners are encouraged to support the nation's ambitious plan to lower global emissions and embrace the exciting times that lie ahead.

Prof. Wilson K. Tarpeh,
Executive Director / Chief Executive Officer
Environmental Protection Agency of Liberia

Preface

Environmental Protection Agency (EPA) of Liberia has compiled this report to meet Liberia's obligations to prepare and submit Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC) by the end of 2020.

The BUR has been prepared per the UNFCCC Reporting Guidelines for Parties not included in Annex 1 to the Convention.

An electronic version of this report is available on the website of the EPA (www.epa.gov.lr).

For any further information

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Acknowledgements

Liberia's First Biennial Update Report falls under the support of the Global Environment Facility (GEF) for convention-related reporting and assessment and is implemented on an agreed full cost basis requiring only in-kind contributions by GEF-eligible countries. The project conforms with objective 3 of the GEF–6 climate mitigation strategy that focuses on fostering enabling conditions to mainstream mitigation concerns into sustainable development strategies. It is aligned to program 5 for integrating findings of convention obligations and enabling activities into national planning processes and mitigation contributions.

Kindly accept my appreciation on behalf of the project steering committee and the project management unit which were directly supported by leaders of four working groups, namely (1) GHG Inventory Team; (2) Climate Change Mitigation Assessment and MRV Team; (3) Climate Modelling and Team and (4) Cross-Cutting Team. Let me also appreciate our international consultant, Dr Daniel Benefoh, for taking the lead in the technical analysis of this report, along with our local consultants.

My heartfelt congratulation also goes to the United Nations Environment Program (UNEP) for serving as a GEF implementing agency and providing the necessary general management and monitoring support during the implementation of the project.

Lest I forget, special recognition is extended to former executive directors, Madam Anyaa Vohiri and Dr Nathaniel T. Blama Sr. as well as current Executive Director, Prof. Wilson K. Tarpeh for their confidence reposed in me to serve as National Project Coordinator of Liberia's First Biennial Update Report Project. A big thanks to the current National Focal Point for the United Nations Framework Convention on Climate Change (UNFCCC), Mr. Jefferson Nyandibo for renewing the confidence reposed. Last but certainly not least, let me register my profound thanks to the former UNFCCC Focal Point, Prof. Benjamin S. Karmorh, Jr., for his guidance. The technical and emotional support of my bosses cannot be overemphasized.

Charles Asumana Sr., PhD.
National Project Coordinator

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Abbreviations

ADB	African Development Bank
AFL	Armed Forces of Liberia
AWS	Automatic Weather Stations
BMC	Bong Mines Company
CBIT	Capacity Building Initiative for Transparency
CH4	Methane
CI	Conservation International
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPO	Crude Palm Oil
CSOs	Civil Society Organizations
DSSAT	The Decision Support System for Agrotechnology Transfer
ECOWAS	Economic Community of West African States
EVD	Ebola Virus Disease
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Database
FDA	Forestry Development Authority
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIEWS	Global Information and Early Warning Systems
GIS	Geographic Information System
HFO	Heavy Fuel Oil
IMF	International Monetary Fund
ISPS	International Ship and Port Security
ITCZ	Inter-Tropical Convergence Zone
LAMCO	Liberian American Swedish Mining Company
LEC	Liberia Electricity Corporation
LFSP	Liberia Forest Sector Project,
LISCR	Liberia International Ship and Corporate Registry
LMC	Liberia Mining Company
MC	Monrovia City Corporation
MDG	Millennium Development Goals
MOF	Ministry of Finance,
MOT	Ministry of Transport,
MRU	Mano River Union
MW	MegaWatts
N/A	Not Applicable
N_2O	Nitrous Oxide
NAM	Non-Aligned Movement
NAPA	National Adaptation Program of Action
NAPs	National Adaptation Plan
NCCPRS	National Climate Change Policy and Response Strategy,
NCCS	National Climate Change Secretariat
NCCSC	National Climate Change Steering Committee
NDC	Nationally Determined Contributions
NEP	National Energy Policy
NMVOCs	Non-methane organic volatile compounds

NO	Not Occurring
NPA	National Port Authority
NRDP	National Reconstruction and Development Plan
NREL	National Renewable Energy Laboratory
PRS	Poverty Reduction Strategy
REDD	Reducing Emissions from Deforestation and Forest Degradation
RESMP	Rural Energy Strategy and Master Plan
RGDP	Real Gross Domestic Product
RIA	Roberts International Airport
SNC	Second National Communication
SO_2	Sulphur Dioxide
SPUR2	Simulation of Production and Utilization of Rangelands Version 2, 154
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change,
UNITAR	United Nations Institute for Training and Research
USA	United States of America
WATBAL	Water Balance

ES: Executive Summary

ES 1 National Circumstances and Institutional Arrangement

ES 1.1 Updates on Liberia's National Circumstances

The Republic of Liberia is a West African nation situated in the Gulf of Guinea. Liberia has an estimated population of 4.2 million people, with 48.9% male and 51.1% female (LISGIS, 2016). The 2008 census indicated a population growth rate of 2.1% and 5.8 fertility rates. Liberia remains one of the poorest nations in the world. In 2014, the Liberian economy was seriously affected by the Ebola epidemic. The epidemic forced the Government to divert scarce resources to combat the spread of the virus, reducing funds available for needed public investment (CBL, 2017). Following the Ebola epidemic, the drawdown of UNMIL in 2016 also severely affected the Liberian economy. With increasing population growth rate coupled with declining economic growth, the challenge to make ends meet is expected to rise in the coming years in Liberia. This has the propensity to pose a serious threat to the environment. The climate of Liberia, like any other country in West Africa, is determined by the position of the Intertropical Convergence Zone (ITCZ) or the Intertropical Discontinuity (ITD), as it is better known in West Africa.

ES 1.1.1 State of Climate change in Liberia

Like any other nation, the impacts from changing climates are expected to be experienced in Liberia. Being one of the least developed nations of the world, the surprises that come with climate change are anticipated to be severe because of poverty, lack of adequate support and institutional framework. Figure ES1 highlights some of the damaging effects of climate change in Liberia.

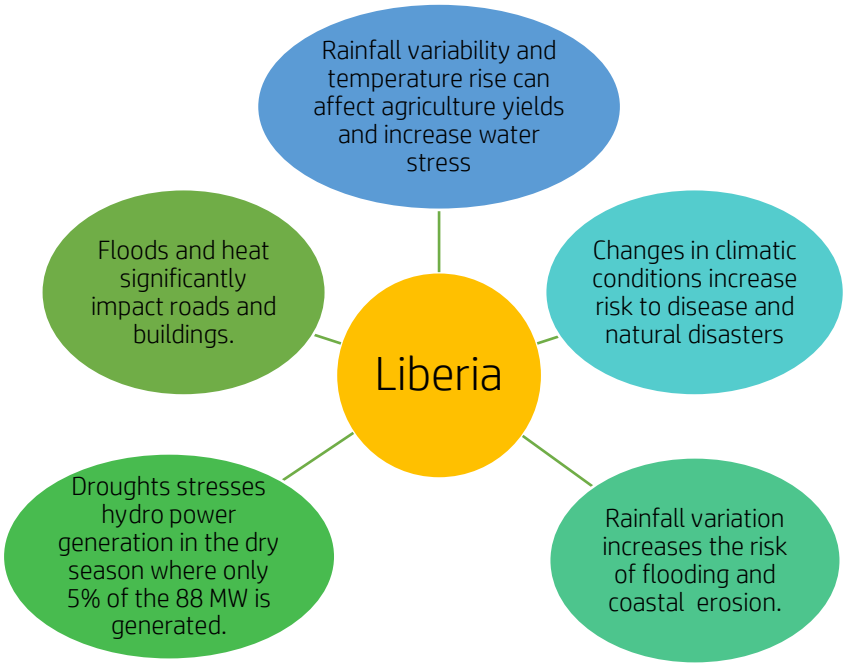

Figure ES 1: Climate change impacts in Liberia

Liberia is a meagre contributor to the global Greenhouse Gas (GHG) emission, with the AFOLU sector contributing the highest followed by the Energy Sector, IPPU and Waste. Without the Land category, the Energy sector is the largest source of GHG emissions in Liberia. Before 2015, the energy intensity of Liberia was so high because of heavy reliance on fossil fuels consumption. To address the rising GHG emissions in Liberia, the GOL has taken steps to formulate measures aim at providing mitigation strategies and adaptation towards climate change in Liberia. In 2008, the National Adaptation Program of Action (NAPA) was introduced. The NAPA program explicitly accounts for synergies between adaptation and national developments plans, such as the National Reconstruction and Development Plan (NRDP), as well as with multilateral initiatives such as Millennium Development Goals (MDGs) and the National Biodiversity and Strategy Action Plan (EPA, 2008). Liberia's Initial National Communication followed this to the UNFCC in 2012.

In 2015, Liberia's Nationally Determined Contributions (NDC) was developed, which includes a component on mitigation and another on adaption. The country also developed the National Climate Change Policy and Response Strategy (NCCPRS) in 2018, a policy document that addresses key sectorial and cross-sectorial issues relative to mitigation and adaptation. A National Adaptation Plan (NAPs) was also launched in 2015 as a means of identifying Liberia's medium and long-term adaptation needs. Currently, the Second National Communication (SNC) is ongoing and is expected to be completed shortly. The international organization have also embarked on different projects to combat climate change in Liberia. For example, Conservation International (CI) introduced the Capacity Building Initiative for Transparency (CBIT) to strengthen Liberia's capacity to implement the transparency elements of the Paris Climate Agreement. Other projects include the Liberia Forest Sector Project (LFSP) which was launched in 2016 to promote the concepts of REDD+ and Blue Ocean by CI whose primary objectives is to ensure the safety of marine species in Liberian waters.

ES 1.2 Institutional arrangement relevant for climate change and the preparation of NCs and BURs

Table ES1 shows the institutional arrangements of related climate change institutions in Liberia. The institutional arrangement is divided into three key groups, namely; Strategic Level Climate Change Institutions, Planning, Budgeting and Coordination Institutions and Climate Change Implementations Coordination Institutions. Ministries and agencies making these groups perform similar but distinct functions.

Table ES 1: Institutional arrangement for climate change in Liberia

Institution	Description of institutional arrangement	
Environmental Protection Agency (EPA)	• Provides policy guidelines for climate change-related activities. • Coordinates inter-ministerial collaboration between line ministries and agencies involved in climate change. • Mobilizes financial and technical resources for the combating of climate change activities in Liberia.	Strategic level Climate change institution
Ministry of Finance and Development Planning (MFDP)	• Formulates and allocates financial resources for climate change in Liberia. • Provides monitoring and evaluation functionalities to ensure that funds allocated are adequately utilized to meet deliverables.	Planning, budgeting, and coordination institutions
Ministry of Agriculture (MoA)	Responsible for collecting activity data for the various sections of the agriculture sector	Climate change implementation coordination institutions
Forestry Development Authority (FDA)	Responsible for collecting activity data for the forestry sector	
Liberia Land Authority (LLA)	Responsible for collecting activity data for the land-use sector	
Ministry of Mines and Energy (MME)	Responsible for collecting activity data for the energy sector	
Ministry of Transport (MoT)	Responsible for collecting activity data for the energy sector	
Liberia Institute of Statistics and Geo-information Services	Responsible for collating all data related to climate change in Liberia	

E.1.3 Institutional arrangement for preparing NCs and BURs

The Liberia EPA is responsible for the implementation of international environment treaties. Within the EPA, the Climate Change Enabling Unit (CCEU) is responsible for the activities for the preparation of National Communications; Biennial Update Reports; and National Inventory Reports to the UNFCCC. The CCEU is also responsible for monitoring climate change-related activities/projects and their execution across the country. The Unit serves as Executing Agency for the preparation of the BUR1. The project management team and reconstituted technical expert groups in consultation with other government ministries, and agencies, as well as civic society organizations, used the best available data scientific approaches for the preparation of the BUR. The Climate Change Enabling Unit was responsible for the day to day running of the project.

ES. 2 National GHG Emissions Inventory

ES 2.1 Summary of the National Emission and Removal Related Trends

ES 2.1.1 Greenhouse gas trend and by sectors

Table ES2 shows the total emission by sector for CO_2-equivalent (CO_2e) in Giga gram (Gg) for the reporting period (2015-2017). Liberia's total emissions for 2017 amount to 5,990.7 Gg CO_2e. The 2017 emission is 5% higher than the 2015 emission levels. The AFOLU sector contributed 67% of the total emissions for Liberia in the same year and followed by Energy (16%), IPPU (9%) and Waste (8%) sectors. When the emission from the land category is excluded, Energy becomes the largest source of GHG emissions.

Table ES 2: Total greenhouse gas emissions by sectors

Sectors	Greenhous gas emissions (Gg CO_2e)			Share (%)	Change (%)
	2015	2016	2017	2017	2015-2017
Energy	1,161.65	1,008.29	957.42	16	-18
IPPU	1,067.63	997.93	555.37	9	-48
AFOLU*	3,069.62	3,711.72	4,014.05	67	31
3A and 3C	*197.03*	*220.05*	*208.36*	*3*	*6*
3B	*2,872.59*	*3,491.67*	*3,805.69*	*64*	*32*
Waste	396.26	410.08	463.86	8	17
Total	5,695.17	6,128.02	5,990.70	100	5

* Agriculture and Land categories combined

ES 2.1.2 Greenhouse gas emissions by gases

In Figure 2 shows aggregate emission trends by gases for 2015-2017. From the figure, CO_2 is the dominant GHG followed by methane, nitrous oxide and hydrofluorocarbons.

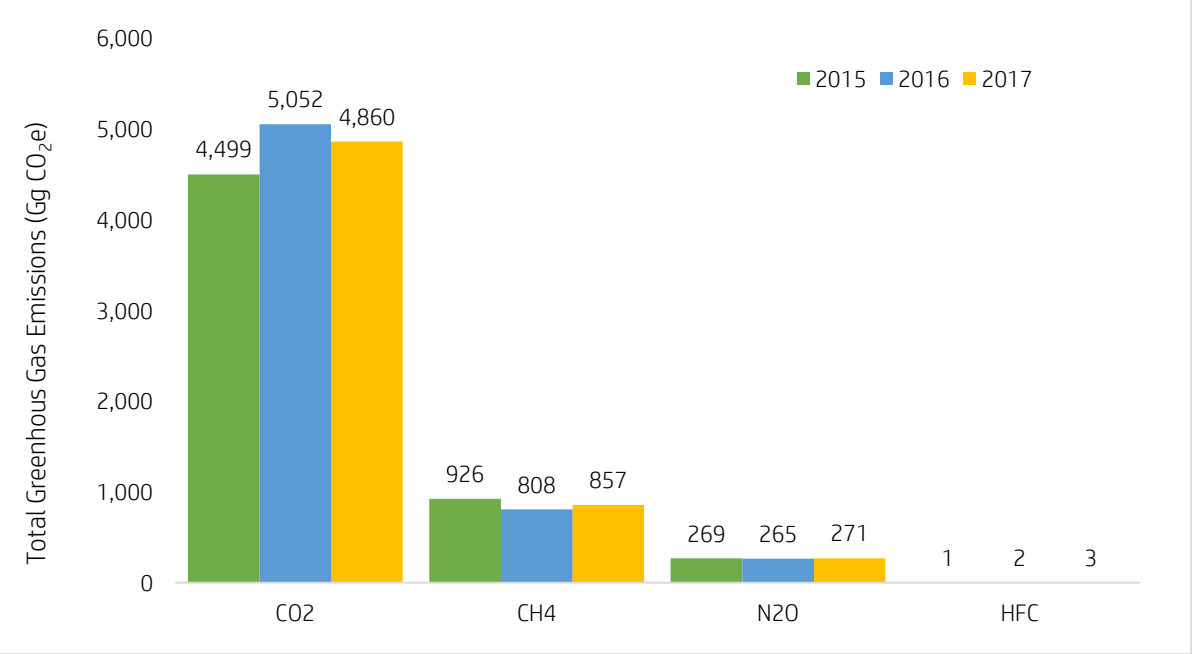

Figure ES 2: Aggregated emissions by gases for 2015- 2017

ES.3 Mitigation Actions and their effects

Climate change mitigation actions in Liberia are outlined in national laws and policies, action plans and projects, primarily in the Energy and Forestry sectors. Mitigation actions are less common in the Agriculture, Transport and waste sectors. Therefore, the Energy and the forestry sectors have made more advances than the other sectors as far as mitigation actions are concerned. The forestry sector could explore traditional conservation method to increase forest conservation like the traditional sacred forest. In the energy sector, Liberia has increased its clean energy production with increasing hydropower and solar power generation. This increment saves annually about 772.48 $GgCO_2e$ per year from being emitted in the atmosphere. The forestry sector, also, sequesters annually 12,305.45 $GgCO_2e$ more carbons and reduce emissions. Liberia could have more prospect in mitigation in the energy and forestry sectors if policies and action plans are supported and implemented across the nation. The inclusion of local/traditional practices and community participation in forestland management and restoration could further boost climate change mitigations in the forest sector, mostly the REDD+ program.

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

ES. 4.1 Financial Support Received

Cash received for the preparation of this BUR came mainly from the GEF. As of the inception of this BUR, the total amount of US$352,000.00 was received. There has been no other financial support from any other source towards the development of this BUR.

ES. 4.2 Support Received for Preparation of BUR

Apart from the GEF, the Government of Liberia is providing infrastructural support through co-financing for the preparation of the BUR. Table E4 shows the full amount received since 2017 from both the GEF and the GOL in-kin contribution.

Table ES 3: Cost of project (Expressed in US $)

Cost of Project:	(Expressed in US Dollars)				
	2017	2018	2019	Total	%
Cost to GEF Trust Fund ($)	63,333	227,500	51,167	342,000[1]	93
Government in-kind contribution ($)	5,000	15,000	5,000	25,000	7
Total cost ($)	68,000	242,500	56,167	367,000	100

ES. 5 Information on Domestic MRV

This document provides information on the Domestic MRV system of Liberia. The first session of this document gives an overview of the MRV system, and what led to the establishment of said system. It also speaks to how the Conference of the Party gradually evolved. The first portion of this document also gives a general idea of International MRV and domestic MRV system. The second half of this session speaks

[1] The total GEF amount is less the US$10,000 advanced to country on signing the project agreement, for BUR PIP preparation

more about the domestic MRV system of Liberia and its institutional arrangement. This portion begins with the assessment of existing MRV system of Liberia for BUR and NC reporting.

It also gives an understanding of steps taken to develop Liberia's MRV system and climaxed with the general design of the country's Domestic MRV system. The system incorporates various departments at the Environmental Protection Agency to include the Department of Planning & Policy (DPP), Department of Inter-sectorial coordination and the Multilateral Environment Agreements (MEA Unit). The design of this system draws inspiration from Liberia's REDD+ MRV System and does include the office of the President. The Overall policy and coordination come from the Office of the President through the National Climate Change Secretariat and then to the Board of Directors and Policy Council, and interns guide the EPA. The development of policy design and decision such as data collection and management protocols, field manual, etc. come from the Department of Planning and Policy with review and inputs from the MEA Unit and then validation and endorsement from the Board of directors and Policy council.

Chapter 1: National Circumstances and Institutional Arrangement

1.1 National Circumstances

1.1.1 Political Geography of Liberia

1.1.1.1 Geographical location

Liberia is located at the Western coast of Africa along the Atlantic Ocean on latitudes 4° 20' to 8° 30' N and longitudes 7° 18' to 11° 30' W. Its neighbors are Sierra Leone to its West, Guinea in the North, and Côte d'Ivoire to the East (Figure 1). With an area of 111,370 square kilometers, the geography is characterized as mostly flat to rolling coastal hills that give way to a plateau and low mountains in the northeast. The country has abundant natural resources in water, minerals, and forests that make up its main economic sectors (mining, agriculture, and forestry) with a coastline of 579 km[2]

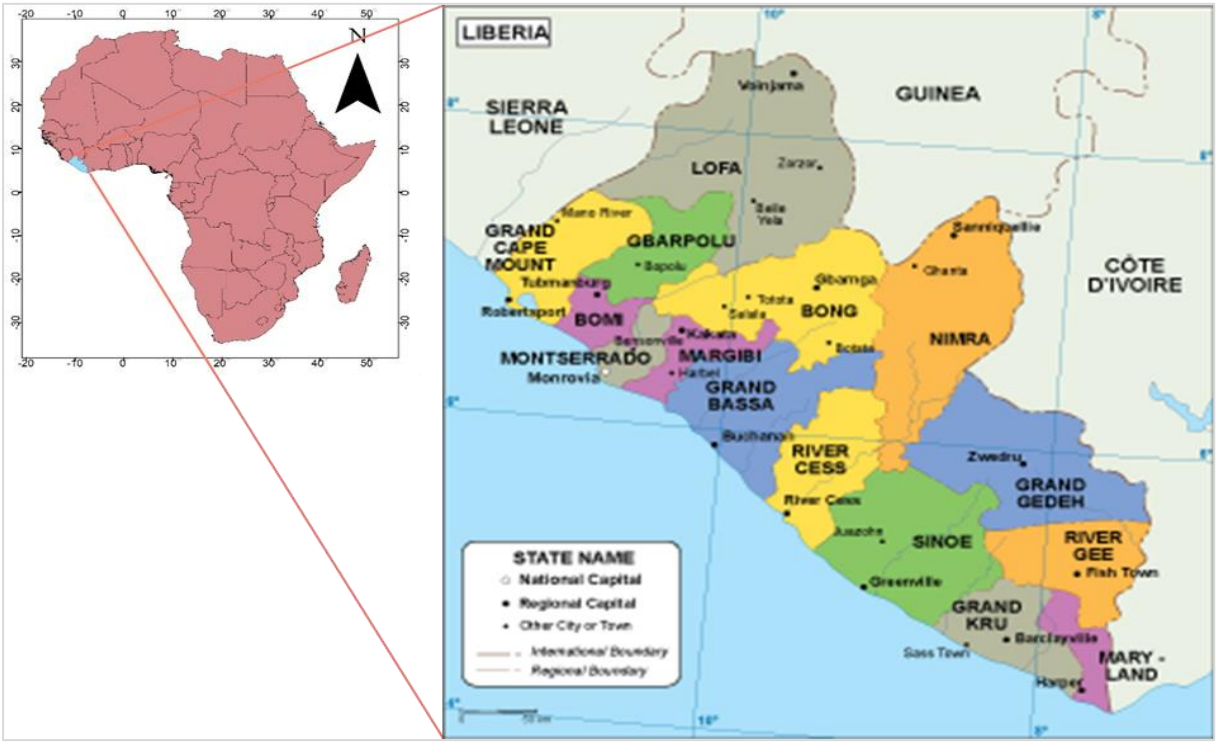

Figure 1: Location and Geopolitical Maps of Liberia

1.1.1.2 Government of Liberia

Liberia gained its independence in 1847 and has had two written constitutions. Professor Simon Greenleaf of Harvard University (USA) wrote the 1847 constitution following the Declaration of Independence. The first constitution existed for 133 years (1847–1980) and was abolished by the military take-over (coup d' état) of April 12, 1980. Liberia's 1986 constitution guarantees the dignity of humankind, freedom of the press, freedom of association, freedom of religion, and freedom of speech and to pave the way for multiparty and republican democracy as a secular state. The Government

[2] https://www.cia.gov/library/publications/the-world-factbook/geos/li.html (accessed on 2/10/2020)

System of Liberia, modeled on the Government of the United States of America, is a unitary constitutional republic and representative democracy with the seat of Government based in Monrovia, the capital city of Liberia. The Government of Liberia has three branches - the Legislative, the Executive, and the Judiciary. The first Branch of Government is the Legislature, which is bicameral in nature consisting of a House of Senate and Representatives. There are thirty Senators and seventy-three Representatives in the Legislature. In the House of Senate, each county is represented by two Senators who are elected based on popular vote and serve a nine-year term. Whereas in the House of Representatives, based on the population of the electoral district in each county, members are elected to represent an electoral district to a six-year term based on popular votes.

The second Branch of the Liberian Government is the Executive, headed by the President, who is the chief foreign policy formulator and commander-in-chief of the Armed Forces of Liberia (AFL). With the consent and advice of the Senate, the President appoints cabinet ministers to form the cabinet which assists in the day-to-day running of the Government. The President also appoints local superintendents, ambassadors, and other officials. The Executive Branch is charged with enforcing the laws enacted by the Legislative Branch. The Third Branch of Government, the Judiciary, is headed by the Chief Justice, who is assisted by four associate justices of the Supreme Court. The constitutional responsibility of the Judiciary is to interpret the laws. The Supreme Court serves as the final arbiter of justice in the country. Under the Supreme Court are several lower courts such as the circuit courts, specialized courts, and magistrate courts. The country is divided into fifteen counties, and subdivided into ninety districts and further into clans which form the local Government system. Counties and cities are headed by Commissioners and majors respectively. The paramount and clan chiefs as well as Zoes and Bodios, serve as the traditional authorities. Liberia is a founding member of the United Nations (UN) and its specialized agencies and is a member of the African Union (AU), the Economic Community of West African States (ECOWAS), the African Development Bank (AFDB), the Mano River Union (MRU), and the Non-Aligned Movement (NAM).

1.1.2 Demographic Profile of Liberia

1.1.2.1 Physical Geography of Liberia

The Liberian landscape is characterized by mostly flat to rolling coastal plains containing mangroves and swamps, rising in the northeast rise to a rolling plateau and low mountains (Bateman *et al.*, 2000). The relief system of Liberia is subdivided into the following four belts:

- The coastal belt extends upland to 32 to 40 km and is composed of gently undulating hills or low plains with an altitude not exceeding 15 m. This belt has three promontories: Cape Mount, Cape Mesurado, and Cape Palmas. The highest of these promontories is Cape Mount on the Sierra Leonean border with a height of over 350 m.
- The second belt is composed of hills, discontinuous ranges, and occasional escarpments that constitute the larger parts of Liberia's hinterland.

- The third belt is composed of plateaus that are about 200 to 300 m above sea level.
- The fourth belt is comprised of mountains that are in the northern highlands and include the Nimba and Wologisi range along the Guinean border.

The highest point solely within Liberia is Mount Wutivi (known as Wologizi) at 1,440 meters above sea level in the northwestern Liberia range of the West Africa Mountains and the Guinea Highlands (Bateman *et al.*, 2000). However, Mount Nimba near Yekepa is higher at 1,752 meters above sea level but is not solely within Liberia as Nimba shares a border with Guinea and Côte d'Ivoire. Liberia's watershed tends to move in a southwestern pattern towards the sea. As shown in **Error! Reference source not found.**, Liberia has six principal river basins (Cavalla, Cestos, St. John, St. Paul, Lofa, Mano) although smaller rivers and streams can be distinguished. All these rivers empty into the South Atlantic Ocean. The country's main northwestern boundary is traversed by the Mano River, while its southeastern limits are bounded by the Cavalla River (Bateman *et al.*, 2000). The largest of these rivers is the Cavalla found along the eastern side of the country. The river reaches east of the city of Tappita and forms the boundary between Liberia and Côte d'Ivoire, emptying into the

South Atlantic Ocean about 25 km east of Cape Palms. The river is also navigable from its mouth for about 80 km inland to its first rapids.

1.1.2.2 Liberia's Population

The results of five major censuses show that the population of Liberia was 1.02 million in 1962, 1.5 million in 1974 (GOL, 2008), 2.1 million in 1984 (LISGIS, 2009), 3.48 million in 2008 (LISGIS, 2009) and estimated to 4.2 million in 2016. Based on estimates from the 2008 National Census, the population of Liberia is expected to increase to 4.3 million by

Figure 2: Water Basins

2018 (**Error! Reference source not found.**). According to the UN World Population, with the current population growth of 2.5%, Liberia's population is likely to hit 6.4 million by 2030. Of 2018 population, 1.26 million people lived in Montserrado County, which is the most populous county and home to the capital, Monrovia. The next most populous area in Nimba County with about 500,000 residents. Liberia has a population density of just 35 people per square kilometer, which ranks 180th in the world. Liberia has sixteen indigenous ethnic groups and several foreign minorities. Indigenous groups account for 95% of the population.

The recognized ethnic groups include the Gio (or Dan), Mano, Bassa, Kpelle, Grebo, Vai, Gola, Kru, Krahn, Kissi, Gbandi, Mandingo (or Mandinka), Dei (or Dewoin), Bella, Mende and Lorma. According to LISGIS, the largest group is the Kpelle, who are concentrated in central and western Liberia. Americo-Liberians are descendants of African American and West Indian people and account for 2.5% of the population.

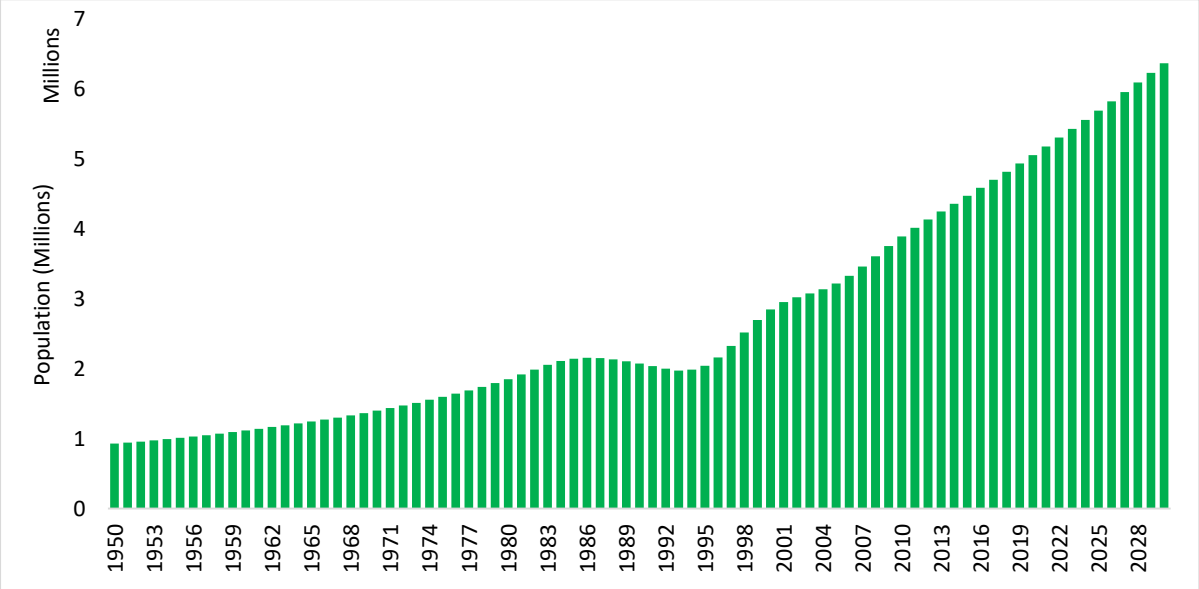

Figure 3: Population trends in Liberia from 1950 to 2017

The Congou people are descendants of repatriated Congou and Afro-Caribbean slaves and make up 2.5% of the population. Liberia also has a sizable population of Lebanese, Indians, and West Africans. According to the World Bank Development Indicators published in 2016, the life expectancy at birth among the general population is 62.5 years. Infant mortality rate stands at 52.2 death/ 1000 live birth. Liberia has a youthful population with a median age of 17.8 years. As shown in Figure 4, 43.8% of the population are 0-14 years, 15-24 years account for 19.6%, with 25-54 representing 30.33%, and while only 6.3% are 55 years and above. Christianity is the major with religion with 85.6%, Muslim 12.2%, Traditional 0.6%, Other 0.2%, and None 1.4%.

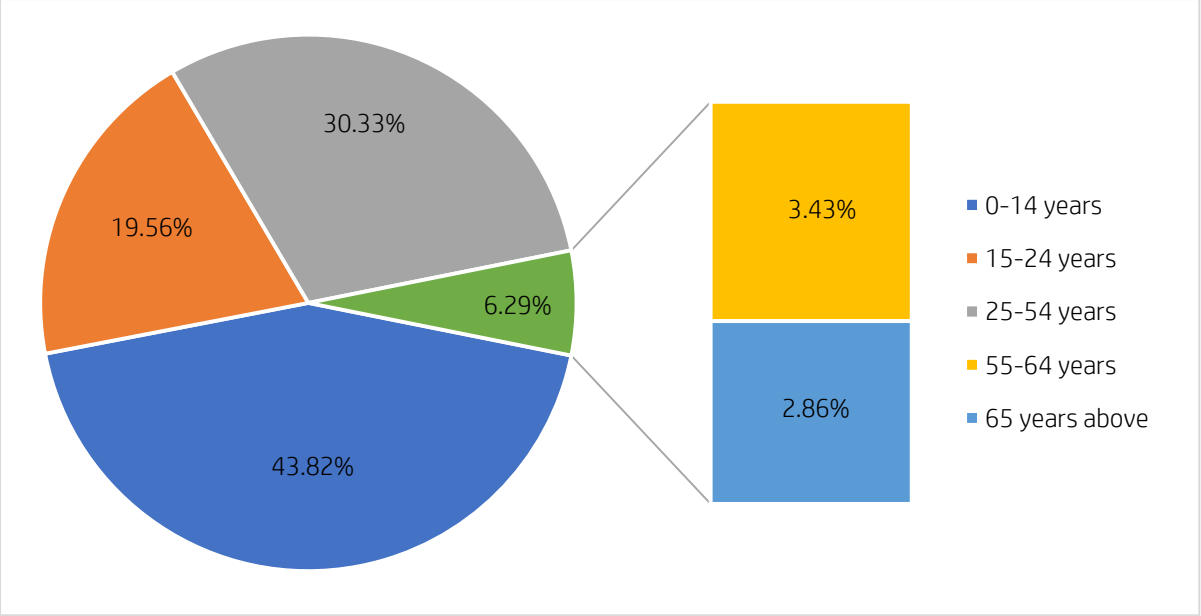

Figure 4: Age distribution of population in percentage
Source: (LISGIS, 2009)

1.1.2.3 Climate Profile of Liberia

Liberia has a tropical climate with one main rainy season, though most months experience rainfall. The wet season is from May-October, with a short break in the rains from mid-July to August as the ITCZ oscillates between the equator and tropic of cancer. The dry season extends from November to April. Average monthly temperatures range between 24°C and 27°C. The highest average temperatures are experienced from February to April, and August through December the lowest. The country experiences rainfall gradient from inland to the coast, with rainfall increasing towards the coast. Average annual rainfall exceeds 1,800 mm in northern, interior Liberia, while coastal Liberia experiences average annual rainfall above 2,800 mm.

1.1.2.3.1 Precipitation

Liberia's tropical climate is also characterised by hot and humid conditions all year round. The rainy season is from May to October, due to the African monsoon, with frequent rains in other months, except in the dry season (November to April), which is more in the northern part of the country. In the southern zone, the rains have a relative break from mid-July to late August. Along the coast, the rainfall exceeds 3,000 mm per year. In the northern part of the coast, in the capital Monrovia, rainfall reaches even 5.1 meters (200 inches) per year, with a maximum in June and July, when nearly one meter (3.3 feet) of rain per month fall, and a relative decrease in August. Here the rains are abundant already in April, and still in November (EPA, 2013).

1.1.2.3.2 Temperature

The weather is generally fair whereas temperature varies from 23 °C to 33°C and is rarely below 21°C or above 34°C throughout the year. The only disaster to hit the country is perhaps a landslide, but apart from that, no earthquakes, tornadoes, hurricanes or tidal waves have claimed a Liberian life. In terms of climate, Liberia has one of the gentlest climates in the world. Figure 5 and Table 1 show the difference in rainfall between the driest and wettest months and the yearly highest and lowest average temperatures. September is the wettest with a total rainfall of 375 mm while February has the lowest with 1 mm of rainfall. The average temperature of April is the highest during the year at 27.4 °C while December has the lowest average temperature of 24.4 °C.

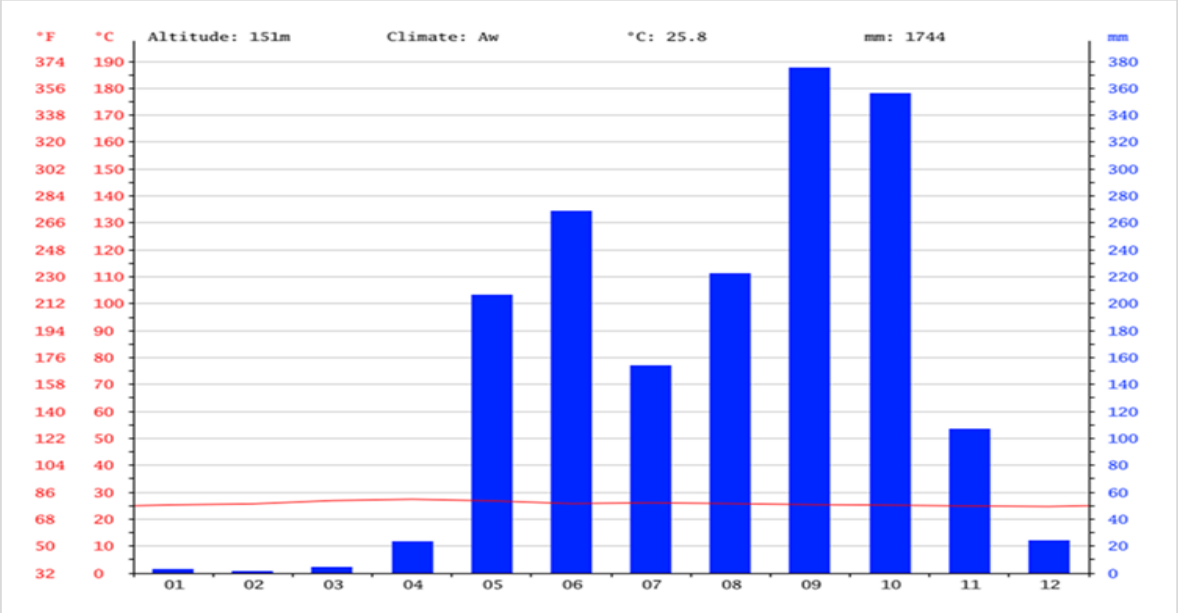

Figure 5: Average temperature and annual precipitation in Liberia

Table 1: Monthly Temperature and Rainfall

Months	Average Temperature (°C)	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°F)	Minimum Temperature (°F)	Maximum Temperature (°F)	Rainfall (mm)
January	25.3	19.2	31.4	77.5	66.6	88.5	3
February	25.7	19.2	32.2	78.3	66.6	90	1
March	26.9	20.3	33.5	80.4	68.5	92.3	4
April	27.4	21.1	33.7	81.3	70	92.7	23
May	26.8	21.4	32.2	80.2	70.5	90	206
June	25.8	21.4	30.3	78.4	70.5	86.5	269
July	26.1	21.4	30.8	79	70.5	87.4	154
August	25.8	21	30.6	78.4	69.8	87.1	222
September	25.4	20.8	30.1	77.7	69.4	86.2	375
October	25.2	20.7	29.7	77.4	69.3	85.5	356
November	24.9	20.1	29.7	76.8	68.2	85.5	107
December	24.7	19.1	30.4	76.5	66.4	86.7	24

Source: Climate Watch, 2017

1.1.2.4 Economic Profile of Liberia

Liberia is a low-income country, is dependent on donor funding and remittances from the diaspora (WorldBank, 2018). The country's main natural resources include water, mineral, forests, and a favorable climate for agriculture. Liberia's principal exports are iron ore, rubber, diamonds, and gold. Palm oil and cocoa are emerging as new export products. The Government is attempting to revive its raw timber extraction and is encouraging oil exploration after the civil war (CIA, 2018). The civil war in the 1990s and early part of the 2000s destroyed much of Liberia's economy, especially infrastructure in the capital, Monrovia. Much of the conflict was fueled by control over Liberia's natural resources.

After the war and the installation of a democratically elected Government in 2006, businesses began to return. Since then, GDP growth began to accelerate, reaching 9.4% in 2007 (IMF, 2011). The global financial crisis slowed GDP growth to 4.6% in 2009 (IMF, 2011), though a strengthening agricultural sector led by rubber and timber exports increased growth to 5.1% in 2010. The 2011 7.7% GDP growth made the economy one of the 20 fastest growing in the world (IMF, 2010). Since 2006 the Government of Liberia (GOL) has instituted robust reforms that fostered economic recovery and sustained growth which also led to improved performance across all sectors of the economy. Per capita GDP declined from US$524.7 in 1987 to US$54.5 in 1995 during the heat of the civil war.

In 2005, the real GDP was US$401.7 million and later grew to US$630.3 million in 2008 (UNDP, Liberia). Liberia's external debt was estimated in 2006 at approximately $4.5 billion, 800% of GDP (GOL, 2011). As a result of bilateral, multilateral and commercial debt relief from 2007 to 2010, the country's external debt fell to $222.9 million by 2011 (MOF, 2011). The country achieved high growth during the period 2010-13 due to favorable world prices for its commodities. Accordingly, RGDP in 2011 increased to US$768.0 million and estimated at US$835.1 million in 2012. Liberia's post-war annual national budget was recorded at US$80 million in 2006 and has grown to US$572 million in 2012, indicating an increase of 615% which has expanded the national fiscal space in support of national development that has strongly driven the MDGs implementation in the short period.

The strong growth over the period was driven by policy reform framework under the Poverty Reduction Strategy (PRS), Lift Liberia (2008-2011) that led to sustained support to the agriculture and the forestry sectors which accounted for 53%. These reforms have strengthened the private sector and particularly Liberia's business sector, which has also led to strong growth in the service sector (IMF, 2008). The Government has also designed its medium-term economic growth strategy for the next five years (2012-2017), called "Agenda for Transformation", that is part of Liberia's long-term development plan ("Vision 2030"), whose objective is to propel the country into the rank of a middle-income country by 2030. These strategies and plans are geared toward achieving the MDGs target by 2015 and beyond.

The Liberian economy showed solid performance in 2013 with real GDP growth estimated at 8.1% which is lower than the previous year 2012 (8.3%), but still stronger

than the 8% growth recorded in 2011 supported by the strong performance of iron-ore production, extractive industries, especially with regard to effective planning, the sustainability of resource use and prudent management of revenues. Inflation at the end of September 2013 was 8.2%, owing primarily to relatively high international and domestic food prices and the pass-through of exchange rate depreciation. Liberia used the US dollar as its currency from 1943 until 1982 and continues to use the US dollar alongside the Liberian dollar. The Liberian dollar depreciated by 7% at the end of 2012 to June 2013 (CBL, 2013). GDP growth in 2017 witnessed some level of recovery at 2.5%, from negative 1.6percent in 2016 due to the Ebola epidemic in the country (CBL, 2017).

However, during the 2014 – 2015 Ebola crisis, the economy declined, and many foreign-owned businesses departed with their capital and expertise. The epidemic forced the Government to divert scarce resources to combat the spread of the virus, reducing funds available for needed public investment (CBL, 2017). The cost of addressing the Ebola epidemic coincided with decreased economic activity reducing Government revenue, although higher donor support significantly offset this loss. During the same period, global commodities prices for key exports fell and have yet to recover to pre-Ebola levels.

In 2017, gold was a key driver of growth, as a new mining project began its first full year of production; iron ore exports also increased as Arcelor Mittal opened new mines at Mount Gangra. The completion of the rehabilitation of the Mount Coffee Hydroelectric Dam increased electricity production to support ongoing and future economic activity, although electricity tariffs remain high relative to other countries in the region and transmission infrastructure is limited and obsolete. The IMF indicated that current impediments to growth include a small domestic market, lack of adequate infrastructure, high transportation costs, poor trade links with neighboring countries, and the high dollarization of the economy (IMF, 2011). Revitalizing the economy in the future will depend on economic diversification, increasing investment and trade, higher global commodity prices, sustained foreign aid and remittances, development of infrastructure and institutions, combating corruption, and maintaining political stability and security. Table 2 gives a highlight of the economic indicators of Liberia.

Table 2: Estimated economic indicators for Liberia

Indicators	Estimated amount/year
GDP (purchasing power parity)	$3.906 billion (2017 est.) $3.808 billion (2016 est.) $3.871 billion (2015 est.) note: data are in 2017 dollars
GDP (official exchange rate)	$2.14 billion (2016 est.)
GDP - real growth rate	2.6% (2017 est.) -1.6% (2016 est.) 0% (2015 est.)
GDP - per capita (PPP)	$900 (2017 est.) $900 (2016 est.) $900 (2015 est.) note: data are in 2017 dollars

Gross national saving	NA. % (2017 est.) -21.9% of GDP (2016 est.) -2.3% of GDP (2017 est.)
GDP - composition, by end-use	Household consumption: 128.8% Government consumption: 16.7% Investment in fixed capital: 19.5% Investment in inventories: 6.7% Exports of goods and services: 17.5% Imports of goods and services: -89.2% (2016 est.)
GDP - composition by sector	Agriculture: 36.1% Industry: 10.5% Services: 53.4% (2017 est.)
Population below the poverty line	54.1% (2014 est.)
Labor force	1.677 million (2017 est.)
Labor force - by occupation	Agriculture: 70% industry: 8% services: 22% (2000 est.)
Unemployment rate	2.8% (2014 est.)
Unemployment, youth ages 15-24	Total: 6% male: 4.3% female: 7.6% (2010 est.)
Household income or consumption by percentage share	lowest 10%: 2.4% highest 10%: 30.1% (2007)
Distribution of family income - Gini index	32 (2014) 38.2 (2007)
Budget	Revenues: $626.1 million Expenditures: $727.6 million (2017 est.)
Taxes and other revenues	29.3% of GDP (2017 est.)
Budget surplus (+) or deficit (-)	-4.7% of GDP (2017 est.)
Public debt	46.5% of GDP (2017 est.) 42.3% of GDP (2016 est.)
Inflation rate (consumer prices)	12.8% (2017 est.) 8.8% (2016 est.)
Central bank discount rate	3.2% (2016)
Commercial bank prime lending rate	15.2% (December 31, 2017, est.) 13.59% (December 31, 2016, est.)
Stock of narrow money	$425.9 million (December 31, 2017, est.) $436.4 million (December 31, 2016, est.)
Stock of broad money	$557 million (December 31, 2017, est.) $639 million (December 31, 2016, est.)
Stock of domestic credit	$706.1 million (December 31, 2017, est.) $789.4 million (December 31, 2016, est.)
Market value of publicly traded shares	$ NA.
Agriculture – products	rubber, coffee, cocoa, rice, cassava (manioc, tapioca), palm oil, sugarcane, bananas; sheep, goats; timber
Industries	mining (iron ore and gold), rubber processing, palm oil processing, diamonds
Industrial production growth rate	3.2% (2017 est.)
Current Account Balance	-$571 million (2017 est.) -$520 million (2016 est.)
Exports	$202.1 million (2017 est.) $169.8 million (2016 est.)
Exports – commodities	rubber, timber, iron, diamonds, cocoa, coffee
Exports – partners	Poland 18.5%, Switzerland 9.7%, UAE 9.4%, Netherlands 8.9%, Germany 6.1%, US 5.9%, South Africa 5%, China 4.4%, Ghana 4.2% (2016)

Imports	$1.247 billion (2017 est.) $1.21 billion (2016 est.)
Imports – commodities	fuels, chemicals, machinery, transportation equipment, manufactured goods; foodstuffs
Imports – partners	South Korea 38.3%, Singapore 18%, China 15.9%, Japan 10.9% (2016)
Debt – external	$1.049 billion (December 31, 2017, est.) $938.9 million (December 31, 2016, est.)
Stock of direct foreign investment - at home	$17.01 billion (December 31, 2015, est.) $16.56 billion (December 31, 2014, est.)

Source: (LISGIS, 2016)

1.1.2.5 Energy sector of Liberia

Energy consumption is dominated by biomass with a share of more than 80% of primary energy sources. Woody biomass is the most dominant primary fuel for domestic cooking and heating. In 2004, over 95% of the population used Firewood and charcoal for cooking and heating needs as well as palm oil for lighting. The 2009 census showed that 70% of the urban population used charcoal for cooking and 5% of the rural population; 91% of the rural population use firewood for cooking and 21% of the urban population. In Monrovia, the percentage of households using charcoal is even higher, 85%. Around 2% of the population has access to clean fuels and technologies for cooking (World Bank, 2015).

Electricity and petroleum products used to support economic production and transportation. In households, energy services mostly involve the use of kerosene, electricity, and liquefied petroleum gas for lighting, cooking, and entertainment. These technologies mainly used by higher-income households in urban areas. Historically, electricity access in the Capital, Monrovia was around 35,000 customers which is almost 13% of the population were served by 1989. Total installed electricity capacity was 191 MW. The grid electricity generation mix consisted of hydropower from the plant at Mt. Coffee—with a supply capacity of 63 MW during the wet season and 5 MW during the dry season (six months)—and 31% HFO and 21% diesel. The utility LEC also handled the electricity supply of rural areas outside Monrovia through 10 small isolated power systems with a total installed capacity of 13 MW.

As shown in Figure 6, Liberia has one of the lowest electricity access rates in the world at less than 2%. In the capital city of Monrovia, only 6.7% of the population has access to electricity. And Monrovia's grid is largely supplied by expensive diesel-fueled generation resources. Less than 23 MW of Liberia's on-grid installed generation operate daily and, therefore, larger facilities such as hotels, restaurants and office buildings self-generate electricity at their premises at levels estimated to be ten times greater than the existing installed generation capacity

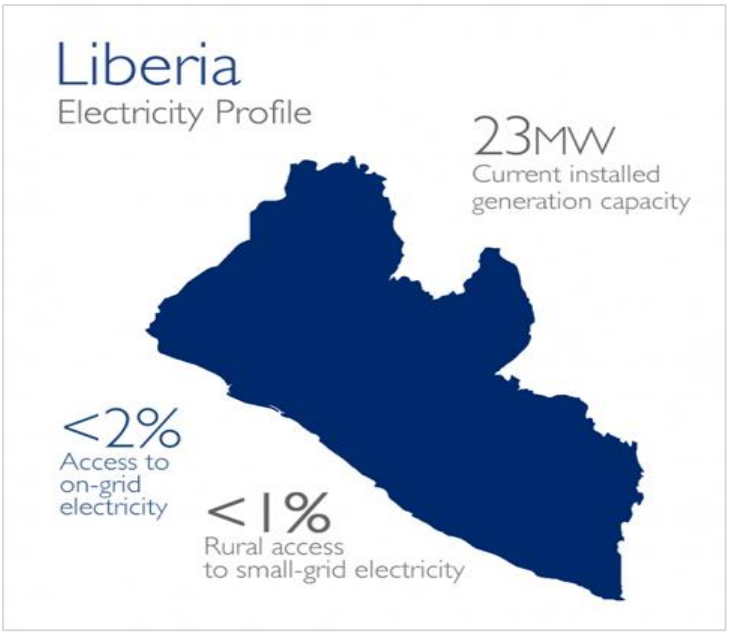

Figure 6: Electricity Profile of Liberia Source: (USAID, 2016)

Liberia with development partner support is rebuilding the Mt. Coffee hydropower plant. The first turbine of the plant came online by the end of 2016 with 20 MW and thermal generation capacity of 30 MW, and the remaining three turbines were turned on at the end of 2017. Subsequently, by the rainy season of 2018, the nominal capacity was at least 80 MW from the Mt Coffee plant. Besides, thermal generation capacity was 48 MW (USAID, 2016). In March 2012, the Liberia Electricity Corporation (LEC) served about 5,600 connections in Monrovia (around 2,500 residents from an estimated number of 210,000 households) taking the number of customers served to 11,000 by August the same year. A baseline study carried out by Norad estimates that close to 90,000 households and businesses in Monrovia may be served by small gasoline and diesel generators. Imported electricity from Ivory Coast can be used by around 36000 persons in Nimba, Grand Gedeh, Maryland County.

1.1.2.5.1 Energy as a Key Sector for Liberia

In formulating its development plans, the GOL recognized Energy as a vital input to national development, accelerating reconstruction and economic revitalization, and the achievement of MDGs. Furthermore, there is a direct relationship between the country's overall development and its level of energy production, delivery and consumption. The production and consumption of Energy could contribute to environmental deterioration, especially the global climate. Some of the key services that are linked to the energy sector include transportation, electricity, communications, agriculture and fishery, health, education, and tourism. Besides its share of about 0.8% of the overall GDP of Liberia as a sector, Energy also contributes to employment, trade, fiscal revenues, food security, and regional and sub-regional development. Imported petroleum products dominate the current energy market, and traditional woody biomass is commonly used for cooking and heating nearly in Sub-Sahara African. The market for petroleum products is formal, while that of woody biomass is informal. The production of fuelwood and charcoal is also an important source of

employment, and sale of these goods is a source of supplemental income for many low income and poor families.

1.1.2.5.2 Liberia Energy Situation

In Liberia, as in nearly all the Sub-Sahara Africa, biomass, petroleum products, and electricity are widely used in the energy sector for domestic cooking and heating, lighting, transportation, electricity etc. Annual consumption of woody biomass is estimated at 10.8 million m^3 for Firewood and forecasted to an annual increase in demand of about 0.6 m^3 per household. Charcoal increased to 100,000 tons from 36,500 tons in 2005. According to the CIA World Factbook, electricity consumption is about 39 million kWh, and the LEC produced roughly 70 million kWh of Energy in 2016.

The policy and regulatory framework for the energy sector is weak and had led to a fragmented sector with no coordination mechanism. That is why Government, through the then Ministry of Lands, Mines & Energy formulated the National Energy Policy (NEP) in 2008 to detail out the strategies for strengthening coordination in the sector. The principal objective of the NEP is to ensure universal access to modern energy services in an affordable, sustainable and environmentally-friendly manner to foster the political, social, and economic development of Liberia. According to the NEP, GOL will seek to leverage the country's biomass resources as a source of carbon credits for energy development. Table 3 shows statistics of the energy sector of Liberia.

Table 3: Relevant Energy Sector Indicators

Indicators	Value	Source, Year
Mixed Petroleum product importation (US gallons)	122,958,226	LPRC, 201
Current power generation (national grid)	131 MW	LEC, 2017
% of urban population with access to	16.8%	World Bank, 2014
Current electricity tariff	US$ 39/KWh	LEC, 2017
% of rural population electrified by national	0.5%	RREA, 2017
% of rural population with access to	1.7%	World Bank, 2014
% of rural population with access	0.5%	RREA, 2017
Charcoal consumption	100,000 tons	NACUL, 2017
Fire wood consumption	~10.8 million m^3	CSET, 2004

1.1.2.5.3 Liberia Energy Potential

Solar Energy

Liberia's humid, tropical climate shows relatively constant temperatures throughout the year, averaging 27° C (81° F), hardly ever outside the range of 20° C (68° F) to 36° C (97° F). The monthly solar radiation on horizontal surface ranges from about 4 kWh/m^2/day during the rainy season in June - August to 6 kWh/m^2/day during the height of the dry season in February and March. This high and consistent potential for solar energy across the country adds to an average level of 1,712 kWh/m^2/year, which could generate approximately 1,400 to 1,500 kWh/kWp (RREA, 2016).

Biomass Energy

Approximately 43% of Liberia's land is covered with forests (41,790 square kilometers) (NREL, 2008); thus, there is no lack of trees in Liberia. There are eleven designated National Forests in the country (under limited protection), and two legally protected areas, Sapo National Park (approximately 149,000 ha) and East Nimba (about 15,000 ha). The Forest Development Authority (FDA), has the exclusive rights to manage forest resources and focuses on large-scale concessions for timber extraction. The US NREL 2008 studied biomass resources (other than forestry) in Liberia with a view on how these resources could be used for energy purposes. NREL also indicated that the potential annual waste stream from logging operations - once they restart - could be very substantial, with an estimated 20 million m^3 available (162,645 TJ/year), of which 10.9 million m^3 at sawmills and the remainder at the logging site; most of that waste would be lost. The annual waste at the sawmills would be able to produce 100 million bags of charcoal if all waste were convertible into charcoal; this is much more than is currently used in the country. NREL further estimates that of the total Cropland in Liberia, 37% of the territory, only 6% is currently cultivated. The remaining Cropland amounts to some 3 million hectares, which indicates that in addition to existing resources, there is a large potential for new crops, including tree crops that could yield resources suitable for charcoal production.

Large-scale rubber plantations (>800 ha) cover an area of approximately 58,000 hectares, some of which are in close vicinity of Monrovia; more land used to be under rubber trees as well: NREL estimates about 100,000 ha in total. Buchanan Renewables indicated that the area currently under rubber trees (all types of plantations combined) would be more like 250,000 ha, of which possibly one-third should be renewed soon. There are also smaller rubber plantations (5-800 ha), but these are generally perceived to have newer trees on their estates. Also, there are numerous household plantations below 5 ha each. An active rubber plantation annually generates considerable amounts of wood residues from pruning and replanting activities, and charcoal makers use them for making charcoal. Trees need replacement after 25-30 years when these cease to be productive; approximately 81 dry tons of wood (trunks, branches) can be obtained per hectare of old trees (about 180 m^3 of green wood).

Hydropower

Liberia has a rainy season between April and November, various rivers and along the sea coast. Annual rainfall is around 510 cm (200 in) on the coast, 200 cm (80 in) inland. The average relative humidity is about 82% in the coastal area during the rainy season and 78% to 50% in the dry season. According to the RESMP, hydropower potential of 2300 MW has been identified in Liberia. This potential is mainly on large rivers with the high mean annual flow and low heads. Several locations have heads and flow above 50 m3/s, thus good for above 5 MW hydro schemes. However, the potential varies between rainy season and dry season.

Wind Energy
The potential for wind energy in Liberia is estimated to be relatively low. Although there might be some potential in coastal and mountainous regions, probably not enough for commercial exploitation; if at all, few sites might have the required minimum wind speed of 7m/s for wind power turbans plants. In the 2015 SE4All Action Agenda Report, Wind Generation in Liberia is projected to reach 0.47GWh in 2025. There is no assessment for wind energy or any recommendation to use wind energy in the Liberia Rural Energy Strategy and Masterplan.

Fossil Fuels
African Petroleum announced the discovery a total of 32 meters (105 feet) of net oil pay in two zones in Liberia. ExxonMobil finally began drilling on November 22, 2016. ExxonMobil found no oil and announced on December 19, 2016, that there is not enough oil in the well to get more than the money required to invest in extracting the oil from the well. However, there was enough evidence in the rock samples that were extracted from the seafloor to keep Exxon investigating other spots in the block with cheaper exploration tools rather than drilling which can cost as much as $1m a day. Several oil companies have relinquished oil blocks, including Anadarko, Repsol and Tullow and recently African Petroleum. Market challenges and lack of interest in the Liberian oil basin due to the history of no discoveries of oil in commercial quantities in the basin.

1.1.2.5.4 Energy-sector Greenhouse Gas Emissions and Mitigation Needs
Energy production and consumption play a major role in global warming and climate change phenomena. The energy sector emits about 530 Gg of GHG annually in Liberia. High consumption of fossil fuel and woodfuel consumption is the contributory sources. For every MWh of biomass power instead of fossil fuel, approximately 1.6 tons of CO_2 are avoided depending on the conversion process and mechanism (NREL, 2008). This figure includes 0.8 tons/MWh from avoided fossil fuel use, and 0.8 tons/MWh avoided from biomass decomposition or open burning. On a global scale, Liberia's contribution to global warming is negligible. But chances are if climate change continues, the country is likely to be disproportionately affected by its impacts considering current scenarios and indicators experienced in the country. Liberia ratified the UNFCCC in November 2002 and implemented an 18-month NAPA project in 2004. However, minimum climate change mitigation measures have been taken so far due to technological constraints, limited human resource capacity and data gathering capability.

Liberia has been able to achieve the below-listed points since 2015:

- Awareness on the use of environmentally friendly electrical appliances;
- Created an enabling environment for the development of the policy framework for the energy sector;
- Switching on of the Mount Coffee Power hydro plant which generates 88MW;
- Installation of Solar PV (Mini-grids) by partners and GOL at hospitals and schools in rural Liberia;
- Increase penetration of improved Eco-stove to replace conventional cookstove;
- Introduction of efficient lamps (lights) at public institutions and street light

1.1.2.6 Transport sector of Liberia

Liberia's transport infrastructures and institution situations are still in post-civil war conditions. The rehabilitation of arterial links in the countries transport networks combined with a solid institutional and policy framework are top priorities of the Government of Liberia and the international community.

1.1.2.6.1 Roads

Liberia has a total area of 111,370 km² and a road system with a total length of 10,600 km. Of this, 657 km are paved while 9,943 km are unpaved. Majority of highways have deteriorated due to heavy rains, lack of maintenance, overloaded trucks and the long rainy season which lasts for eight months. During the rainy season, most of the roads are inaccessible, particularly in Nimba, Lofa, Sinoe, Baporlu and Maryland counties.
Out of the 10,600 km roads in Liberia, less than a quarter are classified as all-weather roads. The road between Monrovia and Ganta was paved in 2015 and is in good condition, and the road between Monrovia and Buchanan Port is paved and in good condition. The road between Monrovia and Bo is paved and in good condition. The World Bank and other development partners support Liberia to rehabilitate major road corridors to foster the economic development of rural areas. Newly rehabilitated roads which connect urban to rural areas have significantly reduced travel time, and increased vehicular movement along those routes, making access to markets, educational institutions, hospitals and other social services critical for economic growth and development of Liberia easier. Poor road conditions make some roads unsafe or inaccessible for types of public transport vehicle and increase operating costs for all vehicle types. Figure 7 shows examples of bad and good roads in Liberia.

Figure 7: Examples of bad and goods roads in Liberia

Vehicle statistics for 2001 to 2004 from the Bureau of Land Transport of the MOT indicate that the total number of vehicles (sedans, Jeeps, trailers, trucks, and buses) plying the streets and roads of Liberia in 2001 was 8,225. The number of vehicles

declined to 5,665 in 2002 and 5,660 in 2003 due to the civil war. In 2005 the number of vehicles increased dramatically to 10,150 and was subsequently estimated at 90,000 in 2017. Most of these vehicles use low-grade diesel and mixed petroleum and have high potential to emit large quantities of GHG (MOT, 2017).

1.1.2.6.2 Railway system

There is no connected rail network in Liberia. Historically, three railways have been constructed for iron-ore transport to the ports. The Nimba Railway has been rehabilitated. LAMCO built the 267 km standard gauge (1435 mm) railway from the Port of Buchanan to Yekepa in 1963. The MDA with ArcelorMittal was signed on December 29, 2006, but is not available to the public. ArcelorMittal has rehabilitated the railway to the initial design as far as required for the prevailing traffic demand. On the Bong Railway, the 78 km standard gauge (1435 mm) railway from Monrovia to Bong Mines was built in 1964 by the Bong Mining Company. In the pre-war era, three train pairs for ore traffic were operated, and the line capacity was approximately three tons per annum. An MDA with China-Union signed on January 19, 2009. Within five years, the concessionaire shall complete the renovation of the existing railway and an approximately 20 km extension to the Non-Goma mines. The MDA specifies a capacity of 12 tons per annum ore traffic plus common carrier freight and passenger services. The 145 km narrow gauge (1067 mm) railway from Monrovia via Tubmanburg (Bomi Hill line) to Mano River was built in 1960 by the National Iron Ore Company. Operations ceased in 1986 when the mines were exhausted. A fourth railway might be built to the Putu Range for which exploration is in the pre-feasibility stage. The new rail link would be 110 to 140 km long. No data are available to evaluate possible spare capacities. At present, no data support the idea of extending the new railway into Ivory Coast.

1.1.2.6.3 Seaports and coastal shipping

The Port of Monrovia currently accounts for almost all of Liberia's seaborne trade. After the war, some progress has been made with rehabilitation work, but much remains to be done. The Freeport of Monrovia is a landlord port that has concessions partnerships with APM Terminals, Firestone, China Union and Western Cluster. It is currently the largest Port within our authority network. However, it was built originally by the United States Military for strategic purposes during World War II. Currently, the harbor at the Freeport of Monrovia is protected by two rock breakwaters approximately 2,300 meters and 2,200 meters long, enclosing a basin of 300 hectares of protected water. The marginal wharf (main pier) is 600 meters long and capable of berthing 3 to 4 ships, dependent on the vessel size. The Freeport of Monrovia also has three finger piers: LMC and BMC Piers. The Freeport of Monrovia is an ISPS certified Security Level One port.

The Port of Buchanan is located 272 kilometer south-east of Monrovia and is the second-largest Port. The harbor is protected by two breakwaters 1,890m and 590m long. Inside the basin, a 225 meters long ore loading quay is located adjacent to the commercial loading quay, providing a water depth of 10.5m below chart datum. Adjacent to the loading quay another waiting berth for ore carriers is available. On the inner side of the secondary breakwater, is a commercial quay, 334m long with an available water depth of 9.5m below chart datum. The access channel to the Port

provides ships a water depth 11.5m below chart datum and a channel width between the breakwaters of 210m.

Shipping activities have increased because of the equipment handling agreement with UMARCO that has improved the Ports handling capacity and efficiency. It improves the handling capacity and efficiency of the Buchanan Port, thus making it better positioned to handle increased customer demand. Shipping activities has increased in Buchanan because of increased log export by logging companies and transhipment activities by Arcello Mittal. Other companies including Chevron, Equatorial Palm Oil, African Petroleum and others are expected to make extensive use of the Buchanan Port facility, thus increasing the revenue earning potential of NPA. This expected increase in shipping activities also creates the need for additional investment to improve operational efficiency and accommodate both new and old customers. The Port of Buchanan is an ISPS certified Security Level One port.

The Port of Greenville, which is 8-9 meters below chart datum, is in Sinoe County, south-eastern Liberia, about 674 kilometers from the Freeport of Monrovia. The Port of Greenville harbor is protected by a 400 meters long breakwater, and on its inner side, by two quays. There are two berthing sections at the 250 meters Greenville Port: 70 meters and 180 meters respectively. The Port of Greenville has been a major facility for the exportation of logs, with several logging agreements are expected to take effect soon, including Iron ore and oil palm concessions which will enhance trade. This will also lead to an increase in the surge of vessel traffic. The Port of Harper is in the southeastern region of Liberia, near the border with the Ivory Coast, about 762 kilometers from the Port of Monrovia. The Port was constructed on the Rocky Russwurn Island, by connecting the Island to the mainland by a causeway, and by constructing a 150 meters long breakwater. A 100-meter long reinforced pier provides berthing facilities with an available water depth of 5.5 meters on both sides. Activities at the Port of Harper are centered on the exportation of logs and sawn timbers from the southeastern hinterland. Management anticipates the expansion of the Port of Harper to handle the anticipated traffic from the reactivation of the oil palm sector and other derivative economic activities in the region.

1.1.2.6.4 Domestic and international aviation

RIA is the sole international airport in Liberia, West Africa. The airport is located near the town of Harbel, 35 miles from the capital of Monrovia. The Robertsfield airport is named after Liberia's first president, Joseph Jenkins Roberts. RIA is owned by the GOL and is operated by a Liberian management unit. It currently serves more than 228,000 domestic and international passengers annually and expected to receive more than 450,000 annual passengers over the next few years. GOL inaugurated a new passenger terminal at the airport in December 2017, as part of an upgrade and expansion project to refurbish the runway, expand the airport and improve safety. Construction on the runway rehabilitation project began in September 2016, and the ground for the new passenger terminal building was broken in November 2016.

As shown in Figure 8, the new international passenger terminal can process approximately 500 passengers at a time and can handle two wide-body aircraft such as Airbus A380. The existing terminal has the capacity of approximately 330 people in

30 minutes and complemented by a 1,500m² parking facility. James Spriggs Payne (JSP) Airport is 6 km downtown Monrovia and is used for regional and domestic flights. The airport is administered by JSP management under the Liberia Airport Authority. The authority manages all the domestic airfields in the country. Runway repair work at Spriggs Payne Airfield was completed in 2014. Taxiway A is now open between the runway holding point B and the runway. The rest of taxiway A, adjoining the apron and including parking position SP 4, is open to aerodrome traffic. The airport is closed during the night.

Figure 8: New RIA Terminal Inaugurated by President Sirleaf December 2017

1.1.2.7 Agriculture Sector of Liberia

Agriculture is the primary livelihood source for over 60% of Liberia's population and provides sustenance for many households who engage in farming of rubber, rice, oil palm, cocoa, and sugarcane. However, low agricultural productivity results in imports of more than 80% of its staple food, making the country vulnerable to global food price volatility. Cassava and rice are the primary staple food crops for the country. Poorly integrated, the sector lacks basic infrastructure such as machines, farming equipment/tools, farm-to-market roads, fertilizers and pesticides, and food storage capacity. The main cash crops and foreign exchange-earners are rubber, cocoa, coffee, crude oil palm and timber (Table 4).

Table 4: Cash crops and timber products (2015-2017)

Commodity	Unit	2015	2016	2017
Rubber	Mt	45,657	43,900	39,700
Cocoa Beans	Mt	14,968	22,400	6,800
Coffee	Mt	58	20,200	800
Crude Palm Oil	Mt	N/A	3,021	7,051
Round log	M^3	111,785	147,181	83,063
Sawn Timber	Pcs	907,505	561,005	553,838

Source: Central Bank of Liberia, 2017 and 2018

Rubber is the most important cash crop and accounts for 21. 5% of the total export receipts in 2017. Commercial rubber farms employ an estimated 30,000 people and up to 60,000 smallholder households are involved in growing of rubber trees. Firestone Rubber Plantation, covering almost 200 square miles, is the largest single natural rubber operation in the world and the biggest private-sector employer in Liberia. Besides the cash crops, there are market opportunities and potential for agribusiness investment, which focuses on developing the value chain of the available food crops such as rice, cassava, vegetables, fruits, poultry and fish.

Liberia has a suitable climate for horticulture such as the production of peppers, okra, onions, tomatoes, bitter balls, etc., which are in high demand throughout the country all year round. Lowland cultivation and low-cost irrigation would allow smallholders to increase productivity and expand the market share of these valuable crops. Liberia has an Atlantic coastline spanning about 580 kilometers endowed with abundant marine fish stocks. The coastline and abundant freshwater resources provide breeding grounds varieties of marine species including crab, lobster, shrimp, tilapia, tuna, shark, croaker and barracuda.

In 2014, the EVD outbreak had a serious impact on the agriculture and food sectors. Rice production in 2014 was estimated at 266,000 tons, 4% below the average production throughout the previous four years. Agricultural production recovered in 2015. According to the 2015 aggregate rice (paddy), production was about 296,000 tons, 11% above the previous year's output and 6% above average (Table 5). Cassava production is estimated to have increased by 9% in 2015, compared to the previous year. The recovery was supported by the intervention of GOL and international partners in supplying improved seeds, fertilizer and purchasing paddy rice from farmers.

Table 5: Rice Production in tons

Crop	2010-2014 (Average)	2014	2015
Rice (Paddy)	284,000	266,000	296,000

Source: FAO/GIEWS Country Cereal Balance Sheets

1.1.2.8 Fisheries and Livestock

Liberia's fisheries sectors contribute about 3% of GDP and employ an estimated 37,000 fishers and processors. Before the war, most industrial fishing companies had adequate processing facilities and were engaged in exporting frozen shrimp and fish to Belgium, Greece, UK, and the USA. Fish distribution and marketing from the coastal area to the interior was through a system of depots and agents, but this activity ceased due to civil strife and deterioration of roads. During the civil conflict, production was mainly aimed towards fulfilling food security needs in the country. Since the end of the conflict, production has gone down to just above 8,000 tons in 2011 (FAO estimates). Marine fisheries are the main production source with more than 7,000 tons in 2011. Freshwater fish sourced from inland waters constitute the second-largest source of catch.

The draft 2013 Livestock Policy is yet to be adopted by GOL. With the assistance of development partners, the livestock sub-sector policy was reviewed, and important recommendations were made for change (AfDB, 2013).

The livestock sub-sector accounts for about 14% of GDP and has a target to expand domestic production to satisfy 50% or more of the national need. Household-based livestock farmers dominated and most of them rear chickens and very little else, 24% and 43% household are involved in livestock and poultry production, respectively (MoA, 2008; LISGIS, 2008-2009). The numbers of livestock in Liberia are estimated to be 8,275 cattle, 120,114 goats, 48,600 sheep, 70,520 pigs, 1,270,875 chickens and 53,350 ducks (MoA Annual Report, 2010 - 2013; Kwaku Agyemang, 2013) and show the steady growth of livestock compared to crop, fisheries and forestry. There has been increased in the number of livestock (41.2%), and poultry (22%) households than the pre-war (1988), but the numbers of livestock has increased by (7%) in 2010 (FAO, 2012).

1.1.2.9 Industrial Sector of Liberia

Extractive industries have historically driven the growth of Liberia's economy with no or little linkage to the wider economy, which had in the past resulted in "growth without development". For Liberia's future, and so that it can achieve its goal of becoming a middle-income country by 2030, the Government recognizes that it needs to create the conditions for economic growth in Liberia. The role of industrialization in development cannot be overemphasized, and the emergence of a dynamic manufacturing sector has typically marked a country's transition from low to intermediate income levels. A strong industrial sector also generates employment and enhances the development of backward and forward linkages in the wider economy. Therefore, it is crucial to mainstream industrialization into national development efforts (GOL, 2011).

Liberia has abundant natural resources such as fertile land for agriculture and tree crops, extensive forestry resources, minerals like iron ore, gold, diamonds, and extensive ocean and coastal areas. However, for many decades these resources had been extracted and exported without local processing or value-addition. Furthermore, Liberia also has an exceptional capacity for growth (particularly in the agro-based industries) as current production levels are far below Liberia's proven capacity in the past – for example, before the war mining contributed to 62% of export revenue in the 1970s and 1980s, while in 2008 it contributed 1% to GDP and 35.4% in 2016 (GOL, 2011).

Liberia's available labor force is estimated to be about 1.1 million, of which 2,785 (or around 0.25%) are reportedly employed in the manufacturing sector. Most manufacturing companies in Liberia tend to be small-sized, employing very few people. Reported employment in the manufacturing sector in 2008 more than doubled from 2006's reported figure of 1,045. These employment figures do not include those employed in the informal sector. The growth in employment in the manufacturing sector is against the background of manufacturing's contribution to Liberia's GDP remaining relatively stable increasing by 1% between 2006 and 2009, and by 14.4% in 2016 (MoCI, 2012). The industrial landscape in Liberia is characterized by a few large manufacturing firms, producing a limited type of goods (cement and beverages) for domestic consumption. Other manufacturing firms in Liberia are in the sectors of household products, paints, varnishes, mattresses, industrial oxygen, bakeries,

woodworking, metalworking, plastic, rubber products and clothing, again to supply the domestic market. Table 6 gives estimates of the number of industries per sector.

Table 6: Names and Number of Industries per Sector

Name of Industries per sector	Number per sector
Mining or Mineral Industries	7
Banking Services/Industries	8
Jewellery processing Industries	17
Audio/Movies Industry	6
Water processing Industries	159
Food Processing Industries	63
Fishing Industries	6
Printing Press Services/Industries	70
Wood Process Industries	113
Tile, Brick, Block Manufacturing	36
Rubber Latex Processing Industries	7
Paint Manufacturing Industries	3
Foam Manufacturing Industries	3
Oxygen Air Manufacturing Industries	3
Beverages (Alcoholic and Non-Alcoholic)	22
Candle, Detergent, Rubbing Alcohol, Toiler Tissue, Manufacturing Industries	12
Metal, Aluminum Welding Industries	4
Cement Manufacturing Industry	1
Assorted Plastic Manufacturing Industries	6
Flour Manufacturing Industry	1
Total	547

Source: (MoCI, 2012)

The growth in employment in the manufacturing sector is against the background of manufacturing's contribution to Liberia's GDP remaining relatively stable increasing by 1% between 2006 and 2009, and by 14.4% in 2016.

1.1.2.10 Waste Management Sector of Liberia

Poor disposal of waste materials in urban and rural areas is one of the most serious problems affecting the Water, Sanitation and Hygiene (WASH) sector in Liberia. Water, sanitation and hygiene are not top priorities in Liberia, even though they are essential for life, health and dignity. According to a recent WASH survey, poor sanitation in and around Monrovia continues to be a serious problem, especially the collection and disposal of garbage. The Monrovia Municipal Corporation (MCC) is the Agency responsible for delivering the solid waste service in Monrovia. MCC was selected by the Government of Liberia to act as the implementing Agency for Emergency Monrovia Urban Sanitation (EMUS). Compliance with safeguard policies is the responsibility of the EMUS project implementation unit.

Figure 9: Pile of Garbage on the Somalia Drive

The environmental management capacity of the unit has steadily improved since the implementation of the parent project and subsequent AF projects. The unit, therefore, has adequate capacity for safeguard policy implementation. The Environmental Protection Agency (EPA) of Liberia and the three Special Implementation Unit at the Ministry of Public Works (MPW) will also provide technical support in the area of environmental compliance. The Integrated Safeguards Data Sheet (ISDS) regards the third Additional Financing (3AF) for the EMUS Project (PI15664) for US$4.64 million to the Republic of Liberia.

EMUS supports key solid waste services management activities, and 3AF will allow Monrovia City Corporation (MCC) to continue the current collection of 45% of the daily waste generated in Monrovia and its safe disposal at a sanitary landfill (EPA, 2013). Despite all the efforts by the GOL and international partners, sanitation remains a major challenge in the WASH sector of the country. Solid Waste Management is arguably the greatest public health threat in Monrovia. With an ineffective waste management sector, along with a lack of proper toilets, mean household trash, human feces, and hazardous medical waste are poorly disposed of at the various site. The collection and removal of garbage in and around the city pose serious huddles to citizens in many communities used as pickups points for garbage.

1.1.2.11 Land Use and Forestry

West Africa has some of the richest tropical rain forest in the world. Home to rare and endangered wildlife, like chimpanzees and the endemic pygmy hippopotamus, the area is one of only 34 biodiversity hotspots worldwide. Liberia has a special status within West Africa—almost half of all the upper Guinea forest that remains in the hotspot is in Liberia (**Error! Reference source not found.**). According to the FAO, 44.9% or about 4,329,000 ha of Liberia is forested. Of this, 4.0% (175,000 ha) is

classified as primary forest (add degraded forest), the most biodiverse and carbon-dense form of forest. Liberia had 8,000 ha of planted forest. Change in Forest Cover: Between 1990 and 2010, Liberia lost an average of 30,000 ha or 0.61% per year. In total, between 1990 and 2010, Liberia lost 12.2% of its forest cover or around 600,000 ha.

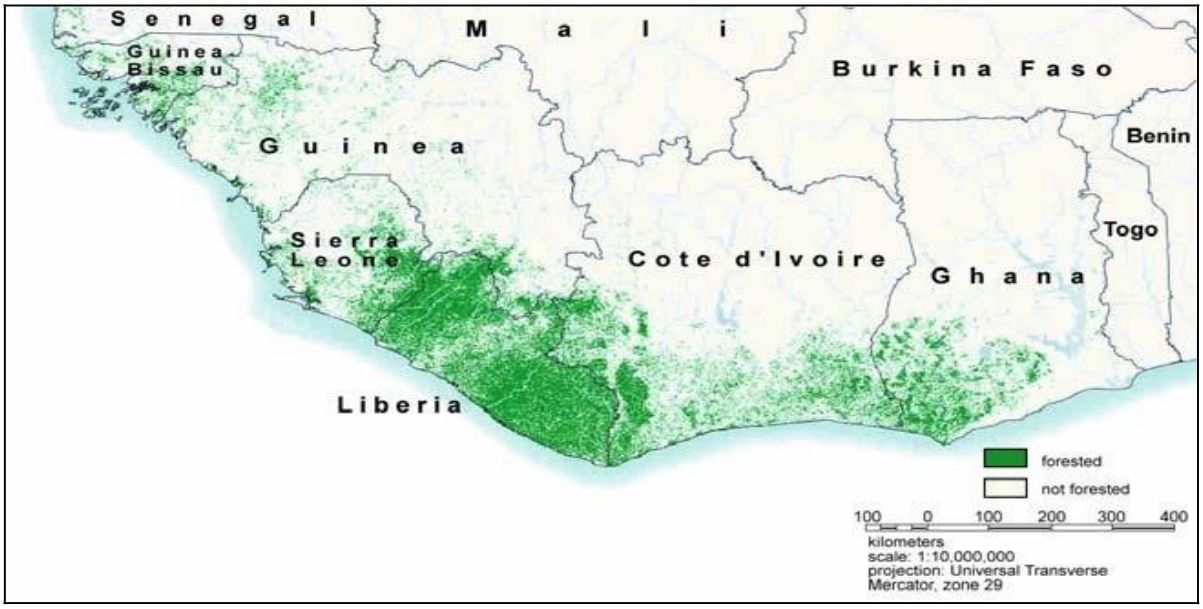

Figure 10: Map showing the extent of West Africa's Forest

Liberia's forests contain 585 million metric tons of carbon in living forest biomass (Table 7). Biodiversity and Protected Areas: Liberia has some 881 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 4.2% are threatened. Liberia is home to at least 2200 species of vascular plants, of which 4.7% are endemic. 1.3% of Liberia is protected under IUCN categories I-V (FDA, 2008).

Table 7: Forest Carbon Stock Value

Forest definition (canopy cover %)	10% tree cover	25% tree cover	30% tree cover
Forest Area (M ha)	9	9	8
Aboveground forest carbon (Mt C)	1,067	990	967
Belowground forest carbon (Mt C)	288	266	260
Total forest carbon (Mt C)	1,355	1,257	1,226
Average Carbon Density (t C/ha)	143	147	148

M=million, t=metric tons; all figures are mean carbon stock values.

In 2003, as civil war raged in Liberia, the UN Security Council sanctioned timber exports because the revenue from logging was financing the purchase of weapons used in the war and therefore fueling the regional conflict. For example, the largest company, the Oriental Timber Corporation (OTC) based in Indonesia, paid US$1.5 million to known arms dealers. Besides, OTC paid millions into Charles Taylor's bank account; all for which they received tax credit. When the war ended in 2003, the UN Security Council began to work with the Government of Liberia on forest sector reforms that would ensure that logging would no longer fuel conflict in Liberia or the

neighboring countries. The Security Council insisted on these reforms before the timber sanctions could be lifted. The first action was to review the conduct of logging companies during the Taylor period. Following the recommendations of the concession review, the new Government began reforming the timber sector. The Liberia Forest Initiative— a consortium of national and international agencies (www.fao.org/forestry/site/lfi)—provided technical assistance to this effort.

Shortly after that, the FDA itself was reformed to become more efficient: staff was cut in half, salaries dramatically increased, and the remaining positions are given clearly defined tasks. In June 2006, the Security Council acknowledged the reforms of the new Government and lifted the sanctions on timber. The new laws require the larger logging companies to have a plan to achieve international accepted standards for certification, such as that of the Forest Stewardship Council (www.fsc.org) or Gabon's Forest Certification Scheme (www.pefc.org), to ensure that their operations are sustainable—environmentally, socially, and economically. More immediately, the FDA has asked the European Union (EU) to reinforce the reforms by ensuring that only Liberian timber that can be verified as complying with all the new Liberian laws be imported into the EU. The EU would achieve this by requiring that all shipments be accompanied by a license issued by the FDA declaring that the timber is legal. Any unlicensed timber from Liberia would be excluded from entry into the EU. This licensing scheme would be codified under a Voluntary Partnership Agreement (VPA) with Liberia.

1.1.2.12 Land Use Planning

One of the biggest challenges facing the FDA is to manage the forests to ensure that community, conservation, and commercial interests are all met. Liberians are dependent on forests for their lives and livelihoods. For example, most people rely on charcoal for their cooking fuel. Liberia is also a leader in agroforestry; it has the largest rubber plantation in the world. Furthermore, climate change has focused the world's attention on the remaining tropical rain forests as an important reservoir of carbon. These demands overlap with logging for the use of Liberia's forests. The FDA has tried to resolve this conflict through scientific planning that accounts for the relative value of specific areas to alternative uses. This planning effort has identified areas good for logging, but that is unlikely to have conflicting claims from local communities. The Government is developing a community forestry law that will clarify the management rights of these communities to have their logging operations. Although the communities will manage their forests, they will still be responsible for complying with all the regulations, just like loggers elsewhere.

1.2 Institutional Arrangement relevant for climate change

1.2.1 National climate change institutional arrangement

The institutional arrangement is an important step in being ready to address the impacts of climate change in Liberia through adaptive or mitigative actions. This involves having a functioning institutional structure to coordinate climate change

initiatives across all sectors at the national and sub-national levels (figure 11). The structure reflects the roles various institutions are playing in the planning and implementation of climate change in the country as envisaged in the NCCSC.

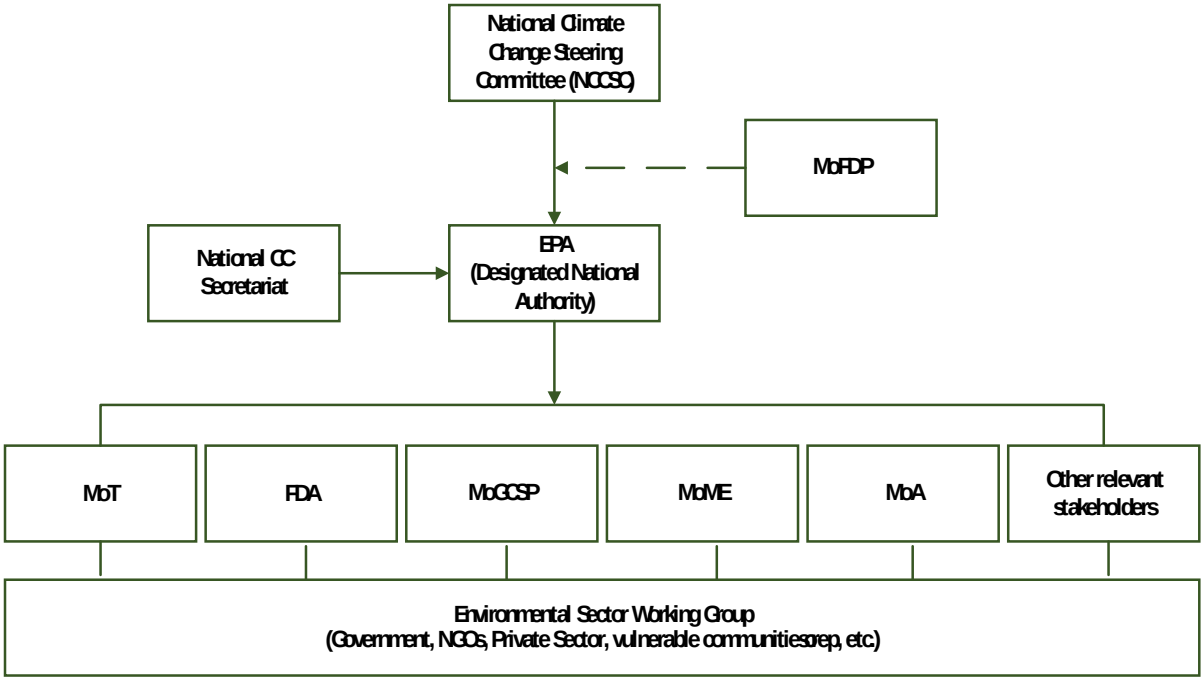

Figure 11: Climate change institutional arrangement for Liberia

1.2.1.1 National Climate Change Steering Committee (NCCSC)

The NCCSC, as the overarching institutional structure, has the mandate for coordinating and supervising the implementation of the climate change policy. Established by the President in October 2010, the NCCSC is a high-level policy coordination committee and is responsible for overall climate change activities in Liberia. It comprises of the President of Liberia, Ministers of Government, Directors of Governmental Agencies, National Energy and Climate Change Advisers to the President, private sector, civil society and international partners.

The primary roles of the NCCSC are as follows:

- Validate and secure government support for the implementation of the climate change policy.
- Supervise and provide leadership for the overall coordination and programs of activities, which accelerates the policy implementation;
- Strengthen the capacity of the National Secretariat (NCCS) to be responsible for carrying out and coordinating the daily operations of the NCCSC;
- Adopt measures and take appropriate actions necessary for achieving the mandate and goals of the policy, including and in particular;
- Report annually on progress made towards implementation of the climate change policy;
- To authorize and/or approve the solicitation of external assistance for activities under the policy; and

- Engage cabinet and the Legislature to secure adequate and accessible funding for the implementation of the policy.

The current and proposed composition of the NCCSC are as follows:

- President of the Republic of Liberia-ex-official
- Energy, Environment and Climate Change Advisor to the President of Liberia
- Heads of Standing Committees on Environment and Natural Resources of the Senate and the House
- Minister of Planning and Economic Affairs (MoPEA)
- Minister of Mines and Energy (MME)
- Minister of Agriculture (MoA)
- Minister of Finance (MoF)
- Minister of Gender and Development
- Minister of Transport
- Minister of Finance & Development Planning
- Managing Director of the FDA
- Executive Director of the EPA
- Chairman, National Investment Commission
- Commissioner of Liberia Maritime Authority
- World Bank
- University of Liberia
- Civil society
- Fauna & Flora International
- NCCS Coordinator

1.2.1.2 The Environmental Protection Agency

The EPA of Liberia is the Designated National Authority (DNA) for the United Nations Framework Convention on Climate Change (UNFCCC/Kyoto Protocol) and has the mandate as the national regulatory Agency for sustainable environmental management including climate change. The EPA is the Republic's regulatory Agency charged with the responsibility to ensure the sustainable use, management and protection of the environment and its natural resources. The Agency is also clothed with the statutory authority to integrate, harmonize and monitor the implementation of environmental policies and decisions of the Policy Council by line ministries and agencies. Based on its mandate, the Agency will coordinate, along with other ministries and agencies, the full implementation of major activities under the policy. As a key member of the NCCSC, the EPA will serve as the implementing Agency of the policy in consultation with Ministry of Transport (MoT), and Forestry Development Authority (FDA), Ministry of Gender, Children and Social Protection (MoGCSP), Ministry of Mines and Energy (MoME), Ministry of Agriculture (MoA), Ministry of Finance and Development Planning (MFDP) and other relevant Sectoral institutions indicated in the Action Plan through the NCCSC.

1.2.1.3 The National Climate Change Secretariat (NCCS)

The NCCS has been set up as a supportive component of the NCCSC. The NCCS provides coordination, monitoring and evaluation as the operational arm of the

NCCSC. It is housed at the EPA to facilitate better coordination of climate change-related activities, access to information, monitoring of key programs and activities and promoting inter-agency cooperation. This will remain unchanged during the implementation of the climate change policy. The NCCS will continue to operate under the direct supervision of the EPA as DNA for climate change and lead Agency in coordinating the implementation of the policy. The roles of the NCCS will be as follows:

- Track progress on implementation and alignment of international climate change programs/policies with the national climate change policy.
- Serve as liaison between the NCCSC, the EPA, the various working groups, and other relevant national stakeholders on climate change.
- Engage in appropriate programs to strengthen national capacity in addressing climate change.
- Cooperate with international organizations, regional centers, institutions and experts in developing programs of action to mitigate and adapt to climate change in the region.
- Collate, document and store data, record and disseminate climate change information to the public and media.
- Maintain full records of the proceedings of the Climate Change Steering Committee, issue citations, serve as a clearinghouse on climate change and inform all stakeholders regularly on the progress of the policy implementation.

1.2.1.4 Environmental Sector Working Group

The Environmental Sector Working Group encompasses all sectors which are said to have a stake in the policy implementation including but not limited to the sectors identified under Table 5 as well as civil societies, the private sector and community representatives. The Environmental Sector Working Group will serve as a multi-stakeholder forum for the exchange of ideas, including for the provision of updates on ongoing and planned climate change initiatives. Issues proposed to be discussed by the working group will focus broadly on issues directly related to the environment and natural resources management, such as forestry, agriculture, biodiversity conservation, land and marine resources. The working group will also address the cross-cutting aspects of climate change that impact on livelihoods, food security, health, shelter, water, education, and gender. To facilitate the smooth operations of the working groups, sub-working group focusing on the issues listed above should be created, as not every member of the working group will have the expertise or interest in all the issues falling with the purview of the working group.

1.2.2 Institutional arrangement for the preparation of National Communication and Biennial Update Reports

The Liberia EPA is responsible for the implementation of international environment treaties. Within the EPA, the Climate Change Enabling Unit (CCEU) is responsible for the activities for the preparation of National Communications; Biennial Update Reports; and National Inventory Reports to the UNFCCC. The CCEU is also responsible for monitoring climate change-related activities/projects and their execution across the country. The Unit serves as Executing Agency for the preparation of the BUR1. The project management team and reconstituted technical expert groups

in consultation with other government ministries, and agencies, as well as civic society organizations, used the best available data scientific approaches for the preparation of the BUR. The Climate Change Enabling Unit was responsible for the day to day running of the project (Figure 12).

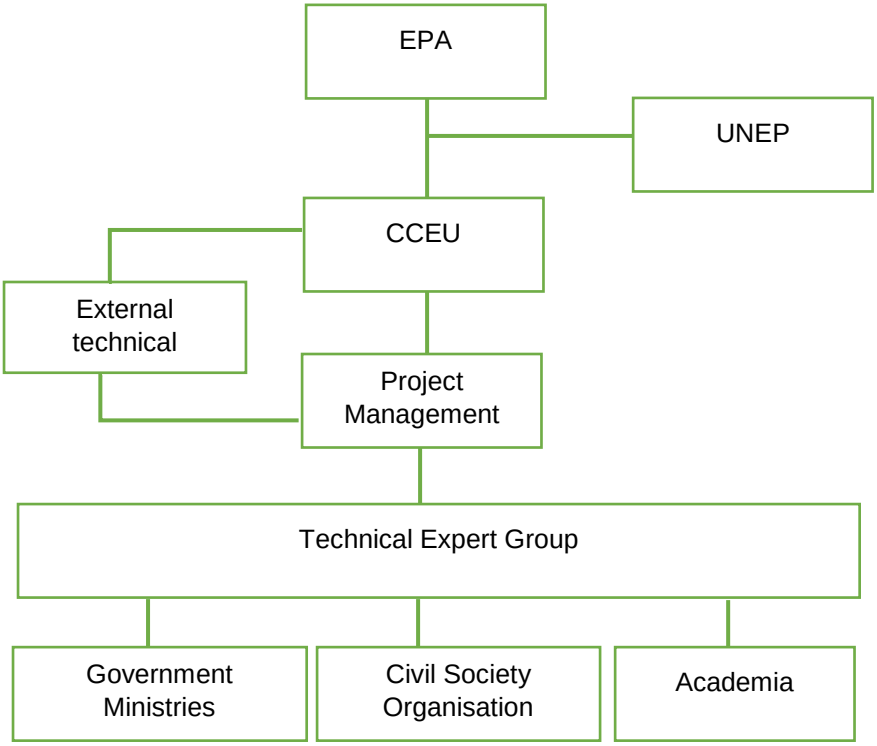

Figure 12: Institutional arrangement for the preparation of BURs and National Communications

Chapter 2: National Greenhous Gas Inventory

2.1 Background and Context

Under Article 4.1 (a) of the Convention, each party has to develop, periodically update, publish and make available to the Conference of the Parties (COPs), by Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties. Liberia has so far complied with the Convention with regards to national inventories of greenhouse gases and has submitted one inventory under the Initial National Communication and the second is in progress under the Second National Communication.

In line with Decisions adopted during COP16, Liberia is committed now to also provide updates to the First National Communications. The BUR should contain a full inventory for a year dating no more than four years from the date of submission. Within this context, Liberia has prepared its BUR including a GHG inventory for the years 2015 to 2017 as an update of the 2000 inventory results in its Initial National Communications. Using the 2006 IPCC Guidelines, Liberia's inventory has been prepared to cover emissions and sinks for 2000 and 2015 to 2017. The inventory is at the national level and covers the Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry, and Other Land Use (AFOLU) and Waste sectors. The gases covered in this inventory are the direct gases Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) and F-gases (HFC). The precursor gases nitrogen oxides (NO_x), carbon monoxide (CO), non-methane organic volatile compounds (NMVOCs) and Sulphur dioxide (SO_2).

Liberia outsourced its two previous inventories and decided to produce current inventory in-house, under the BUR1. Despite the decision to prepare the inventory in-house, it is important to highlight that the preparation of the GHG inventory is a challenge to Liberia due to the severe lack of resources and human capacities. Additionally, delays in accessing the funds for the preparation of the BUR1 reduced the time available for completing the inventory on schedule.

2.2 Methodology for the Greenhouse Gas Inventory

The has been prepared per the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and using this software for the compilation. The 2006 IPCC Guidelines has been supplemented with the European Monitoring and Evaluation Program/ European Environment Agency (EMEP/EEA) air pollutant emission inventory guidebook for compiling estimates for nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and Sulphur dioxide (SO_2). Generally, the method adopted to compute emissions involved multiplying Activity Data (AD) by the appropriate Emission Factor (EF) as indicated in Equation 1.

Emissions (E) = $Activity\ Data\ (AD)\ x\ Emission\ Factor\ (EF)$ Equation (1)

All the methodologies and tools recommended by IPCC within the inventory cycle have been followed according to the 2000 IPCC Good Practice Guidelines. Generally, the inventory has been compiled using tier 1 methodology except for the solid waste category tier 2 was applied.
Global Warming Potentials (GWP) as recommended by the IPCC, have been used to convert GHGs other than CO_2 to the latter equivalent. As per the requirements from decision 17/CP.8, the values adopted were those from the IPCC Second Assessment Report for the four main GHGs, namely: Carbon dioxide, Methane (21), Nitrous Oxide (310) and HFC - 134a (1,300).

2.3 Activity Data

Activity Data (AD) for the inventory come from several national and international sources (Table 8). Consistent with good practice in the 2006 IPCC guidelines, as much as possible, Liberia has used available official national statistics for the inventory. Where country-specific AD is not available, data from recognised international organisations (FAO, AU, ITTO, IEA) has been used to fill the gap. Some data gaps were filled through personal contacts and from results of surveys, scientific studies and by statistical modelling. Local experts' knowledge was resorted to as the last option.

Thus, data collected at the national level from numerous public and private institutions, organizations and companies, and archived by the EPA/LISGIS provided the basis and starting point. In a few isolated cases, due to the restricted timeframe and the inexistence of a declared national framework for data collection and archiving to meet the requirements for preparing GHG inventories, derived data and estimates were made to fill in the gaps. These were considered reliable and sound since they were based on scientific findings and other observations. Not all the AD required to compile an exhaustive GHG inventory could be collected due to the short timeframe or absence of a proper data collection and archiving system, and some categories could not be assessed due to the civil conflict. Nevertheless, the data collected was used to make estimates that are of good quality.

Table 8: Description of activity data and sources

Sub-sector	Category	Data type	Data source	Remarks
1. Energy sector				
1A: Fuel Combustion				
Energy Industry (1A1)	Electricity generation (1A1.ai)	Crude Oil, Diesel Oil	Liberia National Energy Balance (LNEB)	The Ministry of Energy and Liberia compiles LNEB.
	Petroleum Refinery (1A1.b)	Petroleum Products	Not Applicable	All petroleum products are imported from the international market.
	Manufacture of Solid Fuel (1A1.ci)	Woodfuel	Liberia National Energy Balance (LNEB) by the Ministry of Energy and Liberia.	The fraction of woodfuel as input into charcoal production.
	Other Energy Industries (1A1.cii)	Diesel	Not Estimated (NE)	Fuel consumption data unavailable for own use for thermal power producers.

Manufacturing Industry & Construction (1A2)	Iron and Steel (1A2.a)	Diesel	Liberia National Energy Balance (LNEB), Africa Energy Commission	The Ministry of Energy and Liberia compiles LNEB. https://afrec-energy.org/En/administration/bilan.php Accessed on 15/08/2020
	Chemicals (1A2.c)	Diesel		
	Food processing, Beverage and Tobacco (1A2.e)	Diesel, Firewood, Charcoal, LPG		
	Mining and Quarrying (1A2.i)	Diesel		
	Construction (1A2.k)	Diesel, Gasoline		
	Machinery (1A2.l)	Diesel		
	Non-specified (1A2.m)	Diesel		
Transport (1A3)	International aviation (1A3.ai)	ATK	Liberia National Energy Balance (LNEB)	The Ministry of Energy and Liberia compiles LNEB
	Domestic aviation (1A3.aii)	ATK	Not Estimated	ATK for Domestic Airline unavailable
	Road Transportation (1A3b)	Gasoline Diesel LPG	Liberia National Energy Balance (LNEB)	The Ministry of Energy and Liberia compiles LNEB
	Railways (1A3c)	Diesel	Not Estimated	Rail operation limited. Diesel consumption data not available.
	International water-borne navigation (1A3.di)	Diesel	Not Estimated	Unavailable data on diesel consumption.
	Domestic water-borne navigation (1A3.dii)	Diesel	Not Estimated	Unavailable data on diesel consumption.
	Other transport (1A3e)	Not Applicable	Not Applicable	All forms of transports have been covered under 1A3a to 1A3d)
Other sector (A14)	Commercial/Institutional (1A4.a)	LPG, Diesel Charcoal and Firewood	Liberia National Energy Balance (LNEB)	The Ministry of Energy and Liberia compiles LNEB
	Residential (1A4.b)	LPG, Kerosene Charcoal and Firewood	Liberia National Energy Balance (LNEB)	The Ministry of Energy and Liberia compiles LNEB
	Agriculture/Forestry/Fishing/Fish Farms (1A4.c)	Diesel, Gasoline	Liberia National Energy Balance (LNEB)	The Ministry of Energy and Liberia compiles LNEB
1B: Fugitive Emissions				
Oil and Gas (1B2)	Oil (1B2.a)	Not Estimated	Not Estimated	Liberia is not a commercial producer of oil. Oil exploration is underway. Data for

				exploration related is unavailable.
	Gas (1B2.)	Not Occurring	Not Applicable	Liberia is not a commercial producer of natural gas.
Carbon Transport and Storage (1C)	Transport of CO_2 (1C.1)	Not Occurring	Not Applicable	
	Injection and storage (1C.2)	Not Occurring	Not Applicable	
2. IPPU				
Mineral Industry (2A)		Not Occurring	Not Applicable	Liberia has no primary metal producing industry
Chemical Industry (2B)		Not Occurring	Not Applicable	Liberia has no primary chemical industry
Metal Industry (2C)	Iron and steel production (2C.1)	Annual Production of Iron and Steel	Annual Reports of Central Bank of Liberia	The Central Bank of Liberia produce Annual Report
Non-energy Products from Fuels and Solvent Use (2D)	Lubricant use (2D1)	Annual consumption pf Lubricants	Annual Reports of Central Bank of Liberia	The Central Bank of Liberia produce Annual Report
	Paraffin Wax Use (2D2)	Annual consumption pf Lubricants	Annual Reports of Central Bank of Liberia	The Central Bank of Liberia produce Annual Report
2.F - Product Uses as Substitutes for Ozone Depleting Substances	Refrigeration and Air Conditioning (2F1)	HFC (134) consumption	HFC Consumption data was prepared by the Ozone Unit of the Liberia EPA	Data was sourced from https://ozone.unep.org/countries/profile/lbr on 1/10/2020
3. AFOLU				
Livestock (3A)	Enteric Fermentation (3A.1)	Head of Animals (Cattle, Sheep, Goat & Swine)	FAOSTAT, Comprehensive Assessment of the Agriculture Sector,	FAO published data Central Agricultural Research Institute and the Ministry of Agriculture
	Manure management (3A.2)	Head of Animals (Cattle, Sheep, Goat & Swine Poultry)	FAOSTAT, Comprehensive Assessment of the Agriculture Sector,	FAO published data Central Agricultural Research Institute and the Ministry of Agriculture
		System for manure management	Expert judgement by the national consultants	Non-existing country-specific data
Land (3B)	Forest land (3B.1)	Forest land remaining forest land.	FAOSTATS Liberia FRA 2020 Liberia REDD+ FREL to UNFCCC	FAO Liberia Forest Development Authority
		Lands converted to Forest land	Not Estimated	Unavailable land use matrix showing land converted to forest land.
	Cropland (3B.2)	Cropland remaining Cropland	FAOSTATS	FAO

		Lands converted to Cropland	Not Estimated	Unavailable land use matrix showing land converted to Cropland.
	Grassland (3B. 3)	Grassland remaining Grassland	FAOSTATS	FAO
		Forest land converted to grassland	FAOSTATS	FAO
		Other land converted to grassland	Not Estimated	Unavailable land use matrix showing other land converted to grassland.
	Wetland (3B.4)	Wetland remaining wetland	Not Estimated	Unavailable land use matrix showing wetland remaining wetland areas.
		Lands converted to wetland	Not Estimated	Unavailable land use matrix showing other land converted to wetland.
	Settlement (3B.5)	Settlement remaining settlement	Not Estimated	Unavailable land use matrix showing wetland remaining wetland areas.
		Lands converted to settlement	Not Estimated	Unavailable land use matrix showing other land converted to settlement.
	Other land (3B.6)	Other land remaining other land	Not Estimated	Unavailable land use matrix showing other land remaining other land.
		Lands converted to other land	Not Estimated	Unavailable land use matrix showing other land converted to other land.
3C	Emission from biomass burning (3C1)	Forest areas affected by fire	FAOSTAT	FAO
	Rice Cultivation (3C7)	Cultivated rice areas	FAOSTAT Liberia Food Production Survey	National Rice Development Strategy for Liberia

2.4 Emission Factors

The default IPCC Emission Factors (EFs) have been for the inventory. The details on EFs are given under the sectors.

2.5 Greenhouse Gas Inventory Results

2.3.1 Aggregate Greenhouse Gas Emissions

Liberia's total national greenhouse gas emissions for 2017 was estimated at 5,900 $GgCO_2e$, which is 5% greater than the 2015 emission levels of 5,695.17 Gg CO_2e. The observed rise in emissions is associated with high deforestation and inefficient waste disposal. Without the Land category emissions (without FOLU), Liberia's total emissions was 2, 185 $GgCO_2e$ representing a 23% reduction of the 2015 emissions of 2,822.57 $GgCO_2e$ in 2017 (Figure 13).

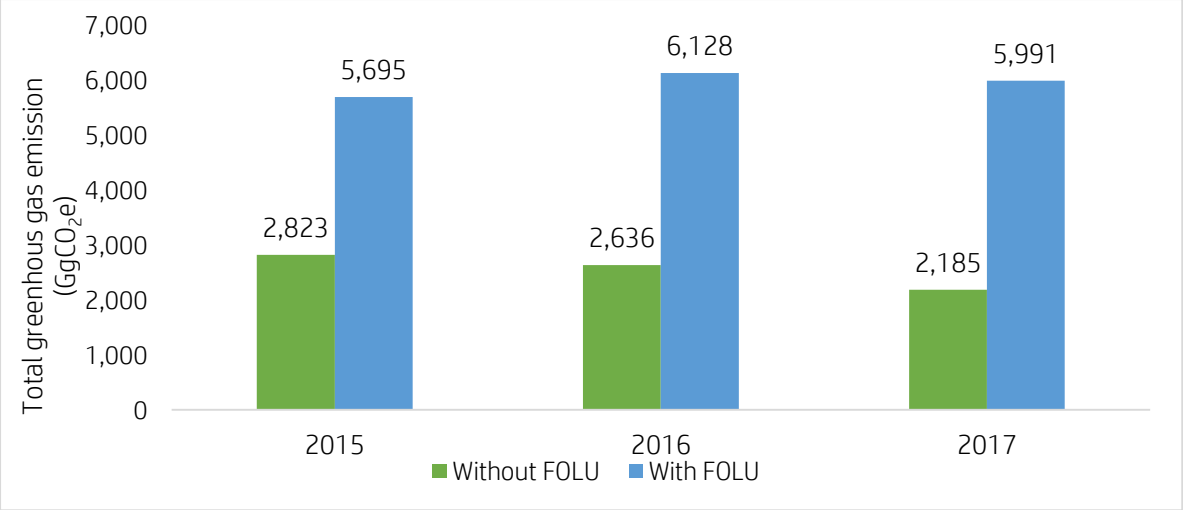

Figure 13: Total greenhouse gas emission trends for 2015-2017

Throughout the time series, the FOLU has been the consistent largest contributor to the national emissions. In 2017, FOLU[3] alone made up 64% of the overall emissions (Table 9). The energy was the second-largest source of emissions and hovered around 16% of all the emissions, followed by IPPU (9%), Waste (8%) and Agriculture-related emissions (3%).[4]

Table 9: Sector contributions to emission for 2015-2017

Sectors	Greenhous gas emissions (Gg CO_2e)			Share (%)	Change (%)
	2015	2016	2017	2017	2015-2017
Energy	1,161.65	1,008.29	957.42	16	-18
IPPU	1,067.63	997.93	555.37	9	-48
AFOLU	3,069.62	3,711.72	4,014.05	67	31
3A and 3C	*197.03*	*220.05*	*208.36*	*3*	*6*
3B	*2,872.59*	*3,491.67*	*3,805.69*	*64*	*32*
Waste	396.26	410.08	463.86	8	17
Total	5,695.17	6,128.02	5,990.70	100	5

While the total emissions recorded a marginal increase of 5% over 2015 to 2017, the trends for the different sectors differed widely. Emissions in the Energy and IPPU sectors showed a declining trend of 18% and 48% respectively. Conversely, AFOLU and Waste sectors recorded increasing emissions of 31% and 17% in the same period.

In terms of direct gases, CO_2 is the dominant greenhouse gas. The CO_2 emission levels of 4,859.92Gg amount to 81.1% of the total emissions in Liberia in 2017 (Tables 11 and 12). Of the CO_2 emissions, 78% came from the land category while 11% and 10% were from the IPPU and Energy sectors, respectively (Figure 14). The conversion of forest land mainly drove the CO_2 emission trends to grassland. The 2017 CH_4 emissions of 857.13 $GgCO_2e$ makes it the second most important greenhouse gas source in Liberia. The majority (54%) of the CH_4 emissions were recorded in the Waste sector through the disposal of solid waste and the discharge of domestic and industrial

[3] Land category under the AFOLU
[4] Include emissions from 3A and 3C

liquid waste. The rest of the CH_4 were emitted from the Energy (28%) and the AFOLU (19%) sectors. Nitrous oxide is the third-largest emission source in Liberia. Its 2017 levels amounted to 270.72 $GgCO_2e$ of which the Energy Sector constituted a signification portion of 81%, followed by the AFOLU (17%) and Waste (1%) sectors. The HFC levels of 2.93 $GgCO_2e$ is the least contributor to the total GHG emission, all of which were emitted from the IPPU sector.

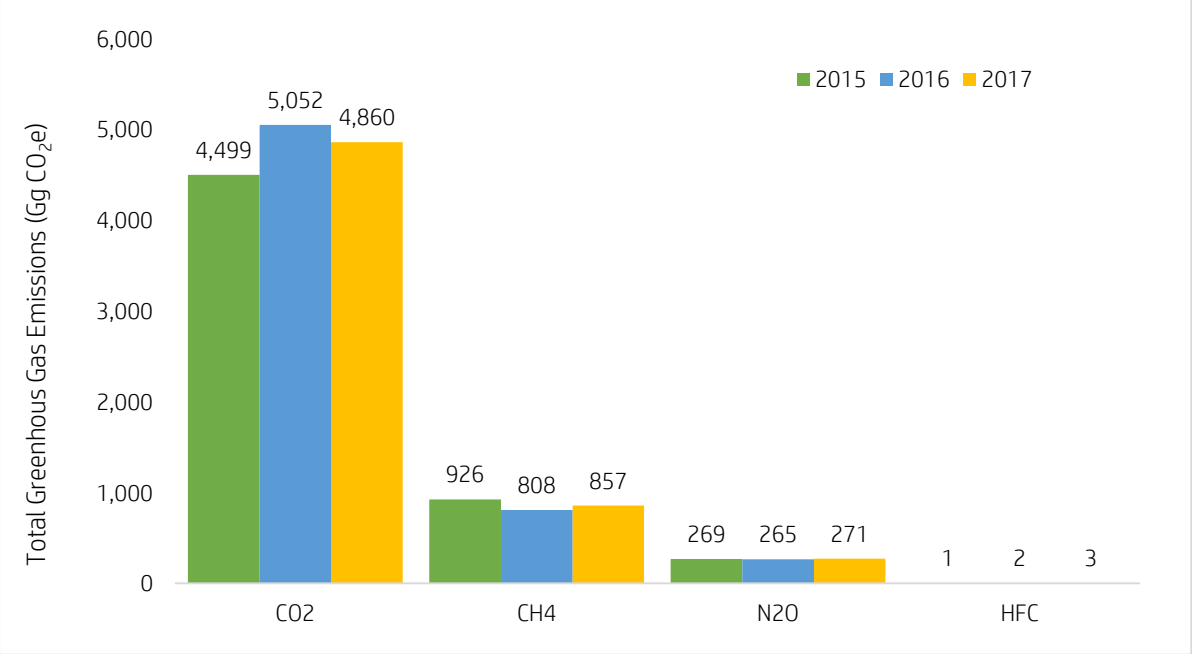

Figure 14: Trends of the greenhouse for different gases for 2015-2017

Precursor gases prevailing in Liberia were mainly NOx, CO and NMVOC as it was a challenge to obtain a reliable date for estimating sulphur dioxide emissions. In this regard, the estimation for the precursor gas (NOx, CO and NMVOC) was limited to the Energy. In 2017, the NOx, CO, and NMVOC emissions were 3.1 Gg, 1,140.99 Gg and 356.87 Gg, respectively (Table 10). Within the Energy sector, most of the precursor gases came from the manufacture of solid fuel (charcoal production) and the use of biomass (charcoal and firewood for commercial and residential cooking). The use of inefficient kiln (earth mound) for charcoal production is the dominant source of CO and NMVOC emissions in Liberia.

Table 10: Short summary of Liberia's emissions for 2017

	Emissions (Gg)			Emissions CO_2 Equivalents (Gg)				
Categories	Net CO_2	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO_2 equivalent conversion factors	Other halogenated gases without CO_2 equivalent conversion factors
Total National Emissions and Removals	4,859.92	40.82	0.87	2.93	-	-	-	
1 - Energy	501.74	11.23	0.71	-	-	-	-	
1.A - Fuel Combustion Activities	501.74	11.23	0.71					
1.B - Fugitive emissions from fuels	-	-	-					
1.C - Carbon dioxide Transport and Storage	-							
2 - Industrial Processes and Product Use	552.43	-	-	2.93	-	-	-	
2.A - Mineral Industry	-	-	-					
2.B - Chemical Industry	-	-	-	-	-	-	-	
2.C - Metal Industry	49.21	-	-	-	-	-	-	
2.D - Non-Energy Products from Fuels and Solvent Use	503.23	-	-					
2.E - Electronics Industry	-	-	-	-	-	-	-	
2.F - Product Uses as Substitutes for Ozone Depleting Substances				2.93	-			
2.G - Other Product Manufacture and Use	-	-	-	-	-	-	-	
2.H - Other	-	-	-					
3 - Agriculture, Forestry, and Other Land Use	3,805.69	7.67	0.15	-	-	-	-	
3.A - Livestock		6.00	0.15					
3.B - Land	3,805.69		-					
3.C - Aggregate sources and non-CO2 emissions sources on land	-	1.67	-					
3.D - Other	-	-	-					
4 - Waste	0.05	21.92	0.01	-	-	-	-	
4.A - Solid Waste Disposal		11.50						
4.B - Biological Treatment of Solid Waste		-	-					
4.C - Incineration and Open Burning of Waste	0.05	-	-					
4.D - Wastewater Treatment and Discharge		10.42	0.01					
4.E - Other (please specify)	-	-	-					

5 - Other	-	-	-	-	-	-	-	-
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3			-					
5.B - Other (please specify)	-	-	-	-	-	-	-	-
Memo Items								
International Bunkers	43.95	0.00	0.00	-	-	-	-	-
1.A.3.a.i - International Aviation (International Bunkers) (1)	43.95	0.00	0.00					
1.A.3.d.i - International water-borne navigation (International bunkers) (1)	-	-	-					
1.A.5.c - Multilateral Operations	-	-	-	-	-	-	-	-

Table 11: Long summary of Liberia's emissions for 2017

Categories	Net CO2 (Gg)	CH4 (Gg)	N2O (Gg)	HFCs (CO_2e Gg)	PFCs CO_2e Gg)	SF6 (CO_2e Gg)	Other halogenated gases with CO_2 equivalent conversion factors	Other halogenated gases without CO_2 equivalent conversion factors	NOx (Gg)	CO (Gg)
ssions and Removals	4,859.92	39.15	0.87	2.93	-	-	-	-	3.06	1,141.00
	501.74	11.23	0.71	-	-	-	-	-	3.06	1,141.00
stion Activities	501.74	11.23	0.71	-	-	-	-	-	3.06	1,141.00
ndustries	150.03	4.73	0.63						1.95	983.35
uring Industries and Construction	116.62	0.08	0.01						0.96	9.53
t	222.36	0.09	0.01						-	-
ctors	12.73	6.33	0.06						0.15	148.12
cified	-	-	-						-	-
issions from fuels	-	-	-	-	-	-	-	-	-	-
ls	-	-	-						-	-
atural Gas	-	-	-						-	-
issions from Energy Production	-	-	-						-	-
ide Transport and Storage	-	-	-	-	-	-	-	-	-	-
t of CO2	-								-	-
and Storage	-								-	-
	-								-	-

sses and Product Use	552.43	-	-	2.93	-	-	-	-	-	-
ustry	-	-	-	-	-	-	-	-	-	-
production	-								-	
duction	-								-	
oduction	-								-	
ocess Uses of Carbonates	-								-	
ease specify)	-	-	-						-	
dustry	-	-	-	-	-	-	-	-	-	-
Production	-								-	
d Production			-						-	
id Production			-						-	
tam, Glyoxal and Glyoxylic Acid Production			-						-	
Production	-	-							-	
Dioxide Production	-								-	
n Production	-								-	
mical and Carbon Black Production	-	-							-	
emical Production				-	-	-	-	-	-	
Please specify)	-	-	-	-	-	-	-	-	-	
try	49.21	-	-	-	-	-	-	-	-	-
Steel Production	49.21	-							-	
ys Production	-	-							-	
m production	-				-			-	-	
um production	-					-		-	-	
duction	-								-	
duction	-								-	
ease specify)	-	-	-	-	-	-	-	-	-	
Products from Fuels and Solvent Use	503.23	-	-	-	-	-	-	-	-	-
Use	503.23								-	
Wax Use	-								-	
Use									-	
ease specify)	-	-	-						-	
Industry	-	-	-	-	-	-	-	-	-	-

d Circuit or Semiconductor				-	-	-	-	-	-	-
Panel Display					-	-	-	-	-	-
taics					-			-	-	-
nsfer Fluid					-			-	-	-
ease specify)	-	-	-	-	-	-	-	-	-	-
s as Substitutes for Ozone Depleting Substances	-	-	-	2.93	-	-	-	-	-	-
tion and Air Conditioning				2.93				-	-	-
owing Agents				-				-	-	-
ection				-	-			-	-	-
				-				-	-	-
				-	-			-	-	-
plications (please specify)				-	-			-	-	-
uct Manufacture and Use	-	-	-	-	-	-	-	-	-	-
Equipment					-	-		-	-	-
PFCs from Other Product Uses					-	-		-	-	-
n Product Uses			-						-	-
ease specify)	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
Paper Industry	-	-							-	-
l Beverages Industry	-	-							-	-
ease specify)	-	-	-						-	-
estry, and Other Land Use	3,805.69	7.67	0.15	-	-	-	-	-	-	-
	-	6.00	0.15	-	-	-	-	-	-	-
ermentation		5.19							-	-
Management		0.81	0.15						-	-
	3,805.69	-	-	-	-	-	-	-	-	-
nd	(3,161.34)								-	-
	(0.02)								-	-
d	6,967.05								-	-
	-		-						-	-
nts	-								-	-
nd	-								-	-

ources and non-CO2 emissions sources on land	-	1.67	-	-	-	-	-	-	-	-
s from biomass burning		-	-						-	-
	-								-	-
lication	-								-	-
O Emissions from managed soils			-						-	-
I2O Emissions from managed soils			-						-	-
I2O Emissions from manure management			-						-	-
vation		1.67							-	-
ease specify)		-	-						-	-
	-	-	-	-	-	-	-	-	-	-
d Wood Products	-								-	-
ease specify)	-	-	-						-	-
	0.05	21.92	0.01	-	-	-	-	-	-	-
Disposal	-	11.50	-	-	-	-	-	-	-	-
reatment of Solid Waste	-	-	-	-	-	-	-	-	-	-
and Open Burning of Waste	0.05	-	-	-	-	-	-	-	-	-
Treatment and Discharge	-	10.42	0.01	-	-	-	-	-	-	-
e specify)	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
emissions from the atmospheric deposition of nitrogen in NOx and NH3	-	-	-	-	-	-	-	-	-	-
e specify)	-	-	-	-	-	-	-	-	-	-
ers	43.95	0.00	0.00	-	-	-	-	-	-	-
onal Aviation (International Bunkers)	43.95	0.00	0.00						-	-
onal water-borne navigation (International bunkers)	-	-	-						-	-
l Operations	-	-	-	-	-	-	-	-	-	-

2.6 Quality Control and Quality Assurance

Liberia has its system for Quality Control (QC) of data being collected within the different institutions. All data are quality controlled at different stages of the process until the EPA makes the final Quality Assurance (QA) before archiving in national databases. Thus, the initial phases of the control system remain beyond the GHG inventory compiler, and the process starts as from the time various consultants receive the AD on the field in collaboration with the UNFCCC focal point in the EPA. QC and QA procedures, as defined in the 2006 IPCC Guidelines (IPCC, 2007) have been implemented during the preparation of the inventory. Whenever there were inconsistencies or possible transcription errors, the responsible institution or consultant was queried, and the problem discussed and solved. QC was implemented through:

- Routine and consistent checks to ensure data integrity, reliability, and completeness.
- Routine and consistent checks to identify errors and omissions.
- Accuracy checks on data acquisition and calculations.
- The use of approved standardized procedures for emissions calculations.

2.6.1 Technical and scientific reviews of data used, methods adopted and results obtained

QA procedures were carried by independent reviewers who were not involved with the preparation of the inventory with objectives:

- Confirm data quality and reliability.
- Review the AD and EFs adopted within each source category as a first step.
- Review and check the calculation steps in the software.

QA/QC procedures were followed throughout the inventory using the systematic records as per the 2006 IPCC Guidelines.

2.7 Completeness Check

Before starting work on the GHG inventory, a source by source category analysis was conducted with a wide stakeholder group. The objective set was to be exhaustive and cover all categories as far as possible within permissible limits of time, capacity, and availability of resources, namely AD and staffing. The scope of the inventory is provided in Table 12.

Table 12: Overview of completeness check based on the 2017 inventory

Category	CO_2	CH_4	N_2O	HFC	NO_x	CO	NMVOC	SO_2
1. Energy sector								
1.A - Fuel Combustion Activities								
1.A.1 - Energy Industries	E	E	E	NA	E	E	E	NE
1.A.2 - Manufacturing Industries and Construction	E	E	E	NA	E	E	E	NE
1.A.3 – Transport	E	E	E	NA	E	E	E	NE

1.A.4 - Other Sectors	E	E	E	NA	E	E	E	NE
1.A.5 - Non-Specified	E	E	E	NA	E	E	E	NE
1.B - Fugitive emissions from fuels								
B.1 - Solid Fuels	NO	NO	NO	NA	NO	NO	NO	NO
1.B.2 - Oil and Natural Gas	NO	NO	NO	NA	NO	NO	NO	NO
1.B.3 - Other emissions from Energy Production	NO	NO	NO	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage								
1.C.1 - Transport of CO_2	NO	NA	NA	NA	NO	NO	NO	NO
1.C.2 - Injection and Storage	NO	NA	NA	NA	NO	NO	NO	NO
1.C.3 – Other	NO	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use								
2.A - Mineral Industry								
2.A.1 - Cement production	NE	NA	NA	NA	NO	NO	NO	NO
2.A.2 - Lime production	NO	NA	NA	NA	NA	NA	NA	NA
2.A.3 - Glass Production	NO	NA	NA	NA	NO	NO	NO	NO
2.A.4 - Other Process Uses of Carbonates	NO	NO	NO	NA	NO	NO	NO	NO
2.A.5 - Other (please specify)	NO	NO	NO	NA	NO	NO	NO	NO
2.B - Chemical Industry								
2.B.1 - Ammonia Production	NO	NA	NA	NA	NO	NO	NA	NA
2.B.2 - Nitric Acid Production	NA	NA	NO	NA	NO	NA	NA	NA
2.B.3 - Adipic Acid Production	NA	NA	NO	NA	NO	NO	NO	NO
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	NA	NA	NO	NA	NO	NO	NO	NO
2.B.5 - Carbide Production	NO	NO	NA	NA	NO	NO	NO	NO
2.B.6 - Titanium Dioxide Production	NO	NA	NA	NA	NO	NO	NO	NO
2.B.7 - Soda Ash Production	NO	NA	NA	NA	NO	NO	NO	NO
2.B.8 - Petrochemical and Carbon Black Production	NO	NO	NA	NA	NO	NO	NO	NO
2.B.9 - Fluorochemical Production	NA	NA	NA	NO	NO	NO	NO	NO
2.B.10 - Other (Please specify)	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry								
2.C.1 - Iron and Steel Production	E	E	NA	NA	NA	NA	NA	NA
2.C.2 - Ferroalloys Production	NO	NO	NA	NA	NE	NE	NE	NE
2.C.3 - Aluminium production	NO	NA	NA	NA	NO	NO	NO	NO
2.C.4 - Magnesium production	NO	NA	NO	NA	NO	NO	NO	NO
2.C.5 - Lead Production	NO	NA	NA	NA	NA	NA	NA	NA
2.C.6 - Zinc Production	NO	NA	NA	NA	NA	NA	NA	NA
2.C.7 - Other (please specify)	NO	NA	NO	NA	NO	NO	NO	NO
2.D - Non-Energy Products from Fuels and Solvent Use								
2.D.1 - Lubricant Use	E	NA	NA	NA	NA	NA	NA	NA
2.D.2 - Paraffin Wax Use	NE	NA	NA	NA	NA	NA	NA	NA

2.D.3 - Solvent Use	NA	NA	NA	NA	NE	NE	NE	NE
2.D.4 - Other (please specify)	NO	NO	NO	NA	NO	NO	NO	NO
2.E - Electronics Industry								
2.E.1 - Integrated Circuit or Semiconductor	NA	NA	NA	NA	NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display	NA	NA	NA	NA	NO	NO	NO	NO
2.E.3 – Photovoltaics	NA	NA	NA	NA	NO	NO	NO	NO
2.E.4 - Heat Transfer Fluid	NA	NA	NA	NA	NO	NO	NO	NO
2.E.5 - Other (please specify)	NO	NO	NO	NA	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances								
2.F.1 - Refrigeration and Air Conditioning	NA	NA	NA	E	NO	NO	NO	NO
2.F.2 - Foam Blowing Agents	NA	NA	NA	NO	NO	NO	NO	NO
2.F.3 - Fire Protection	NA	NA	NA	NO	NO	NO	NO	NO
2.F.4 – Aerosols	NA	NA	NA	NO	NO	NO	NO	NO
2.F.5 – Solvents	NA	NA	NA	NO	NO	NO	NO	NO
2.F.6 - Other Applications (please specify)	NA	NA	NA	NO	NO	NO	NO	NO
2.G - Other Product Manufacture and Use								
2.G.1 - Electrical Equipment	NA	NA	NA	NA	NO	NO	NO	NO
2.G.2 - SF_6 and PFCs from Other Product Uses	NA	NA	NA	NA	NO	NO	NO	NO
2.G.3 - N_2O from Product Uses	NA	NA	NA	NA	NO	NO	NO	NO
2.G.4 - Other (Please specify)	NO	NO	NO	NA	NO	NO	NO	NO
2.H – Other								
2.H.1 - Pulp and Paper Industry	NO	NO	NO	NA	NO	NO	NO	NO
2.H.2 - Food and Beverages Industry	NO	NO	NO	NA	NO	NO	NO	NO
2.H.3 - Other (please specify)	NO	NO	NO	NA	NO	NO	NO	NO
3- Agriculture, Forestry, and Other								
3.A – Livestock								
3.A.1 - Enteric Fermentation	NA	E	NA	NA	NA	NA	NA	NA
3.A.2 - Manure Management	NA	E	NA	NA	NA	NA	NA	NA
3B – Land								
3.B.1 - Forest land	E	NA	NA	NA	NA	NA	NA	NA
3.B.2 - Cropland	E	NA	NA	NA	NA	NA	NA	NA
3.B.3 - Grassland	E	NA	NA	NA	NA	NA	NA	NA
3.B.4 - Wetlands	NE	NA	NE	NA	NA	NA	NA	NA
3.B.5 – Settlements	NE	NA	NA	NA	NA	NA	NA	NA
3.B.6 – Other Land	NE	NA	NA	NA	NA	NA	NA	NA
3C. Aggregate sources and non-CO_2 emissions sources on land								
3.C.1 - Emissions from biomass burning	NA	NE	NE	NA	NA	NA	NA	NA
3.C.2 - Liming	NO	NA	NA	NA	NA	NA	NA	NA
3.C.3 - Urea application	NE	NA	NA	NA	NA	NA	NA	NA

3.C.4 - Direct N_2O Emissions from managed soils	NA	NA	NE	NA	NA	NA	NA	NA
3.C.5 - Indirect N_2O Emissions from managed soils	NA	NA	NE	NA	NA	NA	NA	NA
3.C.6 - Indirect N_2O Emissions from manure management	NA	NA	NE	NA	NA	NA	NA	NA
3.C.7 - Rice cultivation	NA	E	NA	NA	NA	NA	NA	NA
3.C.8 - Other (please specify)	NA	NO	NO	NA	NA	NA	NA	NA
4. Waste								
4.A - Solid Waste Disposal	NA	E	NA	NA	NE	NE	NE	NE
4.B - Biological Treatment of Solid Waste	NA	NE	NE	NA	NE	NE	NE	NE
4.C - Incineration and Open Burning of Waste	E	E	E	NA	NE	NE	NE	NE
4.D - Wastewater Treatment and Discharge	NA	E	E	NA	NE	NE	NE	NE

Key: E = Estimated, N/A = Not Applicable, NE = Not Estimated, NO = Not Occurring

2.8 Key Category Analysis

The Key Category Analysis also was performed using the tool in the 2006 IPCC Software when the compilation process was completed. The results are presented in Table 13. In 2017, nine key categories were identified in using the level assessment (L) with an aggregate emission of 17,270 Gg CO_2e amounting 96% of total Liberia's emissions. Of the nine key categories, CO_2 contributed the most followed by CH_4 and then by N_2O. Without FOLU, seven key categories were identified with a total emission of 1663.95 Gg CO_2e.

Table 13: Level assessment key categories in 2017

IPCC Category code	IPCC Category	GHG	2017 Ex,t (Gg CO_2e)	|Ex,t| (Gg CO_2e)	Lx,t	Cumulative % Contribution
3.B.3.b	Land Converted to Grassland	CO_2	6967.05	6967.05	0.57	0.57
3.B.1.a	Forest Land Remaining Forest land	CO_2	-3161.34	3161.34	0.26	0.82
2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	503.23	503.23	0.04	0.87
4.A	Solid Waste Disposal	CH_4	241.42	241.42	0.019	0.89
1.A.3.b	Road Transportation	CO_2	222.36	222.36	0.018	0.90
4.D	Wastewater Treatment and Discharge	CH_4	218.82	218.82	0.018	0.92
1.A.1	Energy Industries - Biomass	N_2O	195.25	195.25	0.016	0.94
1.A.1	Energy Industries - Liquid Fuels	CO_2	150.03	150.03	0.012	0.95
1.A.4	Other Sectors - Biomass	CH_4	132.85	132.85	0.012	0.96

Regarding the trend assessment of KCA, eight categories were identified (Table 14). For both L and T assessments, the categories with CO_2 emissions dominated followed by CH_4 and then N_2O. Some of the categories that emerged from L and T assessments were as follows: 3.B.1.a -Forest land Remaining Forest land; 3.B.3.b - Land Converted

to Grassland; 1.A.4- Other Sectors – Biomass; and 2. -Non-Energy Products from Fuels and Solvent Use.

Table 14: List of trends assessment key categories for the period 2015-2017

IPCC Category code	IPCC Category	GHG	2015 Year Estimate Ex0 (Gg CO_2 Eq)	2017 Year Estimate Ext (Gg CO_2 Eq)	Trend Assessment (Txt)	% Contribution to Trend	Cumulative Total
3.B.1.a	Forest Land Remaining Forest land	CO_2	-4094.46	-3161.33	0.05	0.341	0.34
2.D	Non-Energy Products from Fuels and Solvent Use	CO_2	1011.00	503.22	0.041	0.273	0.61
3.B.3.b	Land Converted to Grassland	CO_2	6967.05	6967.05	0.027	0.187	0.80
1.A.4	Other Sectors - Biomass	CH_4	291.99	132.85	0.013	0.085	0.89
1.A.1	Energy Industries - Liquid Fuels	CO_2	199.08	150.03	0.0043	0.029	0.92
4.D	Wastewater Treatment and Discharge	CH_4	167.19	218.81	0.003	0.020	0.94
1.A.4	Other Sectors - Biomass	N_2O	50.59	18.04	0.0025	0.017	0.95
1.A.1	Energy Industries - Biomass	N_2O	165.50	195.24	0.0014	0.009	0.96

2.9 Archiving

All raw data collected for the inventory have been stored in a database and the 2006 software database after being processed and formatted for making estimates of emissions and removals. All documentation on the data processing and formatting have been kept in soft copies in the excel sheets with the summaries reported in the BUR1. These versions will be managed in electronic format.

2.10 Uncertainty Management

The uncertainty analysis has been performed using the tool available within the 2006 IPCC Software for the national inventory with and without FOLU. For the national inventory, uncertainty without FOLU was 7.1% while when FOLU was included, it rose to 62.5%. This could be a problem with the software and is being investigated with the Technical Support Unit of IPCC.

2.11 Constraints, Gaps and Needs

Liberia, as a developing country, has its constraints and gaps that need to be addressed to produce better quality reports for reporting to the Convention. The following problems were encountered during the preparation of the national inventory of GHG emissions:

- Lack of AD for key sources (energy data, AFOLU, waste, etc.), in some cases, the available data vary in formats, not in the format required for GHG inventory.
- Lack of EFs to better represent national circumstances and provide for accurate estimates.
- Emissions for some categories have not been estimated due to lack of AD and time.
- Limited institutional and human resource capacity of national experts to take over despite a round of training on running the 2006 IPCC software was not possible.
- Huge turnover of staff in public service.

2.12 Sector Contributions

2.12.1 Energy Sector

Liberia is not a producer of fossil fuels and does not refine or process any fuel but manages strategic storage of secondary fuel imports. Therefore, only fossil fuel consumed and combusted in the country has been used to estimate emissions in the energy sector under Fuel Combustion Activities. The Ministry of Mines and Energy is implementing a project to produce national energy balance for Liberia. In the BUR2, Liberia would be able to report on the energy balance. All IPCC source categories occurring in Liberia have been covered in the inventory. However, due to unavailability of activity data, some emissions of some categories have not been computed. Table 12 provides the completeness list for the inventory, including the energy sector. In line with the IPCC Good Practice, CO_2 emissions have been computed with both the reference and sectoral approaches for comparison as recommended. Emissions from international aviation bunkers have been reported. International and domestic water-borne navigation has not been reported due to lack of due. Fossil fuels constituted the major share of the energy requirements of the country in 2015 followed by renewable sources comprising biomass, solar and wind. Electricity imports had a share of 15% and hydro 8%.

2.12.1.1 Description of the energy sector

For the Energy sector, GHG emissions have been estimated for the IPCC source categories captured in Table 15 below.

Table 15: Completeness check for the energy sector

IPCC Codes	Description	Comments
1	Energy	
1.A	Fuel Combustion	
1. A.1	Energy Industries	E
1.A1ai	Electricity generation	E

1.A1b	Petroleum refining	NA
1.A1ci	Manufacture of solid fuel	E
1. A.2.	Manufacturing Industries and Constructions	E
1. A.3.	Transport (Civil Aviation, Road Transport, Railways, Navigation, Pipeline Transport)	E
1. A.4.	Other Sectors	E
1.A.4a	Commercial/ Institutional	NE
1.A.4b	Residential	E
1.A4ci	Stationary combustion	NE
1.A4cii	Off-road vehicle and other machines	NE
1.A4ciii	Fishing	E
1. A.5.	Other	
1B	Fugitive Emissions from Fuels	NO
1.B.1	Solid Fuels	NO
1.B.2	Oil and Natural Gas	NO
1C	Carbon dioxide transport, Injection and geological Storage	NO
Memo items	International bunkers (Aviation)	E
	International bunkers (Water-borne)	NE
	CO_2 emissions from biomass	E

Note: E = estimated, NA = Not Applicable, NE = Not Estimated, NO = Not Occurring

More details on the IPCC categories are provided below.

1.A1. Energy Industries

Liberia reports on emissions from electricity generation (1.A1.ai) and the manufacture of solid fuel (1. A1ci) relating to charcoal production. The activity data and the emission factors used for the energy industries emission estimate in Table 16.

Table 16: Activity data and emission factors for the Energy industries

IPCC Code	Category	Fuel type	Fuel Quantity (TJ)		
			2015	2016	2017
1.A1ai	Electricity generation	Light Fuel Oil	816.79	938.96	124.87
		Diesel Fuel Oil	1,878.69	1,903.04	1,901.20
1.A1ci	Manufacture of solid fuel	Woodfuel	133,474.83	153,462.13	157,456.81

Under electricity generation, Liberia's total installed electricity generation capacity in 2017 was about 126 MW for peak demand of some 480MW. Hydro contributes about 92 MW in Liberia, and the country is highly dependent on imported fossil fuel. The fossil fuel generation plants are mainly used to supplement these during peak demand time. Solar and wind potential exists but is tapped only marginally now. Plans, within the energy policy, are for these two renewable sources along with biomass from the invader bush to be used in the future. Liberia's energy consumption is dominated by woody biomass with a share of about 80% as a primary energy source and mainly used for cooking and heating. About 70% of the urban population use charcoal for cooking, and 5 % in the rural population (LISGIS, 2009). Charcoal is widely used in urban areas of Monrovia and its environs. According to the World Bank (2014). Charcoal production is a significant source of GHG emissions in Liberia. The emissions associated with charcoal production is determined on by the efficiency of the kilns as well as the fraction of non-renewable woodfuel.

1A.2 Manufacturing Industries and Construction

Fossil fuel inputs are primarily used for generating “process heat” manufacturing and construction. In this inventory, the emissions from the following manufacturing sectors and construction have been covered:

- Iron and Steel
- Chemicals
- Food processing, Beverage and Tobacco
- Mining and Quarrying
- Construction
- Machinery
- Non-specified industry (including metal fabrication, Paint etc.)

The main liquid fuels for the stationary combustion operation in manufacturing and construction include Diesel, LPG, and Gasoline. Charcoal and firewood are the solid biomass fuel used in manufacturing and construction in Liberia. Table 17 presents the activity for the manufacturing and construction category.

Table 17: Activity data for Manufacturing Industries and Construction

IPCC Code	Category	Fuel type	Fuel Quantity (TJ)		
			2015	2016	2017
1.A.2.a	Iron and Steel	Diesel	162.78	174.69	172.11
1.A.2.c	Chemicals	Diesel	20.19	21.67	23.47
1.A.2.e	Food processing, Beverage and Tobacco	Diesel	6.06	6.50	6.41
		Woodfuel	1350.12	1701.90	2145.35
		Charcoal	41.88	42.97	44.09
		LPG	4.35	4.41	4.41
1.A.2.i	Mining and Quarrying	Diesel	1085.18	1164.61	1079.58
1.A.2.k	Construction	Gasoline	7.27	7.37	7.36
		Diesel	50.47	54.17	78.23
1.A.2.h	Machinery	Diesel	13.12	14.08	15.65
1.A.2.m	Non-specified industry	Diesel	155.21	166.57	187.75

1A.3 Transport

The transport sector comprised of domestic aviation, road transportation, railways, and domestic water-borne navigation. Due to the unavailability of disaggregated data, Liberia has report emissions from only road transportation. The road transportation emission has not been disaggregated according to technologies and fuel types. In Table 18, the activity data on fuel has been reported.

Table 18: Activity data for the transport sector

IPCC Code	Category	Fuel type	Fuel Quantity (TJ)		
			2015	2016	2017
1.A.3.b	Road transportation	Gasoline	2599.76	2633.45	2630.91
		Diesel	490.33	496.68	496.20
		LPG	51.14	51.80	51.75

All four sub-categories have been covered in the inventory as well as fuel combusted for international bunkering.

1A.4 Other sectors

Sub-categories covered under other sectors are Commercial/Institutional, Residential and Fishing (Table 19). The main sources of energy used within the residential sector by households for cooking purposes are woody biomass (80%) for cooking purposes, about (70%) mainly use for heating while the electricity (5%), urban use charcoal for cooking. Additionally, about 70% of the urban population use charcoal for cooking and 5 % in the rural population (LISGIS, 2009). Charcoal is widely us in urban areas of Monrovia and its environs. According to the (World Bank, 2014), about 2% of the population of Liberia have access to modern, clean fuel and technology for cooking such as liquefied petroleum gas, kerosene and electricity. Fishing is an important activity in Liberia. Furthermore, the fisheries sector is important to the agricultural sector of Liberia as well as to the national economy. In 2002, fisheries contributed to 12% of agricultural GDP and 3.2% of the national GDP. Fisheries play a key role in the livelihoods of the coastal population, consisting of 15,000 to 20,000 families that use approximately 2,500 boats. The fisheries sector has vital roles in food security and national economic growth (NEPAD/CAADP/FAO, 2006).

Table 19: Activity data for other sectors

IPCC Code	Category	Fuel type	Fuel Quantity (TJ)		
			2015	2016	2017
1.A.4.a	Commercial /Institutional	LPG	4.56	6.64	6.63
		Diesel	213.29	-	-
		Firewood	3,752.00	225.00	252.28
		Charcoal	6,652.80	1,000.67	1,026.72
1.A.4.b	Residential	LPG	83.06	80.84	80.76
		Diesel	26.18	-	-
		Firewood	33,726.00	10,105.92	10,367.42
		Charcoal	6,652.80	14,302.57	14,674.87
1.A.4.c.iii	Fishing (mobile combustion)	Gasoline	84.32	87.33	87.24
		Diesel	15.65	15.86	15.84

2.11.1.2 Memo items

International bunkers cover international aviation and water-borne navigation according to the 2006 IPCC Guidelines. Emissions associated with international water-borne navigation were not reported due to lack of data (Table 20).

Table 20: Activity data for international bunker fuels

IPCC Code	Category	Fuel type	Fuel Quantity (TJ)		
			2015	2016	2017
1.A.3.a. i	International aviation	ATK	607.36	615.23	614.64
1.A.3.d. i	International water-borne navigation	Diesel	NE	NE	NE

2.12.1.3 Description of the method of emission calculation

Reference and sectoral approaches have been used to estimate the CO_2 emissions for the energy sector. Sectoral approach only was applied to the computation of non-CO_2 emissions in the sector. The top-down reference approach was carried out using import-export, production and stock change data based on the energy balance of the country. The sectoral approach is a bottom-up and involves determining fuel consumption from the end-use data by the different sector source categories and using the IPCC conversion and emission factors to determine GHG emissions. The following IPCC source categories were covered under the Sectoral approach:

- Energy industries.
- Manufacturing Industries and Construction.
- Transport.
- Other sectors (commercial/institutional, residential, Agriculture, fishing and forestry sector)

The basic equations used to estimate GHG emissions are given below:

$$\begin{aligned} CO_2 \text{ emissions} &= \Sigma \left(\text{Fuel Consumption J} \bullet \text{Conversion Factor} \left(\frac{\text{TJ}}{\text{unit}} \right) \right. \\ &\left. \bullet \text{Carbon Emission Factor J} \left(\frac{\text{tC}}{\text{TJ}} \right) - \text{Carbon Stored} \right. \\ &\left. \bullet \text{Oxidation Fraction J} \bullet \frac{44}{12} \right) \end{aligned} \quad \text{Equation:1}$$

$$\text{Non} - CO_2 \text{ emissions} = \Sigma \left(\text{Fuel Consumption J} \bullet \text{Emission Factor J} \right) \quad \text{Equation:2}$$

Where J = type of fuel

Activity data

Activity Data (AD) were collected from a vast group of stakeholders involved in the combustion of fossil fuels. AD for working with the reference approach was obtained from the Ministry of Mines and energy database, Liberia Electricity Corporation, and Liberia Petroleum Refinery Company and other agencies on imports and exports of energy products. For the sectoral approach, AD was sourced from the end-user sectors of fossil fuels within the different IPCC categories. Data on biomass used was either collected from the Forest department (mainly harvest wood) or derived from the amount consumed by households (mainly firewood and charcoal). Data on consumption of different fuels by households are collected in the 2008 census and series surveys conducted by the Liberia Institute of Statistics and geo-information System (LISGIS).

The key stakeholders for provision of AD were Ministry of Mines and Energy (MME) and others, the different petroleum distribution companies, the MME, the government entity that generates electricity, Liberia Electricity Cooperation (LEC) and of that regulates the electricity sector and the Liberia Electricity Regulatory Commission

(LERC). AD was not readily available and, in the format, required as well as at the level of disaggregation needed. Gaps were filled using statistical methods such as trend analysis and extrapolation as appropriate. Fuel use for sectors like agriculture, forestry and institutional amongst others could not be traced and even generated. Thus, fuels from these sectors were eventually allocated in different sectors based on distributed and consumed amounts.

Emission factors

In the absence of national emission factors, the greenhouse gas emissions were computed using IPCC default emission factors (Table 21).

Table 21: List of emission factors used in the Energy sector

Fuel	Emission Factor (kg/TJ)			Source		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Liquid fuels						
Crude oil	73,300	3	0.6	Vol. 2, Table 2.2	Vol. 2, Table 2.2	Vol. 2, Table 2.2
Motor gasoline	69300	3.0	0.6	Vol. 2, **Error! Reference source not found.**	Vol. 2, table 2.2	Vol. 2, table 2.2
""	""	3.3	3.2	Vol. 2, **Error! Reference source not found.**	Vol. 2, table 2.2.3	Vol. 2, table 2.2.3
""	""	10.0	0.6	Vol. 2, table 3.5.2	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3
Aviation gasoline	69300	0.5	2.0	Vol. 2, **Error! Reference source not found.**	Vol. 2, table 2.2	Vol. 2, table 2.2
Jet kerosene	71500	0.5	2.0	Vol. 2, **Error! Reference source not found.**	Vol. 2, table 2.2	Vol. 2, table 2.2
Other kerosene	71900	10.0	0.6	Vol. 2, **Error! Reference source not found.**	Vol. 2, table 2.2	Vol. 2, table 2.2
Gas/Diesel oil	74100	3.0	0.6	Vol. 2, **Error! Reference**	Vol. 2, **Error! Reference**	Vol. 2, **Error! Reference**

				source not found.	**source not found.**	**source not found.**
“”	“”	3.9	3.9	Vol. 2, table 3.2.2	Vol. 2, table 2.2.3	Vol. 2, table 2.2.3
“”	“”	7.0	2.0	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3
“”	“”	10.0	0.6	Vol. 2, table 3.5.2	Vol. 2, table 3.5.3	Vol. 2, table 3.5.3
Residual fuel oil	77400	3.0	0.6	Vol. 2, **Error! Reference source not found.**	Vol. 2, **Error! Reference source not found.**	Vol. 2, **Error! Reference source not found.**
LPG	63100	5.0	0.1	Vol. 2, **Error! Reference source not found.**	Vol. 2, **Error! Reference source not found.**	Vol. 2, **Error! Reference source not found.**
Solid fuels						
Wood	112,000	30	4	Vol. 2, Table 2.2	Vol. 2, Table 2.2	Vol. 2, Table 2.2
Charcoal	112,000	200	4	Vol. 2, Table 2.2	Vol. 2, Table 2.2	Vol. 2, Table 2.2

2.12.1.4 Energy sector results

2.12.1.4.1 Reference Approach

The comparison and the reasons accounting for the differences between CO_2 emissions estimated using RA and SA have been provided below in Table 22. The differences in CO_2 emissions between RA and SA ranges from 0.4% to 4.6%. Generally, estimates for RA CO_2 emissions are higher than SA CO_2 emissions. The results show a large difference between the two approaches.

Table 22: Differences in RA and SA estimates of carbon dioxide emissions

Year	Reference	Sectoral	Difference
	CO_2 (Gg)	CO_2 (Gg)	%
2015	1089.09	560.43	94.33
2016	1265.11	564.68	124.04
2017	1469.57	501.74	192.89

The following reasons explain the large differences in the CO_2 emission for both approaches:

- Non-existing energy balance in the years 2015, 2016 and 2017. The Ministry of Mines and Energy has started producing national energy from 2018.
- Inconsistent application of expert judgement in fuel consumption allocation to end-use sectors.

- Inconsistencies in the reporting of total fuel consumption figures.
- Non-existing data on fuel used in non-energy activities or as feedstock.
- No data on diesel fuel consumption for international and domestic water-borne navigation.
- No data on domestic ATK consumption in the domestic aviation industry.

2.12.1.4.2 Sectoral Approach

The estimates of CO_2, CH_4 and N_2O and the total aggregated emissions in CO_2e is given in Table 23 for the IPCC source categories for the period 2015-2017. The total energy sector emissions were 513.68 $GgCO_2e$ which represent an 11% reduction compared to the 2015 levels. The downward trend in the energy sector emission is associated with the increase in renewable hydro energy share of the national grid electricity. Among the energy categories, the transport was the largest emission source constituting 43% of the 2017 total energy sector emissions. The transport emissions were followed by energy industries (30%), manufacturing industries and construction (23%) and other sectors (4%). Individual categories recorded varying emissions trends. While the emissions for the energy industries and other sectors showed a declining trend of 24% and 57% respectively, those of manufacturing industries and construction and transport experienced a marginal rise of 5% and 1%.

Table 23: Emission estimates for Fuel Combustion Activities (Gg) for 2015 - 2017

Categories	Emissions (Gg CO_{2e})											
	2015				2016				2017			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total
1 - Energy	560.4	18.1	0.7	579.22	564.7	10.9	0.7	576.30	501.7	11.2	0.71	513.68
1.A - Fuel Combustion Activities	560.4	18.1	0.7	579.22	564.7	10.9	0.7	576.30	501.7	11.2	0.71	513.68
1.A.1 - Energy Industries	199.1	4.01	0.5	203.63	209.8	4.61	0.6	215.07	150	4.73	0.63	155.39
1.A.2 - Manufacturing Industries and Construction	111.4	0.05	0	111.47	119.5	0.06	0	119.59	116.6	0.08	0.01	116.71
1.A.3 - Transport	219.7	0.09	0	219.82	222.6	0.09	0	222.67	222.4	0.09	0.01	222.46
1.A.4 - Other Sectors	30.22	13.9	0.2	44.29	12.75	6.16	0.1	18.97	12.73	6.33	0.06	19.12

According to Table 24, road transportation and electricity generation are the two most important sources of emissions in the energy sector. Within the manufacturing industry and construction category, emissions from mining tops followed by iron and steel operations.

Carbon Dioxide

Total CO_2 emission for the fuel combustion sector decreased from 579.22 $GgCO_2e$ in 2015 to 576.3 $GgCO_2e$ in 2016 and further to 513.68 $GgCO_2e$ in 2017. The drop in emissions in 2017 is due to the coming online of mount coffee hydro in December 2016 and operated all through in 2017, creating less dependence on imported fuels. The transportation and energy industries are the two key category activities for CO_2 emissions.

Methane

Methane emissions declined by 38% from 18.1 Gg CO_2e in 2015 to 11.23 Gg CO_2e in 2017. The reduction is associated with lower consumption of biomass fuel for heating in commercial and residential activities.

Nitrous oxide

Nitrous oxide emission remained stable over the three years. The energy sector recorded N_2O emissions of an average of 0.72 Gg CO_2e in the same period.

Table 24: Energy sector emissions for 2017

Categories	Emissions (Gg)						
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SO_2
1 - Energy	501.74	11.23	0.71	3.06	1,141.00	356.88	-
1.A - Fuel Combustion Activities	501.74	11.23	0.71	3.06	1,141.00	356.88	-
1.A.1 - Energy Industries	150.03	4.73	0.63	1.95	983.35	333.18	-
1.A.1.a - Main Activity Electricity and Heat Production	150.03	0.01	0.00	0.12	0.03	0.00	-
1.A.1.a.i - Electricity Generation	150.03	0.01	0.00	0.12	0.03	0.00	-
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		4.72	0.63	1.83	983.32	333.18	-
1.A.1.c.i - Manufacture of Solid Fuels		4.72	0.63	1.83	983.32	333.18	-
1.A.1.c.ii - Other Energy Industries				-	-	-	-
1.A.2 - Manufacturing Industries and Construction	116.62	0.08	0.01	0.96	9.53	1.34	-
1.A.2.a - Iron and Steel	12.75	0.00	0.00	0.09	0.01	0.00	-
1.A.2.b - Non-Ferrous Metals				-	-	-	-
1.A.2.c - Chemicals	1.74	0.00	0.00	0.01	0.00	0.00	-
1.A.2.d - Pulp, Paper and Print				-	-	-	-
1.A.2.e - Food Processing, Beverages and Tobacco	0.75	0.07	0.01	0.16	9.43	1.30	-
1.A.2.f - Non-Metallic Minerals				-	-	-	-
1.A.2.g - Transport Equipment				-	-	-	-
1.A.2.h - Machinery	1.16	0.00	0.00	0.01	0.00	0.00	-
1.A.2.i - Mining (excluding fuels) and Quarrying	80.00	0.00	0.00	0.55	0.07	0.03	-
1.A.2.j - Wood and wood products				-	-	-	-
1.A.2.k - Construction	6.31	0.00	0.00	0.04	0.01	0.00	-
1.A.2.l - Textile and Leather				-	-	-	-
1.A.2.m - Non-specified Industry	13.91	0.00	0.00	0.10	0.01	0.00	-
1.A.3 - Transport	222.36	0.09	0.01	-	-	-	-
1.A.3.a - Civil Aviation				-	-	-	-

1.A.3.a.i - International Aviation (International Bunkers) (1)							
1.A.3.a.ii - Domestic Aviation				-	-	-	-
1.A.3.b - Road Transportation	222.36	0.09	0.01	-	-	-	-
1.A.3.b.i - Cars				-	-	-	-
1.A.3.b.i.1 - Passenger cars with 3-way 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 (3)	-			-	-	-	-
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	12.73	6.33	0.06	0.15	148.12	22.36	-
1.A.4.a - Commercial/Institutional	0.42	0.28	0.00	0.09	0.59	0.31	-
1.A.4.b - Residential	5.10	6.05	0.06	0.06	147.53	22.05	-
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	7.22	0.00	0.00	-	-	-	-
1.A.4.c.i - Stationary				-	-	-	-
1.A.4.c.ii - Off-road Vehicles and Other Machinery				-	-	-	-
1.A.4.c.iii - Fishing (mobile combustion)	7.22	0.00	0.00	-	-	-	-
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	-	-		-	-	-	-
1.B.1 - Solid Fuels	-	-		-	-	-	-
1.B.1.a - Coal mining and handling	-	-		-	-	-	-
1.B.1.a.i - Underground mines	-	-		-	-	-	-
1.B.1.a.i.1 - Mining	-	-		-	-	-	-
1.B.1.a.i.2 - Post-mining seam gas emissions	-	-		-	-	-	-
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	-	-		-	-	-	-
1.B.1.a.ii - Surface mines	-	-		-	-	-	-
1.B.1.a.ii.1 - Mining	-	-		-	-	-	-
1.B.1.a.ii.2 - Post-mining seam gas emissions	-	-		-	-	-	-
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	-			-	-	-	-
1.C.1 - Transport of CO2	-			-	-	-	-
1.C.1.a - Pipelines	-			-	-	-	-
1.C.1.b - Ships	-			-	-	-	-
1.C.1.c - Other (please specify)	-			-	-	-	-
1.C.2 - Injection and Storage	-			-	-	-	-
1.C.2.a - Injection	-			-	-	-	-
1.C.2.b - Storage	-			-	-	-	-
1.C.3 - Other	-			-	-	-	-

2.12.2 Industrial Processes and Product Use Sector

2.12.2.1 Description of the IPPU sector

A wide variety of industrial activities produce GHG emissions. The emissions arise mainly from industrial processes during the chemical or physical transformation of materials (for example, in the blast furnace in the iron and steel industry, ammonia and other chemical products manufactured from fossil fuels used as chemical feedstock and the cement industry are notable examples of industrial processes that release a significant amount of CO_2). During these processes, many different greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), can be produced; (2006 IPCC Guidelines V3_1, Ch 1). Other gases are also emitted in different subcategories including SF_6 and NMVOC.

Emissions under Metal industry(2C) (Iron and Steel), Non-energy products from fuel and solvent use (2D) (Lubricant use) and Product Use as Substitutes for Ozone Depleting Substances (2F) (Refrigeration and Stationary Air Conditioning) have been covered in this inventory. The rest of the activities under IPPU is either not applicable or not estimated. Four source categories were not estimated because of locked of data, namely lime production under mineral industry, ammonia and nitric acid production under chemical industry, ferroalloys, aluminium, lead and zinc production under metal industry, and paraffin wax use under non-energy products from fuel and solvents use.

2.12.2.2 Methods

The method adopted is from the 2006 IPCC Guidelines at the Tier 1 level due to unavailability of reliable information on the technologies used in the production processes. Four GHGs CO_2, CH_4 N_2O and HFC were estimated as per the 2006 IPCC software.

2.12.2.3 Activity Data

Activity data for the IPPU sector were obtained from the Central Bank of Liberia based on data generated by the Ministry of Commerce.

2.12.2.4 Emission Factors

In the absence of information on technology use, all EFs that could use were IPCC defaults, with those giving the highest emissions adopted as per Good Practice. When the choice was linked to the country development, the factor attached to developing countries was adopted. The EFs used for the different source categories are listed in Table 26.

Table 25: Emission Factors for the IPPU sector

Category	IPCC Guideline volume	Table and page
Liming	N/A	N/A
Ammonia	N/A	N/A
Nitric acid	N/A	N/A

Iron and steel	V3_4_Ch4 Metal Industry	Table 4.1	Page 4.25
Ferroalloys	N/A	N/A	
Aluminium	N/A	N/A	
Lead	N/A	N/A	
Zinc	V3_4_Ch4 Metal Industry	Table 4.24 Page 4.80	
Lubricant	V3_5_Ch5 Non-Energy Products	Table 5.2 Page 5.9	
Paraffin wax	V3_5_Ch5 Non-Energy Products	Chapter 5.3.2.2 Page 5.12	
Refrigeration and Stationary Air Conditioning			

2.12.2.5 IPPU Results

The total emissions for the IPPU sector stood at 558 $GgCO_2e$ representing 48% drop compared to the 2015 emissions of 1,067.63 $GgCO_2e$ (Table 26). Emissions from all the IPPU categories recorded a downward trend except for Product Uses as Substitutes for Ozone Depleting Substances that saw the most increment of 123% over the same period to the rising consumption of HFC in cooling activities. The highest decrease was observed in the non-energy products from fuels and solvent use category due to the reduction in lubricant use in Liberia.

Table 26: IPPU total emission trends and by gases

	Emissions (Gg CO_2e)									Change (%)	Share (%)
	2015			2016			2017				
Industrial	CO_2	HFC	Total	CO_2	HFC	Total	CO_2	HFC	Total	2015-2017	2017
Processes and Product Use	**1,066.31**	**1.31**	**1,067.63**	**995.62**	**2.31**	**997.93**	**552.43**	**5.87**	**558.30**	-48%	100 %
Mineral Industry	-	-	-	-	-	-	-	-	-	-	-
Chemical Industry	-	-	-	-	-	-	-	-	-	-	-
Metal Industry	55.31	-	55.31	65.05	-	65.05	49.21	-	49.21	-11%	9%
Non-Energy Products from Fuels and Solvent Use	1,011.00	-	1,011.00	930.57	-	930.57	503.23	-	503.23	-50%	90%
Electronics Industry	-	-	-	-	-	-	-	2.93	2.93		1%
Product Uses as Substitutes for Ozone Depleting Substances	-	1.31	1.31	-	2.31	2.31	-	2.93	2.93	123%	1%
Other Product Manufacture and Use	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-

In terms of emission sources within the IPPU sector, the non-energy products from fuels and solvent use category contributed most of the emission throughout the time series. In 2017, 90% of the IPPU came from the non-energy products from fuels and solvent use. The remaining emission, metal industry emissions made up 9% of the total IPPU whereas 1% was from Product Uses as Substitutes for Ozone Depleting Substances. When it comes to gases, CO_2 consistently dominate (about 98.9% in 2017) with the rest being HFC emissions (Table 27).

Table 27: IPPU Emissions for the year 2017

Categories	(Gg)			CO_2 Equivalents (Gg)		
	CO_2	CH_4	N_2O	HFCs	PFCs	SF6
2 - Industrial Processes and Product Use	552.43	-	-	2.93	-	-
2.A - Mineral Industry	-	-	-	-	-	-
2.A.1 - Cement production	-					
2.A.2 - Lime production	-					
2.A.3 - Glass Production	-					
2.A.4 - Other Process Uses of Carbonates	-	-	-	-	-	-
2.A.4.a - Ceramics	-					
2.A.4.b - Other Uses of Soda Ash	-					
2.A.4.c - Non-Metallurgical Magnesia Production	-					
2.A.4.d - Other (please specify)	-					
2.A.5 - Other (please specify)						
2.B - Chemical Industry	-	-	-	-	-	-
2.B.1 - Ammonia Production	-					
2.B.2 - Nitric Acid Production			-			
2.B.3 - Adipic Acid Production			-			
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			-			
2.B.5 - Carbide Production	-	-				
2.B.6 - Titanium Dioxide Production	-					
2.B.7 - Soda Ash Production	-					
2.B.8 - Petrochemical and Carbon Black Production	-	-	-	-	-	-
2.B.8.a - Methanol	-	-				
2.B.8.b - Ethylene	-	-				
2.B.8.c - Ethylene Dichloride and Vinyl Chloride Monomer	-	-				
2.B.8.d - Ethylene Oxide	-	-				
2.B.8.e - Acrylonitrile	-	-				
2.B.8.f - Carbon Black	-	-				
2.B.9 - Fluorochemical Production	-	-	-	-	-	-
2.B.9.a - By-product emissions				-		
2.B.9.b - Fugitive Emissions						
2.B.10 - Other (Please specify)						
2.C - Metal Industry	49.21	-	-	-	-	-
2.C.1 - Iron and Steel Production	49.21	-				
2.C.2 - Ferroalloys Production	-	-				

2.C.3 - Aluminium production	-				-	
2.C.4 - Magnesium production	-					-
2.C.5 - Lead Production	-					
2.C.6 - Zinc Production	-					
2.C.7 - Other (please specify)						
2.D - Non-Energy Products from Fuels and Solvent Use	503.23	-	-	-	-	-
2.D.1 - Lubricant Use	503.23					
2.D.2 - Paraffin Wax Use	-					
2.D.3 - Solvent Use						
2.D.4 - Other (please specify)						
2.E - Electronics Industry	-	-	-	-	-	-
2.E.1 - Integrated Circuit or Semiconductor				-	-	-
2.E.2 - TFT Flat Panel Display					-	-
2.E.3 - Photovoltaics					-	
2.E.4 - Heat Transfer Fluid					-	
2.E.5 - Other (please specify)						
2.F - Product Uses as Substitutes for Ozone Depleting Substances	-	-	-	2.93	-	-
2.F.1 - Refrigeration and Air Conditioning	-	-	-	2.93	-	-
2.F.1.a - Refrigeration and Stationary Air Conditioning				2.93		
2.F.1.b - Mobile Air Conditioning				-		
2.F.2 - Foam Blowing Agents				-		
2.F.3 - Fire Protection				-	-	
2.F.4 - Aerosols				-		
2.F.5 - Solvents				-	-	
2.F.6 - Other Applications (please specify)				-	-	
2.G - Other Product Manufacture and Use	-	-	-	-	-	-
2.G.1 - Electrical Equipment	-	-	-	-	-	-
2.G.1.a - Manufacture of Electrical Equipment					-	-
2.G.1.b - Use of Electrical Equipment					-	-
2.G.1.c - Disposal of Electrical Equipment					-	-
2.G.2 - SF6 and PFCs from Other Product Uses	-	-	-	-	-	-
2.G.2.a - Military Applications					-	-
2.G.2.b - Accelerators					-	-
2.G.2.c - Other (please specify)					-	-
2.G.3 - N2O from Product Uses	-	-	-	-	-	-
2.G.3.a - Medical Applications			-			
2.G.3.b - Propellant for pressure and aerosol products			-			
2.G.3.c - Other (Please specify)			-			
2.G.4 - Other (Please specify)						
2.H - Other	-	-	-	-	-	-
2.H.1 - Pulp and Paper Industry						
2.H.2 - Food and Beverages Industry						

2.H.3 - Other (please specify)						

2.12. 3 Agriculture, Forest, and Other Land Use Sector

2.12.3.1 Description of the AFOLU Sector

The AFOLU sector includes four categories, and except for Harvested Wood products, the remaining three have been covered in this inventory. These are: (a) Livestock (3A), (b) Land (3B) and (c) Aggregate sources and non-CO_2 emissions sources on land 3C). Not all activity areas falling under these categories were inventoried due to the lack of some data sources of the country. For instance, under the Land category, forestland, cropland, and grassland were covered. Table 8 gives an overview of the coverage of inventory, including AFOLU. Tier 1 methodology was applied throughout the sector. Most of the activity data were obtained from the FAO, ITTO and REDD+ Forest Reference Level. Liberia used default factors from the 2006 IPCC guidelines. The country is still developing country-specific emission factors. The methodologies are based on the 2006 IPCC Guidelines, and the 2006 IPCC software was used to estimate emissions and removals.

2.12.3.1.1 Livestock

In this inventory, methane emissions from enteric fermentation and management were computed with tier 1 methodology. The tier 1 method requires inputs data on the number of heads of animals and the relevant default factors to calculate the emissions. The animals include cattle, goat, sheep, swine, and poultry. All the cattle were classified as other cattle since there no data for grouping dairy cattle or lactating cattle. For enteric methane, disaggregated data on the head of animals by sex, weight and feeding system were not available, that is why Liberia resorted to using the bulk figures on livestock. Regarding the manure system, Liberia used expert judgement to categorise manure according to the different management system (Table 28).

Table 28: Fraction of manure management system

Animals	The fraction of Manure management systems					
	Pasture/Paddock/Range	Dry lot	Daily spread	Cattle and Swine deep bedding	Poultry w/o litter	Poultry w/ litter
Cattle	0.4	0.3	0.3	0.1	-	-
Goat	0.4	0.3	0.3	0.1	-	-
Sheep	0.4	0.3	0.3	0.1	-	-
Pigs	0.4	0.3	0.3	0.1	-	-
Poultry	-	0.2	-	-	0.8	-

Activity data for Livestock

The activity for estimating the emissions under enteric fermentation and manure management were obtained from FAO and Liberia's Ministry of Agriculture. The total number of animals has increased by 11% between 2015 and 2017. All the animals

rose in numbers, but Goat and Poultry grew the most by 16% and 13% respectively. The growth in the animals contributed to the increasing livestock emissions.

Table 29: Heads of animals in Liberia for 2015-2017

Year	Heads of Animals (No)					
	Cattle	Goat	Sheep	Pigs	Poultry	Total
2015	44,114	345,698	276,406	287,380	7,673	961,271
2016	43,464	385,546	295,709	345,260	8,383	1,078,362
2017	44,223	400,016	303,081	307,546	8,667	1,063,533

Emission factors for Livestock

Table 30 presents the default factors used in the livestock inventory.

Table 30: Overview of emission factors for the livestock category

Animals	Source		Table
Enteric Fermentation			
Sheep	Volume 4: Agriculture, Forestry and Other Land Use	Enteric fermentation emission factors for tier 1 method	Table 10.10
Goat			
Swine			
Goat			
Other cattle		Tier 1 enteric fermentation emission factors for cattle	Table 10.10
Manure management			
Sheep	Volume 4: Agriculture, Forestry and Other Land Use	CH_4 emission factor by average annual temperature (°C)	Table 10.15
Goat			

2.12.3.1.2 Land

Emissions or removals from the land category is determined by the extent of changes in the prevailing land-use types for a defined period. It is calculated based on the net changes in the areas of the land use types and carbon stocks. Liberia has presented emissions for the land category covering forestland, cropland and grassland. Due to lack of data on area representations and carbon stocks for wetland, settlement and other lands, their emission/removals have not been reported.

Description of the methods for the land category

The land category covers emissions and removals within the six IPCC land classes and between the classes when there is a change in land use within the inventory year. All lands within the Liberian territory has been treated in this inventory as managed land and thus accounted for in the compilation of emissions and removals. Land use data on forestland, cropland and grassland were obtained from FAOSTATS and crosschecked with the figures in Liberia's FRA 2020 and the REDD+ FRL to the UNFCCC. The estimation of the emissions by source and removals by the sink for the land category has been done based on the 2006 IPCC Guidelines and adopted for the computation at Tier 1, was the Gain-Loss method, following the criteria established in

IPCC 2006, Vol. 4, Chapters 2, 4, 5 and 6. The Gain-Loss method requires the biomass carbon loss to be subtracted from the biomass carbon gain. The annual change in carbon stocks in biomass can be estimated using the gain-loss method, where the annual increase in carbon stocks due to biomass growth and annual decrease in carbon stocks due to biomass losses are estimated using the 2006 IPCC software.

In estimating the emissions and removals due to changes in biomass, dead organic matter and soil organic carbon on Forest Land (exclude Land Converted to Forest Land) Liberia applied the Gain-Loss method for Tier 1. The annual change in carbon stocks in biomass was estimated using the gain-loss method, where the annual increase in carbon stocks due to biomass growth and annual decrease in carbon stocks due to biomass losses are estimated. Since there is no available data on land converted to forest land, it is assumed that all managed forest land belongs to the category Forest Land Remaining Forest Land (IPCC, 2007). Emissions data from cropland are currently limited to emissions from cropland remaining cropland and cropland organic soils. Emissions from grassland were from grassland organic soils, and forestland converted to forestland. They are associated with carbon losses from drained histosols under grassland. IPCC Tier 1 method is well organized for grassland organic soils.

Activity Data for the land category

The activity data used for the land category is summarized in Table 31. The areas for the three land-use types (forestland cropland and grassland) were obtained from FAOSTAT, FRA 2020 and Liberia's REDD+ FRL submitted to the UNFCCC. The data based on maps produced by FAO, FDA GIS department and MetroGeoville maps produced for 2015 to 2017.

Table 31: Land representations for 2015 to 2017 in Land

Parameters	2015	2016	2017
	ha		
Country area	11,137,000	11,137,000	11,137,000
Forest land	7,768,740	7,738,480	7,708,220
Naturally regenerating forest	7,746,020	7,714,900	7,683,780
Planted Forest	22,720	23,580	24,440
Cropland	700,000	700,000	700,000
Arable land	500,000	500,000	500,000
Land under permanent crops	200,000	200,000	200,000
Grassland	1,163,260	1,193,520	1,223,780
Land under permanent meadows and pastures	1163260	1,193,520	1,223,780
Inland waters	1,505,000	1,505,000	1,505,000

Source: FAO

2.12.3.1.3 Aggregated sources and non-CO_2 emission on Land

Due to the lack of requisite data, methane emission from only rice cultivation have been covered under this category. The activity data on rice cultivation and the management system were obtained from Liberia's Ministry of Agriculture (Table 32).

Table 32: Activity data on rice cultivation and management

Years	Area cultivated (ha)	upland	Rainfall swamp	Irrigated swamp
		85%	12%	3%
2015	251,253	213,565.05	30,150.36	7,537.59
2016	312,314	265,466.90	37,477.68	9,369.42
2017	233,590	198,551.50	28,030.80	7,007.70

2.12.3.1 AFOLU Sector Emission Results

In 2017, the AFOLU sector recorded a total of 4,014.05 $GgCO_2e$ of greenhouse gas emissions. AFOLU emissions are the leading source for Liberia. The 2017 emissions show a 30.8% increase compared to the 2015 levels. The emissions for 3A and 3B increased by 8.8% and 32.5% respectively over the same period. On the other hand, 3C emission declined by 7.2% over 2015-2017 (Table 33).

Table 33: Emission trends for the AFOLU sector

Parameters	Emissions ($GgCO_2e$)			Change (%)	Share (%)
	2015	2016	2017	2015-2017	2017
Agriculture, Forestry, and Other Land Use	**3,069.62**	**3,711.72**	**4,014.05**	**30.8**	**100**
Livestock (3A)	159.23	173.22	173.29	8.8	4
Land (3B)	2,872.59	3,491.67	3,805.69	32.5	95
Aggregate sources and non-CO_2 emissions sources on land (3C)	37.80	46.83	35.07	-7.2	1

The land category contributed 95% of the total AFOLU emissions. The emission trends were driven by the forest conversion to grassland at the 30, 260ha annually. Within the land category, whiles forestland and cropland are net sinks; grassland is a net source of CO_2 emissions (Table 34). The high annual forest growth in the forestland remaining forestland contributed greatly to making the forestland a net sink. It also a reflection of the effectiveness of Liberia forest protection policies. Liberia has a vast forest area in West Africa, and the proper management of the forest contribute to enhancing the sink capacities of the country. Grassland-instigated deforestation makes it the main source of emission in the land category. The grassland emissions were associated with the annual 30,260ha deforestation in Liberia (Table 34).

Table 34: Summary table for the AFOLU sector Emission in 2017

Categories	(Gg)		
	Net CO_2 emissions / removal	Emissions	
		CH_4	N_2O

3 - Agriculture, Forestry, and Other Land Use	3,805.69	6.08	0.15
3.A - Livestock	-	6.00	0.15
3.A.1 - Enteric Fermentation	-	5.19	-
3.A.1.a - Cattle	-	1.37	-
3.A.1.a.i - Dairy Cows		-	
3.A.1.a.ii - Other Cattle		1.37	
3.A.1.b - Buffalo		-	
3.A.1.c - Sheep		1.52	
3.A.1.d - Goats		2.00	
3.A.1.e - Camels		-	
3.A.1.f - Horses		-	
3.A.1.g - Mules and Asses		-	
3.A.1.h - Swine		0.31	
3.A.1.j - Other (please specify)		-	
3.A.2 - Manure Management	-	0.81	0.15
3.A.2.a - Cattle	-	0.04	0.02
3.A.2.a.i - Dairy cows		-	-
3.A.2.a.ii - Other cattle		0.04	0.02
3.A.2.b - Buffalo		-	-
3.A.2.c - Sheep		0.06	0.03
3.A.2.d - Goats		0.09	0.06
3.A.2.e - Camels		-	-
3.A.2.f - Horses		-	-
3.A.2.g - Mules and Asses		-	-
3.A.2.h - Swine		0.62	0.04
3.A.2.i - Poultry		0.00	0.00
3.A.2.j - Other (please specify)		-	-
3.B - Land	3,805.69	-	-
3.B.1 - Forest land	(3,161.34)	-	-
3.B.1.a - Forest land Remaining Forest land	(3,161.34)		
3.B.1.b - Land Converted to Forest land	-	-	-
3.B.1.b.i - Cropland converted to Forest Land	-		
3.B.1.b.ii - Grassland converted to Forest Land	-		
3.B.1.b.iii - Wetlands converted to Forest Land	-		
3.B.1.b.iv - Settlements converted to Forest Land	-		
3.B.1.b.v - Other Land converted to Forest Land	-		
3.B.2 - Cropland	(0.02)	-	-
3.B.2.a - Cropland Remaining Cropland	(0.02)		
3.B.2.b - Land Converted to Cropland	-	-	-
3.B.2.b.i - Forest Land converted to Cropland	-		
3.B.2.b.ii - Grassland converted to Cropland	-		
3.B.2.b.iii - Wetlands converted to Cropland	-		
3.B.2.b.iv - Settlements converted to Cropland	-		
3.B.2.b.v - Other Land converted to Cropland	-		
3.B.3 - Grassland	6,967.05	-	-
3.B.3.a - Grassland Remaining Grassland	-		
3.B.3.b - Land Converted to Grassland	6,967.05	-	-
3.B.3.b.i - Forest Land converted to Grassland	6,967.05		
3.B.3.b.ii - Cropland converted to Grassland	-		
3.B.3.b.iii - Wetlands converted to Grassland	-		

3.B.3.b.iv - Settlements converted to Grassland	-		
3.B.3.b.v - Other Land converted to Grassland	-		
3.B.4 - Wetlands	-	-	-
3.B.4.a - Wetlands Remaining Wetlands	-	-	-
3.B.4.a.i - Peatlands remaining peatlands	-		-
3.B.4.a.ii - Flooded land remaining flooded land			
3.B.4.b - Land Converted to Wetlands	-	-	-
3.B.4.b.i - Land converted for peat extraction			-
3.B.4.b.ii - Land converted to flooded land	-		
3.B.4.b.iii - Land converted to other wetlands			
3.B.5 - Settlements	-	-	-
3.B.5.a - Settlements Remaining Settlements	-		
3.B.5.b - Land Converted to Settlements	-	-	-
3.B.5.b.i - Forest Land converted to Settlements	-		
3.B.5.b.ii - Cropland converted to Settlements	-		
3.B.5.b.iii - Grassland converted to Settlements	-		
3.B.5.b.iv - Wetlands converted to Settlements	-		
3.B.5.b.v - Other Land converted to Settlements	-		
3.B.6 - Other Land	-	-	-
3.B.6.a - Other land Remaining Other land			
3.B.6.b - Land Converted to Other land	-	-	-
3.B.6.b.i - Forest Land converted to Other Land	-		
3.B.6.b.ii - Cropland converted to Other Land	-		
3.B.6.b.iii - Grassland converted to Other Land	-		
3.B.6.b.iv - Wetlands converted to Other Land	-		
3.B.6.b.v - Settlements converted to Other Land	-		
3.C - Aggregate sources and non-CO_2 emissions sources on land	-	-	-
3.C.1 - Emissions from biomass burning	-	-	-
3.C.1.a - Biomass burning in forest lands		-	-
3.C.1.b - Biomass burning in croplands		-	-
3.C.1.c - Biomass burning in grasslands		-	-
3.C.1.d - Biomass burning in all other land		-	-
3.C.2 - Liming	-		
3.C.3 - Urea application	-		
3.C.4 - Direct N2O Emissions from managed soils			-
3.C.5 - Indirect N2O Emissions from managed soils			-
3.C.6 - Indirect N2O Emissions from manure management			-
3.C.7 - Rice cultivation		0.08	
3.C.8 - Other (please specify)			
3.D - Other	-	-	-
3.D.1 - Harvested Wood Products	-		
3.D.2 - Other (please specify)			

In 2017, livestock account for 4% of the total AFOLU sector emission, of which 86.5% came from enteric fermentation and whiles the remaining 13.5% were from manure management. Sheep and Goat contribute most to the enteric methane emissions.

2.13. 4 Waste Sector

2.13.4.1 Description of sector

Solid waste is generated by domestic, industrial, commercial, and agricultural activities whereas wastewater is generated mostly through domestic, industrial, and commercial activities. As in other countries, waste generation is directly related to population growth, the industrialization rate and the urbanization trend, the latter being an important impacting factor. Greenhouse gas emission in the waste sector is also affected by the type of disposal mechanisms as well as the level of management exercised. In this inventory, the waste source categories covered included only those listed below as no data was available on waste incineration while biological treatment of solid waste.

4. A.3 – Solid Waste Disposal Sites
4. C.2 - Open Burning of Waste
4. D.1 - Domestic Wastewater Treatment and Discharge
4. D.2 - Industrial Wastewater Treatment and Discharge

According to the MCC 2016 report and (LISGIS 2014 Population and Housing Census), only 10.8% had their garbage collected in the country of the solid waste of the country disposed of through burning, 37.2 % is regularly collected, 19.8 % is disposed of in rubbish pits or dumped on the roadside while the remaining 1.4%.
The solid waste from 30% of urban households is collected regularly while two-thirds of rural households burn their waste. A regular waste collection service is provided to only about 5 % of rural households. There is one landfill site in the country, which is in the Paynesville region for the disposal of general and hazardous waste generated within the City of Paynesville area of jurisdiction, and some other smaller disposal site in the region around Montserrado County which receive waste from Monrovia and its environment. The remaining collected solid waste is disposed of in open dumpsites. At the country level, a notable fact is that 48.6 % of the population does not have any toilet facility. All regions confounded, 36.5 % of the population is connected to a sewer system, 3% dispose of wastewater via septic tanks/ cesspool systems and 9.3 % use pit latrines. Industrial wastewater of relevance to greenhouse gas emissions originates mainly from such activities as fish processing, slaughterhouses, meat conditioning, tanneries and breweries. Because of unavailable data, only the beverage sector is covered in this inventory.

Methodology

The waste sector GHG emissions were estimated following a Tier 1 methodological approach as per the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and compiled using the 2006 IPCC software. Development trends show a clear urbanization trend, and the rate doubled over the decade 2015 to 2017 compared to the previous decade (urban population: 2015=22.7 %, 2016= 32.5 %, 2017= 43.0%), and with this, the amount of waste generated is increasing at higher rates. However, the management of wastes has not been following the same pace as evidenced by the fact that such aspects as waste to energy and recycling are still relatively not available in the country.

Activity Data

Solid waste disposal

Data on solid waste disposal was obtained from the population of the people whose waste are managed in Liberia. The solid waste of most of the people living cities in Liberia is collected and disposed of to different final disposal sites. Estimates of solid waste generation for rural regions for 2015 - 2017 were subsequently worked out by discounting solid wastes which are typically generated by urban dwellers from the landfills if data were available on waste characterization. These solid waste generation potentials were also compared with those in the 2006 IPCC Guidelines (Volume 5: Waste, Page 2.5, and Table 2.1).

Using the 2015 baseline, population census data (interpolated for non-census years) and adjusted for socioeconomic factors, estimates for a solid waste generation were not made for the period 2015 to 2017. The process of calculating solid waste generation was not straightforward because of the lack of data. Furthermore, no official data was available on waste categorization, which would have enabled a more accurate calculation of GHG emissions. The fraction of solid waste which is openly burnt was calculated by multiplying the total solid waste estimated by the percentage of the population whose wastes are so treated as evidenced by the MCC 2015 statistics. The amount of sludge generated per capita for 2015 was estimated using that year's data for Paynesville and Monrovia Cities Council. The amount of sludge was generated for the period 2015 to 2017 the quantity of sludge and urban population.

Domestic and industrial wastewater

The actual amount of domestic wastewater generated was not available at the country level. However, the different types and usage levels of treatment or discharge as per the MCC 2015 census report were used as well as the respective 2006 IPCC Guidelines (Vol 5.3 Ch 3 Table 3.1). Exploitable data on industrial wastewater production were available only for the beverage industry sector. The total meat industry product and the amount of wastewater as provided by local authorities were used in conjunction with the respective 2006 IPCC Guidelines (Vol 5.3 Ch 3 Table 3.1) defaults for calculation of emissions.

Emission factors

In the absence of country-specific emission factors, the default values provided within the 2006 IPCC software, and 2006 IPCC Guidelines (Vol 5.3 Ch 3 Table 3.3) were used for estimating GHG emissions.

2.13.4.2 Emission results for the Waste sector

Table 35 presents the overall emission results for the waste sector. The total emissions for the waste sector amounted to 396.26 $GgCO_2e$ and represented a 15% reduction compared to the 2015 emissions. In the same vein, the emissions for all the categories under the waste sector recorded a downward trend. Emissions from 4D

saw the highest decrease of 23% while the emission for 4A and 4C went down by 7% each over the same period. In terms of category contributions, 4A contributed the most (57%) of the total waste sector emissions in 2017 (Table 35) and followed by 4D.

Table 35: Waste sector emissions trends for 2015-2017

Parameters	Emissions ($GgCO_2e$)			Change (%)	Share (%)
	2015	2016	2017	2015-2017	2017
4 - Waste	463.86	410.08	396.26	-15%	100%
4.A - Solid Waste Disposal	241.42	233.59	225.69	-7	57
4.B - Biological Treatment of Solid Waste	-	-	-	-	-
4.C - Incineration and Open Burning of Waste	0.05	0.04	0.04	-7	-
4.D - Wastewater Treatment and Discharge	222.39	176.45	170.53	-23	43

For wastewater emissions, domestic wastewater treatment and discharge is the main source of emissions. Industrial wastewater contributed a meagre amount of the total waste sector emissions (Table 36)

Table 36: Emission from the waste sector categories in 2017

Categories	Emissions [Gg]		
	CO_2	CH_4	N_2O
4 - Waste	0.05	21.92	0.01
4.A - Solid Waste Disposal	-	11.50	-
4.A.1 - Managed Waste Disposal Sites			
4.A.2 - Unmanaged Waste Disposal Sites			
4.A.3 - Uncategorised Waste Disposal Sites			
4.B - Biological Treatment of Solid Waste		-	-
4.C - Incineration and Open Burning of Waste	0.05	-	-
4.C.1 - Waste Incineration	-	-	-
4.C.2 - Open Burning of Waste	0.05	-	-
4.D - Wastewater Treatment and Discharge	-	10.42	0.01
4.D.1 - Domestic Waste waster Treatment and Discharge		10.40	0.01
4.D.2 - Industrial Wastewater Treatment and Discharge		0.02	
4.E - Other (please specify)			

Chapter 3: Mitigation actions and their effects

3.1 Overview of Liberia's mitigation actions

Climate change mitigation actions in Liberia are mostly contained in national laws and policies, action plans and projects, primarily in the Energy and Forestry sectors. Mitigation actions are less common in the Agriculture, Transport and waste sectors. Therefore, the energy and the forestry sectors have made more advances than the other sectors as far as mitigation actions are concerned. The forestry sector could explore traditional conservation method to increase forest conservation like the traditional sacred forest. In the energy sector, Liberia has increased its clean energy production with increasing hydropower and solar power generation. This increment saves annually about 772.48 $GgCO_2e$ per year from being emitted in the atmosphere. The forestry sector, besides, sequesters annually 12,305.45 $GgCO_2e$ more carbons and reduce emissions. Liberia could have more prospect in mitigation in the energy and forestry sectors if policies and action plans are supported and implemented across the nation. The inclusion of local/traditional practices and community participation in forestland management and restoration could further boost climate change mitigations in the forest sector, mostly the REDD+ program.

3.2 Methodology for the assessment of mitigation actions and their effects

The data collection process begins with desk review involving the bibliography reviews of existing national policy, law and action plans adopted by the national government. It encompasses projects with climate change and sustainable development objectives. Data collection form was developed to facilitate information collection from key informants at ministries and agencies. The data collection teams were trained in a 2-day hands-on workshop on data collection method and climate change mitigation. The LEAP software, Version: 2018.0.1.22 and Microsoft excel module were used for the calculation and estimation of mitigation scenarios and avoided emissions.

3.3. Climate change mitigation actions per sectors

3.3.1 Energy sector mitigation actions

Seven domestic mitigation actions were identified in the energy sector. Three of these actions are national law/policy and four project-based actions (Table 37).

Table 37: Mitigation actions in the energy sector

Mitigation Actions	Descriptions	Types
Liberia National Energy Policy – An agenda for action and economic and social development (2009)	The principal objective of the National Energy Policy is to ensure universal access to modern energy services in an affordable, sustainable, and environmentally friendly manner to foster the economic, political, and social development of Liberia.	Law/ policy
National Renewable Energy Action Plan (NREAP) of Liberia (2015)	The NREAP focuses on the use of renewable energy such as solar water heating, biofuels, cooking fuels, technologies. It aims to achieve the following targets by 2030: - 100% of population access electricity with renewable energy contributes about 95% in the electricity mix,	Law/ policy

	- 49% of households use modem cooking devices by 2020, 72% by 2025 and 95% by 2030	
Rural energy strategy and Master plan for Liberia until 2030 (RESMP)(2016)	By 2030, RESMP to: - Electrification rate for rural population outside Monrovia to reach 35% - More than 75% of all electricity generated from renewable energy with 19% coming from other than large hydro: Mini-hydro, Solar and Biomass. - Universal access to affordable solar lamps, efficient appliances and cookstoves. - Cooking gas available in all county capitals and efficiently produced charcoal widespread across the country The Master Plan identifies 92 projects and investments to electrify 265 000 homes and 1.34M people outside Monrovia until 2030.	Law/ policy
Liberia Rural renewable energy sector projects (LRRESP)	The LRRESPs are collections of government, private, community and donor projects on renewable energy in Lofa, Nimba, Bong, Sinoe, Montserrado and Margibi counties with the total production of 15.8 MW	Project
Mount Coffee Hydropower Project (MCHP) (December 2016)	The MCHP increases access to electricity and fosters the use of renewable energy sources by providing 88MW to the nation's energy use.	Project
Firestone hydroelectricity power station (1942)	The Firestone Hydroelectricity power station was built in 1942 with the initial objective to supply power to the United States military facility during world war II and the city of Robertsfield. Currently, it supplies 4.8MW to the Firestone Rubber plantations and the city of Harbel in Margibi County.	Project
West African Power Pool (WAPP) – Cote d'Ivoire – Liberia – Sierra Lone – Guinea (CLSG) interconnection project – 2006	To increasing the share of renewable sources of electricity, mostly hydropower, and importing cheaper electricity from the regional market through the WAPP - CLSG line. Imported 27MW from Ivory coast through the WAPP-CLSG project	Project

3.3.2 Forestry sector mitigation actions

In the forest sector, there are three mitigation actions identified during the assessment of national mitigation actions. Table 38 presents an overview and status of the forestry mitigation actions.

Table 38: Forestry sector mitigation actions

Mitigation Actions	Descriptions	Types
National Forest Reform Law of 2006	The National Forestry Policy of Liberia aims to conserve (30% of the total forest of Liberia) and sustainably manage all forest areas. The forest management will continue to produce a complete range of goods and services for the benefit of all Liberians and contribute to poverty alleviation in the nation while maintaining environmental stability and fulfilling the country's commitments under international agreements and conventions.	Law/ policy
Liberia Forest sector Project - LFSP (2017)	The project development objective is improved management of, and increased benefit sharing in, targeted forest landscapes to: - Increase forest management and reduction in deforestation and forest degradation.	Project

	- Incorporate multiple interrelated interventions such as agriculture and land use planning at the landscape level and considering improvements in both ecosystems and livelihoods.	
Foya afforestation Project (FAP)	The FAP is a government project that aims to afforest the savanna landscape in the Foya District, Lofa County. More than 100 hectares. Currently, 100 acres (40.47 ha) have been planted, and planting is ongoing.	Project

3.3.3 Transports, Agriculture, Waste and Others

In the transport, agriculture, and waste sectors, it was a challenge for Liberia to identify mitigation actions, especially the transport sector as there was a total lack of access to data. The agricultural sector has the prospect of developing and or promoting climate change smart agricultural activities by shifting from upland farm to lowland farming and promoting the use of composite and or biofertilizer –organic farming. Information on smart agriculture in Liberia is common, but there is no data to quantify the extent to consider it as mitigation actions. Mitigation actions in the waste sector were not identified, but there is little information on waste collections and treatments to quantify any actions as mitigations. It has been reported that there are ongoing activities to transform waste into energy and biogas generation. Liberia could take the step to promote waste to energy and biogas generation as means for mitigations. It could contribute to the energy supply. However, the most leading mitigation option in the waste sector is recycling, and various cities could embark on it (Table 39).

Table 39: Potential mitigation actions in the waste and agriculture sectors

Mitigation Actions	Descriptions	Sector
Waste-to-energy and biogas project	Transform waste to energy through incineration of waste for energy production and mechanization for biogas generation	Waste
Climate change smart agriculture project	Shifting from highland farming to low land farming and the use of biofertilizer	Agriculture

Cross-sectorial mitigation has bee reported to include Liberia's National policy and Response strategy on climate change cuts across all sectors and have identified mitigations in most of the sectors (Table 40).

Table 40: Cross-sectorial mitigation actions

Mitigation Actions	Descriptions	Types
National Policy and Response Strategy on Climate change – NPRSCC (2018)	The NPRSCC highlights the emission reduction in every sector with the use of clean and renewable energy. It includes concrete policy and measures in specific areas on climate change adaption and mitigation, action and resource mobilization plans and monitoring and evaluation framework	Law/ policy

3.3.4 Additional benefits from mitigation actions

It is recommended to utilize synergies and trade-offs between measures directed at non-climate goal and GHG mitigation. The assessment recognized the importance of traditional practice, such as the use of sacred forest across the country by elders and the Sande and Poro secret societies. There are numerous sacred forests in Liberia,

and a single sacred bush could range in 5-15 hectares of forestland. Traditional practices highly protect these areas, and no human-induced destruction of forest are common in or around these places. Only followers of these secret societies can visit. The Forestry Development Authority could work with elders to encourage more establishment of sacred forest/bush. Research is encouraged to map out sacred bushes in Liberia and quantify their acreage and numbers in Liberia. The promotion and protection of sacred forest would serve as domestic mitigation action and as well, as supports the conservation of forest resources and biodiversity in these areas with little or no cost.

3.3.5 Tabulation on National mitigation actions and their effects

In Liberia, key GHG emission categories include the Energy and AFOLU sectors (Tables 13 and 14). Significant scope exists for mitigation actions in these areas, namely development of Liberia high hydropower potential, solar and wind energy and conservation and sustainable management of Forestland. That is why Liberia's has committed to undertaking mitigation actions in its nationally determined contributions involving activities that will make the country to meet the targets given that the conditional components are supported. The measures include:

- Reducing greenhouse gas emissions by 10% by 2030.
- Improving energy efficiency by 20% by 2030.
- Raising the share of renewable energy to 30% of electricity production and 10% of overall energy consumption by 2030.
- Increasing the level of biofuels in transport fuel to 5% by 2015.
- Implementing a long-term strategy of making Liberia a carbon-neutral country by 2050

In the Energy and Forestry sectors, the mitigation actions have contributed to 20,075.96 Gg CO_2e of emission reduction year. The breakdown of the overall mitigation benefits is: (a) Energy sector: 774.18 $GgCO_2e/yr$. and (b) Forestry sector: 19,301.78 $GgCO_2e/yr$ (Table 41).

Table 41: Tabulation of the mitigation action and effects

Name of Action	Main objective	Description	Gas	Type	Status	Implementing entity	Progress indicators	Steps taken/envisaged	Methodologies/ assumptions	Achievements	Co- benefits	GHG reductions (Gg/year)
Liberia National Energy Policy – An agenda for action and economic and social development (LNEP)	To ensure universal access to modern energy services in an affordable, sustainable, and environmentally friendly manner to foster the economic, political, and social development of Liberia.	Ensure energy sector reforms for private sector investment in the energy supply, creates requisite institutional and legal framework and independent regulatory regime to ensure accessibility, quality assurance and affordability of energy for both urban and rural populations.	CO_2	Policy	Adopted in 2009	Ministry of Mines & Energy (MOME) Rural and Renewable Energy Agency (RREA) Energy Regulatory Board (ERB) Liberia Election Cooperation (LEC)	Developed and passed into law: The rehabilitation of the Mount Coffee hydropower plant. The engagement of the private sector for the provision of small renewable scale and utility-scale electricity generation plants. Investments for associated transmission and distribution.	Refer to objectives	N/A	Developed and implemented	To ensure effective coordination of national energy planning, programs and policy Implementation. To foster International co-operation in energy trade and projects development	N/A
National Policy and Response Strategy on Climate	The climate change policy and strategy document are prepared to	The NPRSCC includes concrete policy and measures in	$C0_2$, CH_4 N_20	Multi-sectoral	Adopted in August 2018	Environmental Protection Agency – Liberia	Comprehensive strategy, as well as a number of	Climate change mitigation & Adaptation efforts considered in	N/A	NPRSCC adopted and implemented	Sustainable development and Economic growth	N/A

Name of Action	Main objective	Description	Gas	Type	Status	Implementing entity	Progress indicators	Steps taken/envisaged	Methodologies/ assumptions	Achievements	Co- benefits	GHG reductions (Gg/year)
change (NPRSCC)	ensure that climate change adaptation and mitigation issues are mainstreamed at the policy level and in key sectorial and cross-sectorial development efforts.	specific areas on climate change adaption and mitigation, action and resource mobilization plans and monitoring and evaluation framework					specific policies adopted	policy Plans and initiatives. Comprehensive strategy and several specific policies adopted				
National Renewable Energy Action Plan (NREAP) of Liberia	Renewable energy, solar water heating, cooking fuels and technologies and biofuels. National planned targets & projections by 2030. Examination of present national energy policies, enabling legislation and regulatory environment and institutional frameworks.	By 2030: 100% of population access electricity; RE contribute about 95% in electricity mix, 49% of households use modern cooking devices by 2020, 72% by 2025 and 95% by 2030	CO_2	Policy	Approved	Rural and Renewable Energy Agency (RREA), Liberia Electricity Cooperation (LEC) and Ministry of Mines and Energy (MME)	Adopted the SE4ALL, National Energy efficiency action plan (NEEAP) and NREAP 2015. Signatory to the ECOWAS-RE&EE. The rehabilitation of the Mount Coffee hydropower plant.	See progress indicators		NREAP adopted 2015	Increase investment in the Renewable energy sub sector Security of energy supply Gender mainstreaming in the energy sector	N/A

Name of Action	Main objective	Description	Gas	Type	Status	Implementing entity	Progress indicators	Steps taken/envisaged	Methodologies/ assumptions	Achievements	Co- benefits	GHG reductions (Gg/year)
West African Power Pool (WAPP) – Cote d'ivoire – Liberia – Sierra Lone – Guinea (CLSG) interconnection project	To increase the share of renewable sources of electricity, mostly hydropower, and importing cheaper electricity from the regional market through the WAPP - CLSG line.	Imported 27MW from Ivory coast through the WAPP-CLSG project	CO_2	Regional electricity market access	signed	Liberia Electricity Cooperation (LEC)	Adopted WAAP in 2016. Investments for associated transmission and distribution	Adopted 2016	N/A	Implemented	- Provision of cheaper electricity	154.15
Liberia Rural Renewable Energy sector Projects (LRRESP)	The development objectives of Liberia Rural Renewable Energy are to increase access to electricity and to foster the use of renewable energy sources.	The LRRESPs is a collection of government, private, community and donor projects on renewable energy in Lofa, Nimba, Bong, Sinoe, Montserrado and Margibi counties.	CO_2	Fiscal incentives	Initiated and ongoing	Rural Renewable energy Agency of Liberia, PLAN & VOSIEDA, Mercy Corps.	Provides 15.8 MW of renewable energy for the rural population in Lofa, Bong, Nimba, Sinoe, Margibi and Montserrado counties	Development and installation of power of 15.8MW	LEAP Model was for computing the baseline and the project scenario impacts.	Implemented and ongoing	Provision of affordable electricity for the rural population	90.2
Mount Coffee Hydropower Project	To increase access to electricity and to foster the use of renewable energy sources.	Provision of 88 MW	CO_2	Technology project	completed	Ministry of Mines, LEC	Completed and operational since December 2015	Completed and operational since December 2015	LEAP Model was for computing the baseline and the project		Increase access to green electricity.	502.43

Name of Action	Main objective	Description	Gas	Type	Status	Implementing entity	Progress indicators	Steps taken/envisaged	Methodologies/ assumptions	Achievements	Co- benefits	GHG reductions (Gg/year)
									scenario impacts.		Forester the use of renewable energy.	
Firestone hydroelectricity power station	Supply of power to the Firestone Rubber plantation	4.8 MW	CO_2	Technology project	Completed	Firestone Rubber Plantation	Operational since 1942	Operational since 1942	N/A	Operational since 1942	Energy supply to the Firestone plantation	27.4
Rural energy strategy and Master plan for Liberia until 2030	Electrification rate for the rural population to reach 35% by 2030. More than 75% of all electricity generated from renewables by 2030 with 19% coming from other than large hydro: Mini-hydro, Solar and Biomass. Universal access to affordable solar lamps, efficient appliances and cookstoves. Cooking gas available in all	The Master Plan identifies 92 projects and investments to electrify 265, 000 homes and 1.34M people outside Monrovia until 2030.	CO_2, N_2O, CH_4	Policy	Signed and adopted 2016	Adopted 2016	Rural and Renewable Energy Agency	Adopted 2016	N/A	Implemented and ongoing	Rural electrification. Sustainable development	N/A

Name of Action	Main objective	Description	Gas	Type	Status	Implementing entity	Progress indicators	Steps taken/envisaged	Methodologies/ assumptions	Achievements	Co- benefits	GHG reductions (Gg/year)
	county capitals and efficiently produced charcoal widespread across the country											
National Forest Reform Law of 2006	The assurance of sustainable management of Liberia's forestland and conservation of forest resources (30% of Liberia forest land)	Conservation of 30% forest land. Sustainable forest management	CO_2	Regulation	Adopted 2006	Forestry development Authority	Increase number of Protected areas. Proposed protected areas. Sustainable forest management practices	Increase number of Protected areas. Proposed protected areas. Sustainable forest management practices	N/A	Adopted 2006	Sustainable forest management	12,305.2
Liberia Forest sector Project (LFSP)	The project development objective is improved management of, and increased benefit sharing in, targeted forest landscapes	Increase forest management and reduction in deforestation and forest degradation; Incorporate agriculture and land use planning at the landscape level and improve in both	CO_2	Governance	Launched March 14, 2017	Forestry Development Authority Ministry of Agriculture Liberia Institute of statistics and geo-information systems Environmental Protection Agency Ministry of Mines and Energy	Increase number of Protected areas. Proposed protected areas	Launched since March 14, 2017	N/A	Launched March 14, 2017	Poverty reduction and increased benefit sharing in forested landscapes	6,996.33

Name of Action	Main objective	Description	Gas	Type	Status	Implementing entity	Progress indicators	Steps taken/envisaged	Methodologies/ assumptions	Achievements	Co- benefits	GHG reductions (Gg/year)
		ecosystems and livelihoods.				Liberia Land Authority						
Foya afforestation Project (FAP)	To afforest the Foya savanna landscape	The FAP is a government project that aims to afforest the savanna landscape in the Foya District, Lofa County. More than 100 hectares. Currently, 100 acres (40.47 ha) have been planted, and planting is ongoing	CO_2	Investment	Operational since 2006	Forestry Development Authority	40.5 ha planted	Operational	N/A	40.5 ha planted with different tree species	Employment opportunity for community dwellers. Enhancement of carbon sinks.	0.23

Chapter 4: Constraints and Gaps, and Related Financial, Technical and Capacity Needs

4.1 Country context

In every country, more so in poor, vulnerable Least Developed Countries (LDCs) including Liberia, climate change should be viewed and implemented as a development issue in a development pathway. Hence, the United Nations Convention on Climate Change (UNFCCC) and its Kyoto Protocol (KP) is being implemented with sustainable development guiding all future activities and programs in Liberia.

Liberia being a party to the UNFCCC submitted its initial national communication to UNFCCC in 2013, in compliance with the provisions of the Articles 4.1, 4.2, and 12 of the Convention. The communication is in line with the decision 17 /CP.8 – the guidelines for the preparation of national communications from non-Annex 1 Parties to the convention. The EPA of Liberia executed the preparation of INC through a process of participation and consultation with various experts and technical teams from different institutions in Liberia.

The development of this Biennial Update Report (BUR-1) of the Republic of Liberia to the UNFCCC has not been easy and has met many challenges. A lot of data and information gaps exist.

4.2 Constraints and Gaps

Liberia faces challenges in the implementation of its climate change programmes and the regular preparation of the BUR. Chief among them is inadequate access to resources to meet prioritized financial, technical and capacity needs. The current levels of the GEF funding for the regular preparation of the BUR are not adequate to meet the full cost for compiling the report. So, Liberia is exploring other options, including considering GEF's medium-size proposal window to mobilize additional funding. Some of the identified financial constraints and gaps are as follows:

- **Inadequate funding in the national budget** – funding for climate change activities in the country is largely donor-driven and project-based. Domestic financing of climate change activities is difficult to estimate. This is because in the national budget, there is no clear differentiation of climate expenditure items, and this leads to challenges in tracking actual government expenditures on climate change.

- **Duplication of activities and funding** – weak institutional coordination within government and among donors, leads to avoid duplication of activities, and in most cases, resources are not directed to where they are needed most.

- **Insufficient transparency on non-financial support for training and technical assistance**– there are cases where Liberian institutions have received training and technical assistance support without much financial disclosure from the donor

because most of this support is tapped from global projects that might have different financial contributors. In such situations, reporting is constrained because the recipient countries do not have full access to the funding and accounting information.

- **Gaps in tracking capacity and technical assistance** - Most of the climate change activities take place at different levels, so it is difficult to track them. This means that information on capacity may not be complete to inform future capacity planning.

The major constraint lies in the lack of expertise for adequately and appropriately analyzing, developing, and costing mitigation and adaptation options and projects. There has been no development of national- and regional-specific emission factors with the ultimate objective of improving and updating the national GHG inventory by reducing uncertainties in the statistics. The institutional framework and technical expertise for the development of a comprehensive and integrated vulnerability (impacts and adaptation) assessment are limited. Sustained access to a reliable body of scientific and technical information does not exist. However, it should be noted that capacity building is not gained all at once but through a continuous, progressive, and iterative process. At the same time, adequate human and institutional capacity is a necessary condition for the implementation of the programmes.

Based on stakeholder consultations and the dialogue between agencies that participated in the development of this BUR-1, Table 43 lists the capacity building needs, which are considered urgent and immediate priorities for the Republic of Liberia. These issues and the efforts to tackle them will build on the limited national capacity developed over the years and on other capacity needs identified in preceding sections of this report.

Table 42: Capacity Building Needs

No	Activity	Requirement	Estimated Support Needs per Year in USD
1	Sectoral Working Groups	Need to be identified with the provision that changes will be made in the teams as and when necessary.	US$30,000 for each sector
2	National Climate Change Steering Committee	The Committee needs to be continuously engaged for it to guide the national GHG inventory making process in the country.	US$ 150,000 per year
3	GHG inventory Technical Advisory Committee	A technical advisory group should be led by a designated senior technical officer from EPA with members from the Central Agriculture Research Institute, Forestry Development Authority, any other as found suitable by EPA.	US$ 60,000 per year
4	Inventory Management Team	Needs to establish that manages the entire process of GHG inventory preparation within the EPA.	US$ 50,000.00 per year
5	Adopt Memorandum of Understand with relevant agencies	Need to be in place for ensuring continuity of access to data and availability of technicians/experts for inventory estimation.	EPA can ensure it is done

4.3 Assessment of Capacity Constraints for Priority Issues at the Various Levels

4.3.1 Capacity Constraints at the Systemic Level

At the systemic level, the limited or non-existent enabling environment is a constraint. Current global, regional, and national policies, strategies, and regulatory measures do not adequately consider climate change. Re-orientation and development of national policies and programs to take fully into account climate change as a sustainable development path should be initiated in the shortest possible time. What is needed are policies and measures to facilitate sustainable development strategies that make climate-sensitive sectors resilient to climate variability and change, and that allow development to proceed in a low- or carbon-neutral pathway. The policies should lead to reduced pressure on resources and enhance adaptive capacity. Liberia urgently needs to develop a climate change policy and a Low-Carbon Development Strategy (LCDS). The stakeholder consultations and various workshops on climate change have contributed to increasing the awareness of the Liberian public about climate change issues. A sensitized population is capable of changing attitudes towards building a better climate system. Sustaining this awareness through continuing consultations is necessary. However, this activity needs an adequate and sustained flow of financial resources, the lack of which is a current constraint in Liberia.

4.3.2 Capacity Constraints at the Institutional Level

At the institutional level, the Liberia EPA and its collaborating institutions are constrained by inadequate financial resources and insufficient human resources with the appropriate scientific and technical expertise. Specifically, there are limited financial resources for and limited technical and scientific expertise in:

- Integrated and comprehensive assessment of mitigation and adaptation options.
- Development of national or regional specific emission factors with the ultimate objective of reducing uncertainties in the national inventory statistics.
- Development of a comprehensive vulnerability assessment.
- Access to a reliable body of scientific information due to the near absence of enabling facilities.

Long-term and accurate data and information are prerequisites for conducting research and assessments of climate change. These are available only from an extensive and reliable network of recording stations. The greater part of Liberia's observation network has been lost, and the remaining stations have deteriorated during the past few years. This is a major constraint as data and information gaps are increasing, and this will continue to lead to uncertainties in climate change research and modelling results.

4.3.3 Capacity Constraints at the Individual Level

The absence of a dedicated climate change committee or task force means that at the beginning of any activity on climate change, the EPA struggles to assemble a body of capable experts. Technical experts who have been trained in the development of national inventories and assessment of vulnerability to climate change in previous activities may be available from their parent institutions, but in most cases, fresh technicians are nominated to participate in the implementation of the activity. The rate of turnover is high, as is the number of fresh members with no previous knowledge of climate change issues. Generally, these new members have no hard exposure to or training on issues related to climate change. This is a constraint. Most of the technicians that participate in the implementation of climate change activities and gain knowledge and expertise in climate change are from the central government. This is an important constraint, especially when it comes to using the services of contractors and consultants who cannot be employed by the government. There is hardly any individual in the private sector who has been or is currently engaged in climate change activities. On the other hand, the membership of a dedicated climate change committee or task force is relatively stable. These technicians are involved in the implementation of most of the climate change activities and thus continuously receive knowledge and develop their expertise.

4.3.4 Opportunities for Capacity Building to address the constraints and gaps

A high priority is strengthening the capacity of the Liberia EPA and its collaborating institutions to enable their effective participation in the implementation of the convention, Kyoto protocol and the Paris Agreement especially Article 13 on enhanced transparency framework. This will involve the following program of activities:

- Institutionalization of a dedicated Technical National Climate Change Committee (TNCCC) with an open-ended membership from all sectors of the Liberian economy.

- Improving the capacity of the EPA and the membership of the institutionalized TNCCC in the science, economics, and politics (negotiations) of climate change through participation in appropriate in-country or regional and international training programs. For a start, it is necessary to train three staff members of the EPA and five members of the TNCCC (two from the government and one each from an NGO, and private sector entity) on specific themes such as climate change negotiation skills. This can be achieved through training at the national level or enabling the participation of Liberians in regional training programs. With a nominal cost, the UN Institute for Training and Research (UNITAR) has been conducting training courses for countries and regions in the developing world. Opportunities for web-based and on-line training are also within reach.

- Enabling the development of a climate change policy, a comprehensive LCDS and a CCAP with an integrated implementation strategy. The process of developing the LCDS and CCAP took into consideration the outputs of the previous INC, the 2005 National Capacity Self-Assessment (NCSA), the 2008 National Adaptation Programme of Action (NAPA), and national and sectoral policies, development plans and programs. Both short-term and long-term issues in the implementation of the UNFCCC in Liberia will be taken into consideration. The short-term and long-term issues include:

    - Revising education curricula and developing education and training programs and specialized skills and expertise.
    - Developing and strengthening scientific and technical institutions of higher learning with the necessary equipment and scientific information.
    - Enhancing public awareness at all levels.
    - Re-orienting and developing appropriate policies and regulations that facilitate sustainable development, reduce pressure on natural resources, and enhance mitigative and adaptive capacities.

In updating and improving the national inventory of GHG emissions, the members of the TNCCC assigned the study will need to develop a country-specific methodology in collaboration with the IPCC Inventory Guidelines and Guidance materials and the default emission factors contained in those guidelines. This is likely to be achieved through conducting studies at the national or at the regional level to determine emissions factors that are relevant and applicable to Liberia, with the ultimate objective of reducing uncertainties in the national inventory statistics. It will be necessary to train at least ten members of the TNCCC through an Industrial Attachment (IAP) or crash program at the national level. Upon completion of such training, the candidates will be capable of conducting experiments in the Liberian environment and developing emissions factors for the categories.

In conducting vulnerability (impacts and adaptation) assessments, technical experts acquire coarse General Circulation Model (GCM) outputs and use these to develop national-level climate and climate change scenarios. These scenarios are then used as input to biophysical models such as DSSAT, WATBAL, SPUR2, GAP, etc. in assessing the vulnerability of the economy to climate change. However, the technicians have very limited expertise in influencing the source codes of these models to fine-tune them to the national circumstances of their own countries such as Liberia. For a comprehensive vulnerability assessment, the technical capacities and skills of experts need to be developed and enhanced beyond those acquired through workshops. It will be necessary to train the lead agency of each of the sectoral teams (agriculture, forestry, water resources, coastal resources, health, etc.) in the execution of the model required for the sectoral vulnerability assessment. It will also be necessary to train two members of the EPA and some of the members of the committee on integrated assessment.

Effective capacity building in these areas can be achieved and sustained through the promotion and institutionalization of networking and collaboration between the leading global climate modelling groups and the TNCCC of Liberia. These efforts will build and sustain the capacity of TNCCC members to develop and execute climate change and biophysical models. The collaborative efforts should include the transfer of the model technology to Liberia. Development and implementation of climate change programs is a process that depends on access to a reliable body of scientific information. The information is developed from raw data acquired from national, regional, and global systems of observation networks. Liberia has limited historical climate data (less than 100 years), and meteorological and hydrological networks have deteriorated, and gaps in data have occurred, especially in the 1980s and 1990s.

Inadequate or non-available equipment for systematic, long-term observation and collection of climate system variables has the consequence of limiting vital data required for the development of adequate and accurate inputs to model and simulate climate and climate change. It is thus a priority in Liberia to reverse this deterioration of the observation networks and improve the data and information availability. Improvement will entail the acquisition of Automatic Weather Stations (AWS) and rehabilitating and stocking meteorological stations with the required number of instruments and automatic recorders. An adequate number of replacement parts and spares should also be stocked for timely replacement. Instrument and electronic technicians should be trained to maintain the networks.

Chapter 5: Support Received for the preparation and submission of Biennial Update Report

5.1 Overview of support flows to Liberia

According to the guidelines for the preparation of the biennial update reports, the Liberian government has prepared this first BUR intending to enhance transparency on mitigation actions, as well as on finance, technology and capacity-building support needed and received. Without prejudice to any future request for financial support in subsequent update reports or any other communications, following articles 4.3, 4.7 and 12 of the Convention, the Liberian government has elaborated this first BUR concurrently to the efforts to prepare the country's Second National Communication. The team involved in the preparation of this BUR would like to acknowledge the support provided by the Government of Liberia, through the EPA, through the organization of two training workshops on the preparation of BUR, which significantly contributed to facilitating the preparation of this document. Some criteria have been defined for the presentation of information on financial support received:

- The table includes resources on a grant or concessional basis received from bilateral and multilateral channels for climate-specific actions, in line with the principle of additionality of climate finance, as per article 4.3 of the UNFCCC.
- Due to the lack of precise guidelines for MRV of support and a consequential lack of available information, resources directed to the private sector were not included.

The table does not include resources received directly by subnational entities. Other partners in promoting sustainable development in Liberia through bilateral cooperation have not been included in Table 44 due to different approaches for accounting the provision of support and cooperation, which could not be effectively assessed or were not encompassed by the criteria above.

Table 43: Financial support received by Liberia, the information provided by funding source, grouped per year (all values presented in US dollars)

Financial support received in the context of Climate Change					
Source	**2016**	**2017**	**2018**	**2019**	**TOTAL (USD)**
GEF	10.000.00	63,333.00	40,000.00	120,000.00	233,333.00
National budget	N/A	N/A	N/A	N/A	N/A
Private sector	N/A	N/A	N/A	N/A	N/A
TOTAL	10.000.00	63,333.00	40,000.00	120,000.00	233,333.00
*Government in-kind contribution – co-finance		5,000	15,000	5,000	25,000

*Support received from GOL in kind.

5.2 Summary of Donor Funds Committed to Climate Change Projects In Liberia (2016-2019)

Climate support is critical to achieving high climate ambition. Therefore, Liberia has been consistent in mobilizing financial resources and technical assistance. The GEF is the traditional source of grant for climate change initiatives in Liberia. Majority of donor funding for climate change is in the form of projects financing. The total fund approved for the preparation of this report was US$ 352,000.00. From March 2016 to August 2019, the total fund received, as indicated in the table above, is US$ 233,333.00. GEF approved budget not yet received is US$ 118,667.00.

Liberia is presently gearing up to address its capacity gaps while readying itself to report its Second National Communication to the UNFCCC. The capacity gap assessment has thrown up areas of improvement including a suitable institutional arrangement that ensures the sustainability of the process; activities that need to be covered for a comprehensive assessment of national GHG inventories by sources and sinks; capacitated sectoral experts who can map and gather relevant activity data and estimate GHG emissions by sources and sinks, manage uncertainties and undertake quality assurance and quality control of the GHG inventory the need for a standard operating procedure to comprehensively complete preparation of GHG inventory by sources and sinks on time. The EPA responsible for the implementation of REDD+ programme has decided to apply a portion of the grant received on developing the capacity of the Government of Liberian GHG inventory team towards GHG accounting and reporting procedures, consistent with the IPCC guidelines and requirements of the UNFCCC.

Chapter 6: Liberia's Domestic Monitoring Reporting and Verification System

6.1 Domestic Monitoring Reporting and Verification Requirements

Under the Paris Agreement, all Parties to the UNFCCC – developed and developing countries alike – agreed on the most ambitious goal to date to limit the increase of greenhouse (GHG) emissions and avoid dangerous climate change. The Paris Agreement aims to 'hold the increase in the global average temperature to well below 2°C above preindustrial levels and pursue efforts to limit the temperature increase to 1.5°C above preindustrial levels, recognizing that this would significantly reduce the risks and impacts of climate change' (Article 2), and to 'achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century' (Article 4, UNFCCC 2015).

In showing commitment to the Paris Agreement, on the path with other developing countries, Liberia has decided to develop its Domestic MRV system. The MRV system comprises institutions with the Environmental Protection Agency being the lead institution. The MRV system includes the office of the president as the overall policy and coordination point. Though the system seeks inputs from other government's institutions, Liberia's Domestic MRV system is a single-entity driven system-meaning, the environmental protection agency implements it. The institutional arrangement is being effectuated at the EPA, where the role of each department is spelt out within this document.

6.2 Assessment of existing Domestic MRV system of Liberia for BUR/NC Reporting

The review of available documents and stakeholder's engagement has shown that Liberia has an undocumented and unstructured MRV system. Liberia's system needs an amendment to allow sustainability. Additionally, it requires the building of human capacities and logistics for effective and efficient continuous reporting. The existing MRV Institutional arrangement is centralized within Liberia's EPA. It is to be noted that Liberia's EPA, is the sole agency for climate change matters related to UNFCCC reporting and is overseen by the National Environment Policy Council or 'Policy Council' and the Board of Directors. It is also the Nationally Designated Inventory Agency (NDIA). The EPA has six Department/divisions: Department of Administration, Department of Finance, Department of Intersectoral Coordination, Department of Planning and policy, Department of Compliance and Enforcement and Multilateral Environment Agreements (MEA) unit. The MEA unit oversees all Climate change-related matters and hosts the national focal point for climate change for Liberia to the UNFCCC. Table 45 describes the existing national undocumented MRV system.

Table 44: Description of Existing National MRV system

Institutional Arrangement		
Measurement & Estimation	**Reporting**	**Verification**
MEA Unit TWGs Consultants	MEA Unit	No internal verification UNFCCC

6.3 Measurement and Estimation's Intuitional arrangement

In the preparation of Liberia's initial national communication, EPA as the NDIA hired teams of consultants who were involved in the preparation of the GHG inventory and other MRV related issues. However, in the preparation of Liberia's First Biennial Update report, EPA has established a team of Technical Working Groups (TWG) comprising of all GHG reporting sectors. The TWGs oversees the collections of activity data and measurement or estimation of emissions or mitigation actions working under the supervision of BUR/NC/INDC coordinators within the MEA Unit and in collaboration with other ministries and agencies for data collection and integration.

An initial communication had been sent, and a second national communication is in preparation at this time of assessment. No real capacity exits within the EPA to undertake the national GHG inventory as this work was primarily undertaken by consultants employed by EPA and established Technical Working groups, as stated earlier. There was also no formal methodology for the collection of data, and the initial national communication only included basic methodological details. With regards to data sharing, there is no MoUs in place between institutions involved in data collection. However, there exits some form of MoU between the EPA and Forestry development Authority for the REDD+ program. This could be used to allow data sharing between the two agencies, but the MoU is not a data-sharing agreement. Given that the first or the second national communication is not yet in place, there was no indication of how QA/QC conducted or put in place.

6.4 Institutional arrangement for Reporting and Verification

Since EPA is the sole agency, reporting under the perceived existing MRV system lies only with EPA's MEA unit for reporting to the UNFCCC. The National Focal Person to UNFCCC sits within the MEA Unit and reports directly under the directive of the Executive Director of the EPA. There is no indication of existing international verification of GHG inventory or climate-related issues. This could be as the results of the lack of capacity at the EPA and since consultants undertake all technical works.

6.5 Steps taken to develop Liberia's MRV system

In September 2018, a regional workshop on Country Needs Assessment for Implementation of National Forest Monitoring Systems, and MRV in Addis Ababa, Ethiopia, organized by the World Bank and GEF was held. This workshop was attended

by two of Liberia's MRV consultants. Outputs from the workshop provide an overview of the current state of M&MRV in Liberia. This review also provides an opportunity to review the outstanding actions and to discuss and finalize the institutional arrangements.

6.5.1 Design of Liberia's Domestic MRV system

6.5.1.1 MRV Institutions

There are several institutions involved in MRV activities in Liberia, in the case of the domestic MRV system, the EPA will manage the roles these institutions play in the process of monitoring reporting, and verification of the Nationally Appropriates Mitigating Actions.

Since the national focal point for reporting to the UNFCCC sits within the Environmental Protection Agency, the reporting process to the UNFCCC becomes easy because it does not require establishing a link with external institutions to request a reporting person.

6.5.2 Proposed Domestic MRV System & Institutional Arrangements

Following the assessment of the existing MRV system at Liberia's EPA and International MRV system, Liberia proposes to establish a domestic MRV system for future climate change reporting (Figure 15). The system incorporates various departments at the EPA to include the Department of Planning & Policy (DPP), Department of Intersectoral coordination and the MEA Unit. The Executive Director and the office of the UNFCCC focus person manage the signing and submission of the BUR, NC, NDC and others to the UNFCCC and other climate change international bodies. The preparation of reports for BUR, NDC, NC etc. is the sole responsibility of the MEA unit, but final validation and signing of reports and subsequent submissions to relevant bodies are the sole roles of the Executive Director and the office of the UNFCCC focus person, who also sits in the MEA Unit (**Error! Reference source not found.** 14).

These are existing arrangements, and it is important to maintain this arrangement for sustainability. The Verification of the MRV systems is both internal and external. The external aspect being the International Technical assessment conducted by the UNFCCC roster of experts. The internal verification includes QC/QA (quality control and quality assurance) during and after the measurement and estimation stage. The MEA unit will coordinate the implementation of QC during data collection and estimation by technical working groups and consultants and as well, as to identify relevant Academic institutions and civil society organizations or CSOs to carry out QA on estimates and reports. The MEA unit will coordinate the activities of recalculating emissions using proxy data to compare results with estimated emissions. Also, compares national GHG estimates with neighboring countries to improve and reduce the uncertainty of GHG estimates.

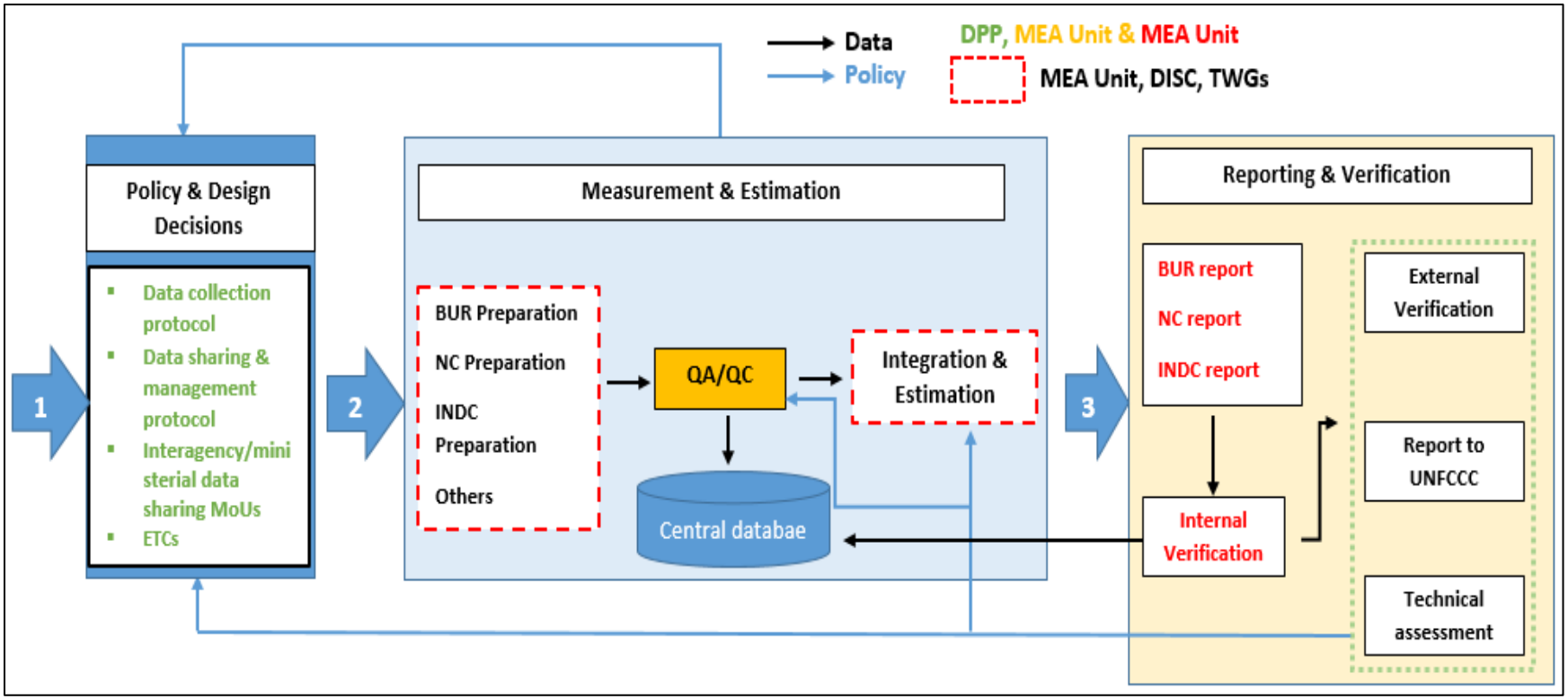

Figure 15: Proposed Liberia's Domestic MRV system

The institutional arrangement for the proposed domestic MRV system has various levels of interactions and include some departments of EPA and ministries for effective outputs. The design of this system draws inspiration from Liberia's REDD+ MRV System and does include the office of the President. The overall policy and coordination come from the Office of the President through the National Climate Change Secretariat and then to the Board of Directors and Policy Council, and guide the EPA (Figure 15)

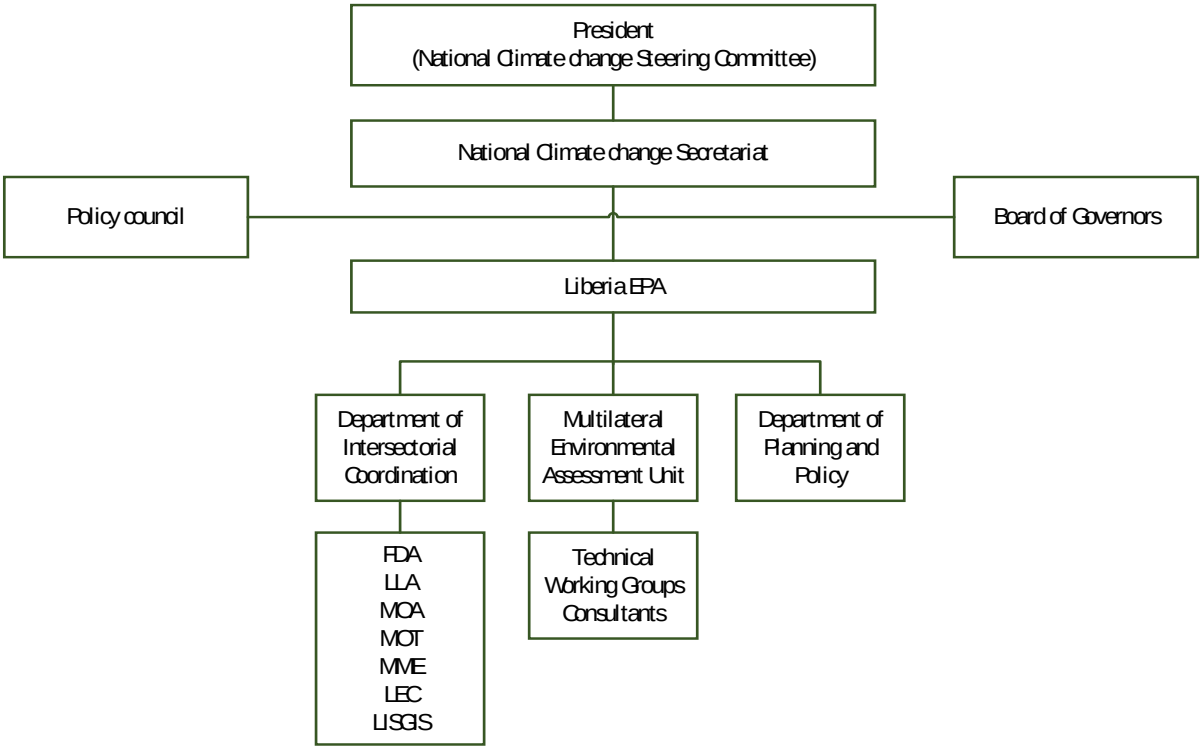

Figure 16: Institutional arrangements for Liberia's domestic MRV for NAMA+

The development of policy design and decision such as data collection and management protocols and field manual comes from the Department of Planning and Policy with review and inputs from the MEA Unit and then validation and endorsement from the Board of directors and Policy council. As figure 15 shows, the system requires policy and SOPs for effective results of the MRV system. The MEA Unit will drive and coordinates the day-to-day activities of the MRV work with the Department of Intersectoral coordination and Technical working groups (TWGs) for Activity data collection, especially with GHG sectors. Estimation and integration of GHGs and other related estimation will remain the sole responsibility of the MEA Unit. The MRV processes cannot be undertaken by one Government institution. In Liberia, the structure of the domestic MRV is evidenced through the institutional arrangements. Overall policy and coordination come from the Office of the President through the National Climate Change Secretariat, which in turns guides the EPA. The sources of emissions of GHG in Liberia are complex and encompass all GHG reporting sectors such as Energy, IPPU, Waste, LULUCF, agriculture, etc.).

6.5.3 Reporting and Verification

The MRV system requires activities on reporting and verification, for which Liberia's domestic MRV systems as outlined in the single centralized entity has driven system (Figure 16). The reporting and verification function lies with the EPA to prepare climate reports to the UNFCCC or any other international bodies.

Chapter 7: Any other information relevant to the achievement of the objective of the Convention

7.1 Preparation of National Adaptation Program of Action (NAPA)

In 2008, the National Adaptation Program of Action (NAPA) was launched with technical support from the GEF and UNDP. EPA facilitated the preparation of Liberia's NAPA based on the initiative that emerged from the Seventh Session of the Conference of the Parties (COP-7) of the UNFCCC held in Marrakech in 2001. The preparation of NAPA followed the guidance provided by the Least Developed Country Expert Group (LEG) in their annotated guidelines. Consistent with these guidelines, the NAPA document explicitly accounts for synergies between adaptation and national development plans, such as the NRDP, as well as with multilateral initiatives such as MDGs and the National Biodiversity and Strategy Action Plan.

The participation of stakeholder groups was an essential part of the NAPA process. Civil society organizations, women groups, indigenous people, CBOs, National and International NGOs, policymakers, academic and research institutions played major roles in the development of the NAPA document, as well as in the assessment of impacts, vulnerabilities and adaptation measures. As a result of this process, it is now overwhelmingly clear that the adverse effects of climate change variability and extreme events are already significantly impacting sustainable development priorities in Liberia. At the policy level, several adaptation initiatives aimed at reducing the adverse effects of climate change while promoting sustainable development were identified as being of the highest priority, including:

- Capacity building to integrate climate change in development planning, designing infrastructure, land and coastal zone management planning and institutions

- Raising awareness by dissemination climate change and adaptation information, particularly to vulnerable communities such as farmers and coastal settlements

- Mainstreaming adaptation to climate change into policies through programs in agriculture, forestry, fisheries, energy, health, gender and meteorology/hydrology.

At the project level, several highest priority initiatives aimed at reducing the vulnerability of local communities to increasing climatic variability were identified through a participatory process, including:

- Integrated cropping/livestock farming to diversify crop farming through the cultivation of soybeans, lowland rice and small ruminants rearing.

- Improved Monitoring of Climate Change to generate reliable hydrometeorological data and improve the measurement of climatic parameters.

- Coastal defense systems for the cities of Buchanan and Monrovia to reduce the incidence of flood, erosion, and siltation in Monrovia and Buchanan.

The NAPA process identified several projects, and urgent adaptation needs using multi-criteria analysis, which was validated at a stakeholder's forum. Based on this analysis, three projects were selected as the most urgent priority needs of the country:

- Agriculture adaptation: enhancing resilience to increasing rainfall variability through the diversification of crop cultivation and small ruminants rearing.

- A National Meteorological and Hydrological Monitoring System: enhance adaptive capacity through the rebuilding of the national hydro-meteorological monitoring system and improved networking for the measurement of climate parameters.

- Coastal Defence: reducing the vulnerability of coastal urban areas (Monrovia, Buchanan, and Robert sport) to erosion, floods, siltation, and degraded landscapes.

7.2 The Climate Change Agriculture Adaptation Project (CCAAP)

The Ministry of Agriculture executed the CCAAP from September 2011-2015 with support fund funding from the GEF, UNDP, and the Government of Liberia's in-kind contribution. The project was intended to increase resilience and enhance adaptive capacity to address the additional risks posed by climate change in the agriculture sector and provide the conduit through which agriculture adaptation can be implemented in Liberia. The project was designed to achieve the following expected outcomes:

- Integrating concerns into relevant policies and planning processes at the state and national levels.
- Comprehensive capacity development for individuals in national agencies, focusing on agriculture in pilot counties and farmers.
- Demonstration of risk reduction strategies and measures at pilot sites.
- Strengthening of technical capacity to integrate climate change risk management into farmer level agricultural capacity, and
- Capturing and disseminating lessons learned to key stakeholders

7.3 Intended National Determined Contributions

In 2015, Liberia developed the Intended nationally Determined Contributions (INDC) for onward submission to the UNFCCC. The INDC presents a context for the global effort to create a new international climate agreement by the end of the Paris Climate Summit in December 2015, to limit temperature increase. The INDC includes one component on mitigation and another on adaptation. The extent of implementation of the intended contributions on mitigation and adaptation sated here is conditioned upon

the provision of adequate means of implementation by the international community (financial resources, capacity building and the transfer of technologies). The INDC presents a platform to integrate its Low Carbon Development Strategy into the country's long-term sustainable development Vision by 2030 (Agenda for Transformation).

7.4 National Policy and Response Strategy on Climate Change

Liberia's EPA prepared the National Policy and Response Strategy on Climate Change based on the national demand from the climate impact on social, economic and environmental assets. The strategy was implemented to tackle the impact of climate change in Liberia. Table 46 shows the analysis of the adaptation strategies using the Adaptation Policy Framework (APF). Under the APF, four major principles provide the basis from which integrated actions to adapt to climate change can be developed.

- Adaptation to short-term climate variability and extreme events to serve as a starting point for reducing vulnerability to longer-term climate change.
- Adaptation at different levels in society, including the local level.
- Adaptation policy and measures have been assessed in a development context; and
- The adaptation strategy and the stakeholder process by which it is implemented are given equal importance.

Table 45: Adaptation interventions in key sectors

Thematic Area	Policy Statement
Forestry and Wildlife	Using the '3 Cs' approach' as the basis for sustainable forest management ensures that forests and wildlife be considered when planning adaptation policies and practices in areas of the economy beyond forestry and wildlife. It also defines and implements measures for reducing the negative impacts of climate change on the forest and wildlife.
Agriculture	To reduce the vulnerability of agriculture systems to risks related to climate change through direct and indirect supports to farmers, including the settling of a robust monitoring system to detect early changes that will affect agriculture production.
Coastal Area	Ensure the protection of Liberia's 350 miles coastline.
Water Resources	Ensure the continuous availability of critical water resources that are important for domestic, agricultural, energy, and recreational purposes.
Fishery	Recognizing the importance of fishery as a major contributor to the food supply, food security and livelihoods, adopt policies and programmes that maintain and protect the integrity of Liberia's fishery sector.
Energy	moving Liberia's economy and social sectors forward based on universal access to affordable, sustainable, and environmentally friendly modern energy services
Mining	Ensure that climate change adaptation principles are integrated into the mining sector so that climate stressor scenarios on mining, as well as its exacerbation effect on climate change, will be minimized. In doing so, sustainable mining which contributes to the sustainable development of the country will be promoted. To realize this the following strategies are identified
Industry	Incorporate climate change considerations in industrial sector planning so that the manufacturing industries sector will be resilient to climate chocks emanated from energy, resources and infrastructure needs as well as physical damage

Transport	Ensure the development of an efficient, effective, and affordable transportation system that is resilient to the possible shocks of climate change and which contributes to the sustainable development of the country.
Tourism	Develop and implement culture and tourism development programs that are resilient and responsive to the challenges caused by climate change
Infrastructure	Ensure that our infrastructure is 'climate-proof.'
Urbanization and settlement	Develop a comprehensive land-use plan to achieve sustainability in urbanization and settlement developments to adapt to the climate.
Health	Strengthen the capacity of the health infrastructure and systems to achieve the objectives of the National Health and Social Welfare Policy and Plan, the Public Health Law, and the SDGs 3 (good health) in the face of climate change and its risks.

Table 47**Error! Reference source not found.** shows the mitigation intervention in key sectors through which the government will engage its partners and citizens in mitigating the impacts of climate change.

Table 46: Mitigation interventions in key sectors

Thematic Area	Policy Statement
Forestry and Wildlife	Significantly enhance Liberia's potential for carbon sequestration by promoting conservation, sustainable forest management, community forestry and curbing, key drivers of deforestation and forest degradation, which in turn will contribute to sustainable wildlife management
Agriculture	Move towards a sustainable agricultural system by encouraging lowland farming, investing in smallholder agriculture, and allowing large-scale concessions on degraded land to avoid and reduce national emissions levels.
Energy	Improve Liberia's economy and social sectors toward universal access to affordable, sustainable, and environmentally friendly low carbon energy services.
Mining	Ensure that mining the sector in Liberia develops in an environmentally sustainable manner by gradually mixing the use of low emission energy sources and technologies.
Industry	Ensure that the future of Liberian industrial base will not be locked into carbon-emitting technologies but rather develop on environment-friendly, economically viable and socially acceptable basis so that it will be competitive in domestic and world markets
Transport	Build the future of Liberia's transport system and associated infrastructure on a low carbon-emitting base.
Tourism	Ensure the development of an environment-friendly tourism management system that contributes to the sustainable development vision of the country
Waste Management	Pursue the development and implementation of a comprehensive waste management strategy that includes the development of environmentally sustainable landfills, recovery and use of methane emissions for energy generation and instituting programs at the community and national level for recycling, reduce and reuse of waste.

Table 48 shows the cross-cutting issues which have a strong impact across all specific sectors and need to receive special attention. The cross-cutting themes are separately treated as they are applicable and essential to all sectors specified in the adaptation and mitigation intervention sectors.

Table 47: Cross-cutting areas

Thematic Area	Objective
Communication, education, and Awareness	Promote communication, education, and awareness programs to incorporate climate change issues so that a society resilient to climate change and contributing to the reduction of the global GHG can be created.

Capacity Development and Training	Ensure that capacity development, training and capacity enhancement activities at the systemic, institutional, and individual level are prepared and continuously implemented to build adaptation and mitigation capacity to climate change.
Research and Development	Promote research and development aimed at addressing climate change issues at the national level; and encourage cooperation and networking at the regional and international level to promote climate change research.
Technology Transfer	Promote the transfer of technology that is proven to be locally adaptable, environmentally friendly, appropriate to users, culturally friendly, and manageable in a sustainable way for use in Liberia.
Gender, HIV and AIDS	Ensure that issues of gender, HIV and AIDS are mainstreamed in all climate change mitigation and adaptation interventions across the country as a means of promoting inclusiveness, equity and adequate participation of all.

Chapter 8: Conclusions

The preparation of the first BUR has been beneficial to Liberia in many areas such as highlighting key climate change issues to decision-makers, capacity building, the establishment of national arrangement for regular climate reporting and raising awareness. First, the BUR1 compilation has helped to shine a light on the key climate change areas that require the attention of policymakers to take targeted action at national, sectoral, and local levels. Such policy measures are consistent with the national development strategy of Liberia and are expected to deliver multiple sustainable development and climate protection outcomes. Similarly, in the BUR1, Liberia has reported on the progress, achievement and challenges of the climate policies the Government is implementing. The feedback on policy effectiveness can be critical inputs in the formulation of new policies or policy changes.

Not only has the BUR compilation has been useful to climate policy, but the entire preparation processes also served capacity development tool. For the more than twenty national experts from the public, academia and the CSOs who were involved in the BUR preparation, it was an impressive opportunity to improve on their technical knowledge through learning-by-doing. Some of the technical areas the team benefitted from are the use 2006 IPCC Guidelines for National Greenhouse Gas Inventories, CGE training materials and handbooks on the preparation of the BURs and tools for the assessment of mitigation actions and their effects.

The findings in the BUR1 and underlying dataset would be useful to the analytical work that would underpin the Liberia NDC revision. Since the NDC revisions would build on the existing national arrangements, the gains Liberia have made in preparing the BUR will be critical to the NDC. The gains are in the areas of improved awareness and capacity levels, data and analytical capabilities of the national experts and the key findings. During the NDC revision, Liberia will make use of these critical resources to ensure continuity and relevance to the key stakeholders.

The BUR preparation also contributed to justifying the need for Liberia to establish a functional national system for the regular compilation and publication of the climate report to the UNFCCC. So far, through the EPA, Liberia formed an inter-ministerial technical group as the first important step. The next immediate step Liberia will be pursuing is to build on the moment the BUR has generated to begin the process of institutionalization of the institutional structures to support sustainable climate report in the future.

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Annex

Appendix A

Appendix A.1

Figure A.1 gives the inventory cycle of the entire BUR1 project phase. The project commenced with official launching which was held in August 2017 followed by the recruitment of a National Project Coordinator and Staff. The project inception workshop was held on October 13, 2017, followed by a joint capacity-building training with the GHG Components held on December 11-15, 2017. Various institutions holding GHG Data were identified in March 2018, followed by a technical workshop to assign roles and mandates to GHG Sector consultants. The various consultants for all components of the BUR were then hired on their respective dates indicated in the figure. A Technical Assistant was hired on February 17, 2020, for the compilation of the entire BUR-1. A national validation workshop was held on February 20-21, 2020 to validate the compiled BUR1 document.

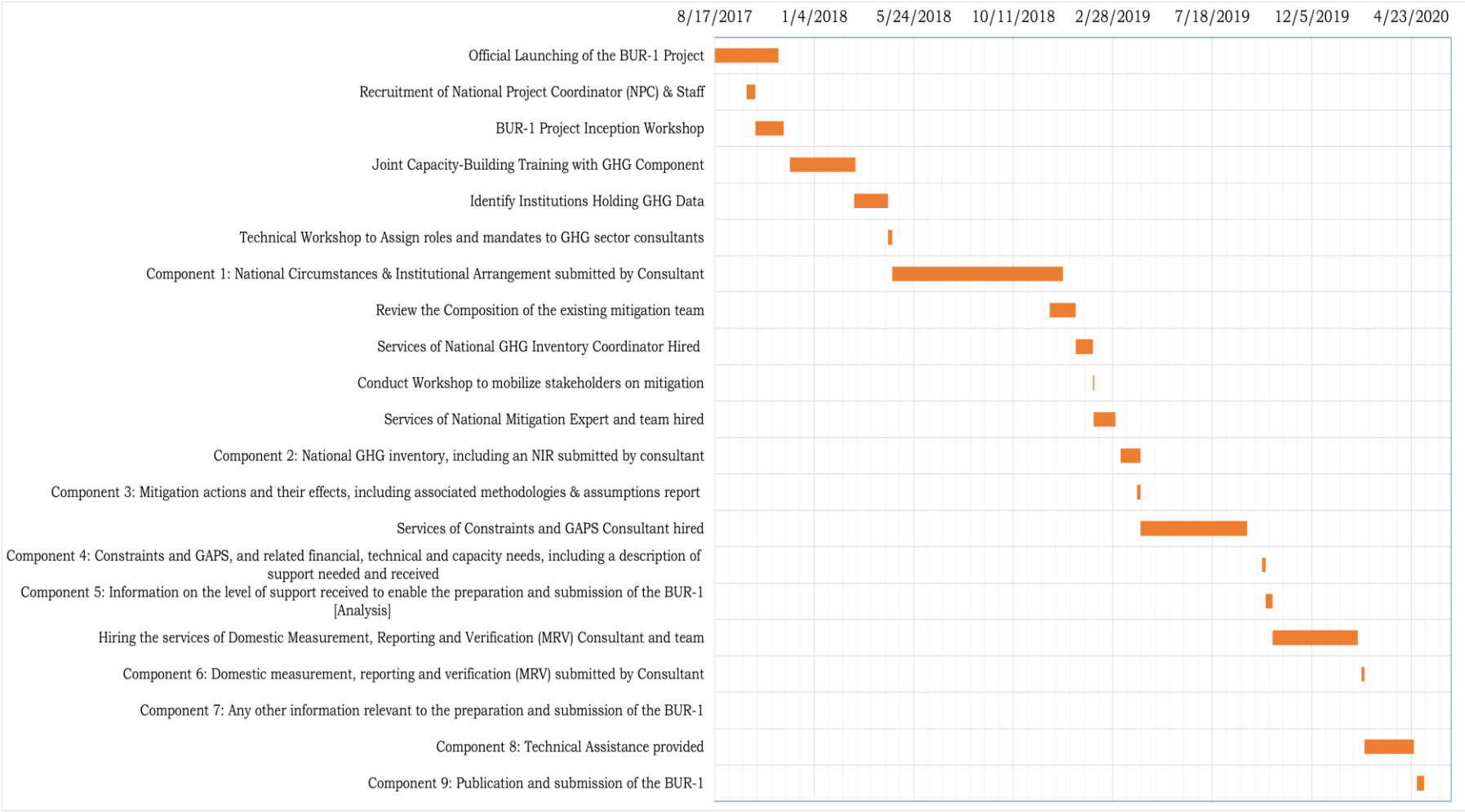

Figure 17: BUR1 Project Lifecycle