The State of Eritrea

Ministry of Land, Water and Environment

Department of Environment

First Biennial Update Report (BUR I) Under the United Nations Framework Convention on Climate Change (UNFCCC)

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List of Acronyms and Abbreviations

Acronyms	Description
AD	Activity Data
AF	Adaptation Fund
AFOLU	Agriculture, Forestry & Other Land Use
BAU	Business As Usual
BUR	Biennial Update Report
CBOs	Community - Based Organizations
CC	Climate Change
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CFL	Compact Flourcent Lamp
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
COP	Conference of the Parties
DoE	Department of Environment
EF	Emission Factor
ENPEP	Energy and Power Evaluation Programme
EPHS	Eritrean Public Health Survey
FAO	Food and Agricultural Organization
FWA	Forestry and Wildlife Authority
GDP	Gross Domestic Product
GEF	Global Environmental Facility
Gg	Giga gram
GHG	Greenhouse Gas
GIS	Geographical Information System
GoSE	Government of the State of Eritrea
GPG	Good Practice Guidance
ha	Hectare
HFCs	Hydro Fluorocarbons
IFAD	International Fund for Agricultural Development
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
I-PRSP	Interim Poverty Reduction Strategy Paper

LEAP	Long range Energy Alternative Planning
LPG	Liquefied Petroleum Gas
LUCF	Land Use Change & Forestry
LULUCF	Land Use Land Use Change and Forestry
M &E	Monitoring & Evaluation
MAED	Model for Analysis of Energy Demand
MDG	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
MoA	Ministry of Agriculture
MoEM	Ministry of Energy and Mines
MoF	Ministry of Finance and National Development
MoH	Ministry of Health
MoI	Ministry of Information
MoLG	Ministry of Local Government
MoLWE	Ministry of Land, Water & Environment
MoMR	Ministry of Marine Resources
MoTC	Ministry of Transport & Communication
MoTI	Ministry of Trade and Industry
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
MSY	Maximum Sustainable Yields
N_2O	Nitrous oxide
NAMA	National Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programmes of Action
NBSAP	National Biodiversity Strategy & Action Plan
NC	National Communication
NCSA	National Capacity Needs Self-Assessment
NDC	Nationally Determined Contribution
NGHGITWG	National Green House Gas Inventory Technical Expert Working Group
NHCP	National HealthCare Policy
NMVOC	Non-Methane Volatile Organic Compounds
NOx	Nitrogen oxides
NVAWG	National Vulnerability and Adaptation Assessment Working Group
PFCs	Per Fluoro Carbons
PIF	Project Identification Form
PPG	Project Preparation Grant
QA	Quality Assurance
QC	Quality Control

RET	Renewable Energy Technology
SDG	Sustainable Development Goals
SF_6	Sulphur hexafluoride
SGP	Small Grant Programme
SNC	Second National Communication
SO_2	Sulphur dioxide
TED	Technological and Environmental Data
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Foreword

Eritrea hereby submits its First Biennial Update Report (BUR1) to UNFCCC Secretariat pursuant to decision 2/CP 17 of COP17. The report is complementary to the third National Communication (TNC), which is built on the work carried out under the Initial and Second National Communications reported in 2000 and 2012 respectively.

Prepared according to the template provided by the Secretariat, Eritrea's BUR1 is focused mainly on national circumstances, institutional arrangements, greenhouse gases emission by sources and removal by sinks, measures undertaken to mitigate climate change and their effects, constraints and gaps related to financial, technical and capacity needs, as well as on domestic measurement, reporting and verification (MRV) and the support received for the preparation of the BUR 1.

The national GHG inventory, which assumed 2018 as a target year, shows that Eritrea's emission contribution remains insignificant. However, in consonance with the objectives of the Paris Agreement, Eritrea is committed to play its part in contributing towards limiting the global average temperature rise to 1.5°C. Although much remains to be done, Eritrea has been exerting efforts within its capacity to implement ambitious climate actions that it has committed itself to by its Nationally Determined Contribution (NDC-2018). Improvement of energy efficiency, enhancement of fuel shift, introduction and expansion of renewal energy technologies, as well as afforestation and degraded landscape restoration activities in the AFOLU sector have been areas of focus.

Eritrea remains committed to doing its best to combat climate change challenges by expanding the on-going mitigation interventions and initiating new once. It will also continue to enhance its reporting capacity through the Capacity Building Initiative for Transparency (CBIT) and will submit its revised NDC in 2022. In this regard, financial and technical support from development partnersis paramount in the achievement of the objectives of the endeavours.

In conclusion, on behalf of the government of the state of Eritrea and myself, I would like to express my gratitude to all who have contributed for the preparation of this report and the UNEP and GEF for their financial and technical support.

Tesfai G.Selasssie Sebhatu
Minister of Land, Water and Environment

Acknowledgement

First of all, I am honoured to thank H.E. Mr.Tesfai G.Selassie, Minister of Land, Water and Environment for his valuable support, encouragement, and continuous guidance and advice throughout the preparation process of the First Biennial Update Report.

The First Biennial Update Report is prepared through active involvement of various key stakeholders. In this regard, I would like to extend my gratitude to the Ministries of: Local Government, Energy and Mines, Trade and Industry, Transport and Communication, Health, Agriculture, Marine Resources and other institutions such as Forestry and Wildlife Authority, Segen Construction Company, Regional Administrations, Eritrean Institute of Technology, Hamelmalo Agricultural College, Adikeih College of Business and Social Sciences for providing reliable data and information.

Further, my thanks go to the Bureau of Standard and Evaluation of the Higher Education and Research Institute consultants for preparing this document in accordance with the guidelines provided by UNFCCC secretariat. My special words of appreciation also go to the team of experts emanated from the key stakeholder institutions for gathering and synthesising data and information from their respective institutions and for reviewing the document meticulously.

I am also grateful to all UNEP and GSP Experts for their relentless efforts in providing technical support, guidance andfor their efficient facilitation of the financial transaction for the preparation of the BUR1 document

Kibrom Asmerom
Acting Director General
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EXECUTIVE SUMMARY

The National Development Strategy of the Government of State of Eritrea (GoSE) is founded on the principle of sustainability and inclusiveness with a goal of achieving prosperity to its population. Eritrea ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 as a Non-Annex I Party and is obliged to submit information in accordance with Article 4, paragraph 1 of the Convention. This is the First Biennial Report (BUR1) for Eritrea; and contains the following major chapters (a) national circumstances (b) institutional arrangement relevant measures on reporting and verification (c) national greenhouse gasses inventory of anthropogenic emissions by sources (d) mitigation actions and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies (e) constraints and gaps related to financial technical capacity needs.

National Circumstances

Eritrea possesses a geopolitically significant location covering a total of 124,320km^2. Its climate is most influenced by altitude and topography, which cause variations in temperature. Based on the climatic parameters, the country is divided into six agro-ecological zones. There are two rainfall regimes, summer (June-September) and winter (Nov-February), and the main feature of rainfall is the extreme variability within years and variations over short distance. The country is one of the most vulnerable countries of the world to the adverse effects of climate changes due to its geographic location in the *Sahelian* Zone. Land degradation is prevalent throughout the country, but is particularly manifested in the central, northern highlands and southern plateau.

The major land-use/land-cover types in the country are categorized into seven major categories, i) Settlement Land, ii) Forest Land, iii) Crop Land, iv) Grass and Shrub Land, v) Grazing Land, vi) Wetland and vii) Bare and Other Land. Grazing land and bare land and other land altogether accounts for the largest proportion of the land cover system in the country. Soils with the highest agricultural potential are found in the southern central highlands and south-western parts of the country.

The immediate development priority of Eritrea is to meet the basic needs of its population through achieving economic stability, and rehabilitating and expanding infrastructures. The Government of the State of Eritrea formulated Macro Economic Policy in 1994, which clearly sets out the path for enhanced national development. In this respect, Eritrea has made significant efforts to provide education and health services to all its citizens. Eritrea is one of the few countries to have achieved the Millennium Development Goals in health before the given deadline date.

Eritrea's economy is based on the extraction of natural resources such as agriculture, fishery and mining. Agriculture is the main source of income and food security for the great majority of the population. It plays a significant role in reducing poverty and supports industrialization at a national level. There is ample opportunity in the fishery and developing tourism industry particularly along its coastal area. Since recent years, the economy has been driven by the mineral resources.

Institutional Arrangements Related to Measurement, Reporting and Verification

Eritrea prepared and submitted the Second National Communication in 2012 with a base year of 2000**.** The Ministry of Land, Water and Environment oversees the implementation of the climate change policy and the Department of Environment is responsible for coordinating and implementing climate change activities, including the preparation of the National Communications and Biennial Update Report. Reporting requirements came into force with the introduction of the revised improved standards of the national communication and the newly introduced Biennial Update Report.

In the planned institutional arrangements, there is sharing of responsibilities with regard to quality control, evaluation and validation processes. Accordingly, at the national level, it is planned to establish a national steering committee for verification. Under the climate change unit of the DoE, four hubs namely Energy, IPPU, AFOLU and waste are established which will periodically report to the ministry though the Department of Environment on the progress achieved under the auspices of the Nationally Determined Contribution of the country.

The Ministry of Land, Water and Environment, as focal point for climate-related UN Conventions including the UNFCCC coordinates and implements climate change related strategies and policies and programmes. MoLWE as an implementing governmental institution approves action plans ensure the disbursement of budget and undertake follow up and monitoring activities through implementation plan. The Ministry also appraises funding opportunities for climate change mitigation and adaption; and disseminates the modalities and guidelines for funding requests from partners' institutions to enable them understand the project implementation modalities. It also undertakes specific project needs assessment in consultation with key government stakeholders and local communities. In parallel, the key sectors are also requested to provide explanation about their strategic plans including goals, objectives, activities and expected outputs and outcome. The Department of Environment carries out both Mid-term and Terminal project evaluations by an authorized competitive external body contracted by the funding agency. Moreover, plans are analyzed in view of the short-term and extrapolated to medium and long-term perspectives.

The section on Monitoring Reporting and Verification covers roles, responsibilities and processes for the overall coordination, compilation and submission of National Communications, BURs and details related to the GHG inventory, and support received.

Greenhouse Gases inventory: The GHG inventory covered four sectors namely energy, IPPU, AFOLU and Waste. The GHG emissions included the direct GHG gases and other gases include in the Montreal protocol like F-Gases. To develop the national greenhouse gas inventory the 2006 IPCC guidelines using Tier 1 methodology was applied. National activity data were collected using questionnaire and data survey for the Energy, IPPU, AFOLU and Waste sectors.

Activity Data: The Ministry of Energy and Mines, and Ministry of Transport and Communication were the activity data sources for GHG emissions from the energy sector. The Ministry of Trade and Industry was the activity data source for accounting of GHG emissions from the Industrial Processes and Product Use. The Ministry of Agriculture provided activity data for GHG emissions from the agricultural sector. Municipalities of the

main cities and towns and cities provided activity data source for the waste sector. The most recent data on forest obtained from Forestry and wild Life Authority and the Global Forest Resources Assessment (FRA, 2015) reported to FAO were used.

Aggregate overall GHG emission excluding emission from biomass in Eritrea in 2018 is estimated to be 3,992.20 GgCO2-eq. The sectoral GHG emissions of this total are Energy, IPPU, AFOLU, and Waste sector that emitted respectively 783.43 GgCO2-eq, 190.56 GgCO2-eq, 2985.15 GgCO2-eq and 33.07 GgCO2-eq. It also estimated the GHG emissions from the multilateral operations of biomass based on the revised 2006 IPCC software and the result of the emission were 2404.52 GgCO2. Therefore, overall net GHG emission in Eritrea in 2018 is 6396.72 Gg of CO2-eq.

Taking 2015, as a base year for the inventory year of 2018, GHGs emission in Eritrea excluding biomass consumption is increased by 3.24%. Particularly, the GHG emissions from IPPU and Waste sectors showed significant increase within three years' time span which is attributed to change in lifestyle, urbanization and increased production of minerals. In Energy sector, the GHG emission was reduced by 0.09% following the introduction of renewable energy and energy efficient technologies in the country.

Aggregated GHG Emission in 2018: All the aggregate GHG emission by gases from different sectors increased from the base year of 2015. Accordingly CO_2, CH_4, N_2O showed an increase of 6.22%, 2.74, and 2.54 respectively from the base year. In 2018, the GHGs emission contributions of the four sectors were AFOLU 74.77%, energy 19.62%, IPPU 4.77% and waste 0.83%.

The GHG emissions increased from the base year in 2000 from 3,286.76 Gg of CO2-eq to 3,992.2 Gg of CO2-eq in 2018 inventory year which is equivalent to 21.46%. This clearly indicates that there is dire need for concerted national effort to reduce GHG emissions.

In 2018 inventory year, CH4 emission was the highest followed by CO2 contributing 81.19% and 15.13 % respectively. CH_4 emission is mainly from enteric fermentation in the livestock sub-sector and some of Energy activities. The CH_4 and N_2O emissions came from livestock, energy activities and solid waste disposal

Emissions of HFCs, PFCs and SF6: In 2018 inventory year, anthropogenic emissions by sources of PFCs and SF6 from production activities did not occur; and only the emission of HFCs from the use of refrigeration and air conditioning both for refrigeration and stationary air conditioning and mobile air conditioning were estimated to be about 21.24 Gg CO2-eq.

Sectorial GHG Emissions

Energy Sector: In 2018, the total direct GHG emissions from the Energy sector were estimated to be 783.43 $GgCO_2$-eq. These emissions were generated from fuel combustion activities. The highest emission came from the energy industries (42%) followed by other sectors (35%), i.e. commercial, residential, agriculture and fishing of energy consumption and transport (21%). In the energy sector, CO_2 (79%), CH_4 (17%) and N_2O (4%) are emitted to the environment.

The Reference Approach and the Sectorial approach have different results. The difference between the two approaches was found to be -4.88% in Energy consumptions and -5.39% in

CO_2 emissions. These differences arose as the result of data loose in the recording system of the institutions/ stakeholders; and some illegal importation of liquid fuels like gasoline and diesel from the neighbouring countries.

Memo Items: The GHG emission from International Aviation Bunker in 2018 came from the use of Jet Kerosene which produced 13.19 Gg CO2-eq. GHG emissions from the multilateral operations of biomass based on the revised 2006 IPCC software were estimated; and the emission were 2404.52 GgCO2

Industrial Processes and Product Use (IPPU) Sector: Under the Industrial Processes and Product Use (IPPU) sector, cement production, lime production, and limestone and dolomite were estimated. In 2018, the total direct GHG emissions from IPPU sector were 190.56 GgCO2-eq mainly from the mineral production. While the cement production accounts for 97.24% of the total emissions the remaining emissions came from lime production. The emission from this sector dramatically increased since 2010.

Agriculture, Forest and Other Land Use (AFOLU) Sector: In 2018, the total Net GHG emissions from the AFOLU sector were 2,985.15 GgCO2-eq. The net CO2 removal from the sector accounts 205.01 Gg, whereas the total CO_2-eq emission specifically from livestock sub-sector accounts 3,190.16 Gg. In the same year, about 207.98 GgCO2 was sequestrated by the forest land from the atmosphere. The GHG emission from enteric fermentation remained the highest contributor in AFOLU sector in all the inventory years; and it increased by 3.03% from the 2015 inventory year. The second contributor is manure management which increased by 4.09% from the same inventory year. Enteric fermentation contributed about 2,947.62 Gg CO2-eq and the manure management contributed for 242.54 Gg CO2-eq of the total emission in 2018 inventory year. The highest emission of CH4 came from enteric fermentation (91%) of the GHG emission from AFOLU is methane. N2O is emitted from manure management.

The Waste Sector: The GHG emission from waste sector considers only the solid waste disposal and open burning of waste. The result of aggregate GHG emission from waste sector in 2018 was 33.07 GgCO2-eq. The highest GHG emission contributor from the waste sector was solid waste disposal with a share of 97% and the remaining 3% came from open burning of waste.

Uncertainty Analysis: For the year, 2018 the uncertainty analysis of GHG inventories includes both level and trend assessment was undertaken. The trend assessment for the 2015 base year data were used, the average result of uncertainty analysis of Eritrea's national GHG inventory of the data showed were approximately 10.081% for level assessment and 9.597% for trend assessment.

Key category Analysis (KCA): In 2018 inventory, KCA reported were estimated for both level and trend assessment. For level and trend assessment was done taking 2015 base year. The key categories in the level assessment by considering the gas emission are i) Enteric fermentation, ii) Energy industry, iii) Forest land remaining forest land, iv) Cement production and Road transport followed by other sectors and manure management. In trend assessment, the energy industry and road transport are the lead based on the 2015 base year as reported in the TNC. The trend analyses shows the following sequence; i) Energy industries-liquid fuels ii) Road transportation iii)Other sectors –liquid fuels iv)cement

production v) enteric fermentation vi) other sectors –Biomass vii) energy industries-solid fuels viii) manufacturing industries and construction –liquid fuels ix)solid waste disposal x) refrigerators and air conditioning and xi) forest land remaining forest land.

Activity data for each source category include all the years starting from TNC base year of 2000. The calculations used to find for the missing data between the inventory years were interpolation and extrapolation methods. These activity data used the 2006 IPCC software using the same emission factor to allow a consistent comparison of GHG emissions across time; and reflects the adequate emission trends.

Completeness: The completeness of the 2018 inventory was conducted with each source category by extracting from the 2006 IPCC software analysis. The foremost lack of completeness of data in this inventory was in IPPU in which more than half of the subcategories are not applicable as Eritrea is in transition development period. The second lack of completeness was detected in the non GHG gases that do not occur for the emission of gases in the application of 2006 IPCC software explained its version in the methodology. Generally the lack of completeness particularly for the non GHG gases and not estimated data would be considered in the next inventory report; and are thoroughly explained in the improvement plan.

Quality Assurance and Quality Control (QA/QC): Currently, the GHG inventory process, there was no Quality Assurance / Quality control (QA / QC) system put in place to ensure routine and consistent checks required for data integrity, correctness and completeness from different data sources. Nonetheless, Eritrea placed its own quality control (QC) system for data collected by different ministries and institutions. 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; and technical and scientific reviews of data used, methods adopted and results obtained.

The QA was undertaken by independent reviewers who were not involved in preparation of the inventory. The experts are national GHG inventory expert and registered at UNFCCC roster of expert which has undertaken the quality Assurance by putting the activity data in the 2006 IPCC software to check the quality of emissions and KCA. The UNEP Global Support Program also reviewed and commented on the overall reporting requirements.

Archiving: All documentation on the data processing and formatting are kept in soft copies in excel sheets with the summaries reported.

National Mitigation Policies and Targets

GoSE mainstreamed mitigation concept into sectorial policies. The Development of National Biodiversity Strategy Action Plan (NBSAP), National Adaption Plan of Action (NAPA), the Energy Development Framework and Strategy (EDFS) are few examples. Eritrea also integrated mitigation actions into its development strategies and action plans.

Fuel and electricity use in households can be characterized by inefficient lighting, heating and cooking systems; limited use of LPG for cooking and intensive biomass use for cooking

stoves. This situation is further aggravated by an inability to switch to more efficient and renewable energy generation. Promoting of alternatives to replace fuel wood to control woodcutting and preserve plant cover through promotion of LPG use for cooking. The introduction of renewable energy option aims at improving the security of electricity supply system, minimize dependence on unsustainable imported fossil fuel use and reduce GHG emissions from national power generation system through the following renewable policy options and renewable energy targets:

i) The introduction of 50 MW of Solar PV Power systems into existing national grid by 2030;
ii) The introduction of 15MW mini-grid hybrid system in rural towns and surrounding villages by 2030;
iii) The integration of 40 MW of Wind farms power plants into existing national grid by 2025;
iv) The integration of 30 MW of geothermal power plants national generation mix by 2030; and
v) The promotion of individual solar home systems (SHS) in rural areas to cover every rural household by 2025.

In addition to the above mentioned background, the country has also prepared and submitted the Nationally Determined Contributions (NDCs) in *2018*. The NDC presented the most recent business as usual and mitigation scenarios with aim of defining the potential emission reduction at aggregated national levels. The NDCs proposed 12% GHG emission reduction from Business as usual with unconditional scenario by 2030.

Mitigation Actions

To address these issues, the country has been implementing various mitigation actions in the Energy, Agriculture, Forestry and Other Land uses (AFOLU) sectors to reduce GHG emissions. The total GHG emission annually reduced by implementing these mitigations from BAU in Eritrea is 165.30 ktCO2 and 117.6 ktCO2 sequestrated over the targeted year. The mitigation actions by sectors are the following:

In the Energy sector the following key mitigation actions are mainly focused in three focal areas. These are the promotion of renewable energy, development of energy efficiency in household and transport subsectors.

In the area of **renewable energy**, activities are underway in the introduction of renewable energy such as: i) installation of Grid connected Solar PV system, ii) Installation Mini-Grid Solar PV system, iii) promotion of Off-grid solar PV in rural areas, iv) Wind farm for wind diesel hybrid and standalone system, and v) Geothermal power plants developed and interconnected into existing national grid. The expansion of renewable energy, it is estimated to contribute about 113 k tons of CO_2 emission reduction per year.

In the area of **energy efficiency**, the following activities are carried out to reduce greenhouse gases' emissions. The major activities are i) Power Distribution Rehabilitation (Efficiency Improvement) ii) Installation of Mini-Grid Solar PV system iii) Dissemination of improved traditional biomass stoves and iv) Promotion and Distribution of Solar Water Heaters in

household and Commercial sectors. From energy efficiency mitigation actions, a total of 4**9.7 k tons of CO_2 emission** is reduced per year.

The Energy efficiency targets are to increase the efficiency of exiting power generation systems and improvements in transmission and distribution facilities. The introduction and widespread penetration of efficient light emitting diode and efficient refrigeration as well as dissemination of improved traditional biomass stove in the household sector are main achievements. In the Fuel switching; the target includes switching from traditional biomass fuel to LPG for cooking and from kerosene wick lamps to electricity and solar lanterns in household. It also involved fuel switching from traditional biomass to diesel fired for commercial bakeries and to LPG other commercial food catering businesses. The penetration of renewable energy in the electricity generation mix will effectively include the development of small to medium scale, grid connected geothermal, wind and solar PV system. Widespread introduction of micro-mini scale standalone solar PV systems and water pumps to replace diesel pumps in shallow wells were considered.

In **transport** sub-sector, activities are underway in the promotion and encouragement of energy efficient mass transport and Vehicle importation control. These activities are expected to mitigate **2.6 $ktCO_2$.** It also by promotion and encouragement of solar pumps reduced 0.00195 ktons of CO2 per year.

In the Agriculture, Forestry and Other Land Uses (AFOLU) diversified activities are underway. These include, among others climate adaptation activities carried out at the national and local levels. Soil and water conservation activities to reduce soil erosion from farmlands and hillsides are carried out through community based endeavors. Although not quantified efforts to adapt and up-scale climate -smart agriculture to reduce GHGs emissions are also underway. The concrete undertaking in the AFOLU sector under implementation focus mainly in Forest Management and civic cultural activities to promote natural and assisted forest regeneration through afforestation and reforestation activities are underway. These endeavors sequester about 117.6 ktCO2.

Constraints and Gaps, and Related Financial, Technical and Capacity Needs

Inadequate institutional set up combined with limited manpower to handle climate change mitigation policies is setback. Hence climate mitigation policy and legislative framework needs to be emplaced. In addition, in adequate public and donor funding for delivering mitigation policies and actions as well as weak monitoring capacity of mitigation impact is a gap that needs immediate attention of decision making bodies. There is inadequate research capacity on clean energy technologies, and that results in insufficient information base as well as low public awareness on renewable energy and energy efficiency use.

The following are the major technical and capacity constraints that should be addressed immediately.

At macro-level, there is inadequate Institutional set including human resources to effectively handle climate change mitigation policies. Much remains to be done to adequately craft a Policy and Legislative Framework to oversee mitigation actions.

Inadequate public and donor funding for delivering mitigation projects is another setback to effectively and efficiently implement mitigation projects on sustainable basis. Once projects

are approved, there is weakness in monitoring and reporting capacity of mitigation activities to assess their impacts. This is particularly related with GHGs inventory and mitigation assessment. Focus should be given to the development of country specific emission factors in the energy sector and categorization of solid wastes. Further, there is a need to have comprehensive and up-to-date land use plan as well as information on the spatial and temporal dynamics of the forest cover of Eritrea.

There is no or inadequate research capacity on clean energy technologies. Introduction of renewable energy technologies need to be evaluated to assess their suitability and effectiveness which requires adaptive research capacities in solar, wind, and geothermal. The introduction of improved stoves should be reassessed to ensure that it is delivering the required level of efficiency and further improvements.

Inadequate knowledge management is critical in climate change GHGs inventory and mitigation assessment. There is dire need for establishing a sustainable data management, information generation and retrieval of data when and if needed for further reporting. As it stands now, there is low institutional memory regarding climate change.

Mitigation activities require active and proactive participation of the public. As it stands now, there is low public awareness regarding the risks involved in climate change in general and the links between climate change and the energy, AFOLU, IPPU and waste. Further, public awareness should be promoted in collaboration with the mass media and the press on the importance of renewable energy (wind, solar and geothermal) in general and energy efficiency uses from the view point of human welfare and costs.

1. NATIONAL CIRCUMSTANCES

1.1.INTRODUCTION

Eritrea is one of the developing African countries highly vulnerable to the impacts of climate change due to its geographical location. In recognition of this fact, the Government of the State of Eritrea launched a national youth campaign in 1994 to rehabilitate and restore the degraded natural resources which was neglected by successive colonial powers in the past. In this regard, particular attention was given to reforestation and soil conservation to reduce the impacts of climate change.

Since its establishment in 1988, the Intergovernmental Panel on Climate Change (IPCC) provided conclusive evidence that greenhouse gases (GHGs) concentration in the atmosphere are increasing beyond tolerable levels. Thus, GHGs cause global climate change thereby negatively impacting our planet. Eritrea having appended her signature and ratified in 1995 to the United Nations Framework Convention on Climate Change (UNFCCC) convention and duty-bound to fulfil its obligations undertook significant strides to respond to it. In this regards, the country is required to produce and regularly update national GHG inventories to enable it cooperate with the international community to tackle climate change issues and challenges. This step is also taken to comply with the obligation under Article 4, paragraph 1(a), and Article 12, paragraph 1(a) of the UNFCCC which requires developing, periodically updating and publishing the reports on the national inventories of anthropogenic emissions by sources and removals by sinks of all its greenhouse gases not controlled by the Montreal Protocol using comparable methodologies and following the provisions of Decision 17/CP.8.

The Initial National Communication (INC) and Second National Communications (SNC) were submitted to the COP in 2000 and 2012, respectively. The National GHG Inventories covered the years 1994 and 2000. Following this, the Third National Communication (TNC) summary of GHG for the years 2006, 2010 and 2015 are included. As a follow-up and updating the TNC, the BUR1 presents a summary of GHG emissions inventory conducted for the year 2018. The inventory covers anthropogenic GHG emissions from four sectors namely Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU) and Waste.

It is hoped that the description on the national economic developments as well as that of sectors would help readers to understand how the emissions in GHG inventory changed over time. It would also indicate potential reductions areas which are related to the requirements outlined in paragraph 3 of the guidelines for the preparation of national communications from non-Annex I Parties (Annex to decision 17/CP.8). This specifically focuses on the national and regional development priorities, objectives and circumstances, on the basis of which climate change and its adverse impacts is addressed. Such information features on geography, climate and economy which affect Eritrea's ability to deal with mitigating and adapting to climate change, as well as information regarding specific needs and concerns arising from the adverse impacts of climate change and/or the impact of the implementation of response measures.

1.2. GEOGRAPHICAL CHARACTERISTICS

Eritrea is geographically located between $12^{0}22'$ and $18^{0}02'$ north and $36^{0}26'$ and $43^{0}13'$ east. It is bounded by the Sudan to the north and west, the Red Sea to the east and northeast,

Djibouti to the southeast, and Ethiopia to the south. It covers an area of 124,320 km^2, with two major physiographic zones identified as highland and lowland. The country has a mainland coastline of approximately 1,200 km. and about 1,950 km of coastline around the islands forming the Dahlak archipelago. The elevation ranges from below sea level in the southern arid region to over 3000m in the central highlands.

1.3. ADMINISTRATIVE AREA

Eritrea is divided in to six administrative regions (Figure 1.1). Each region is further subdivided into sub – regions that vary in size and numbers. The names of the regions (Zobas) are: the i) Central (Maekel) ii) Anseba iii) Gash-Barka iv) South (Debub) v) Northern Red Sea and vi) Southern Red Sea.

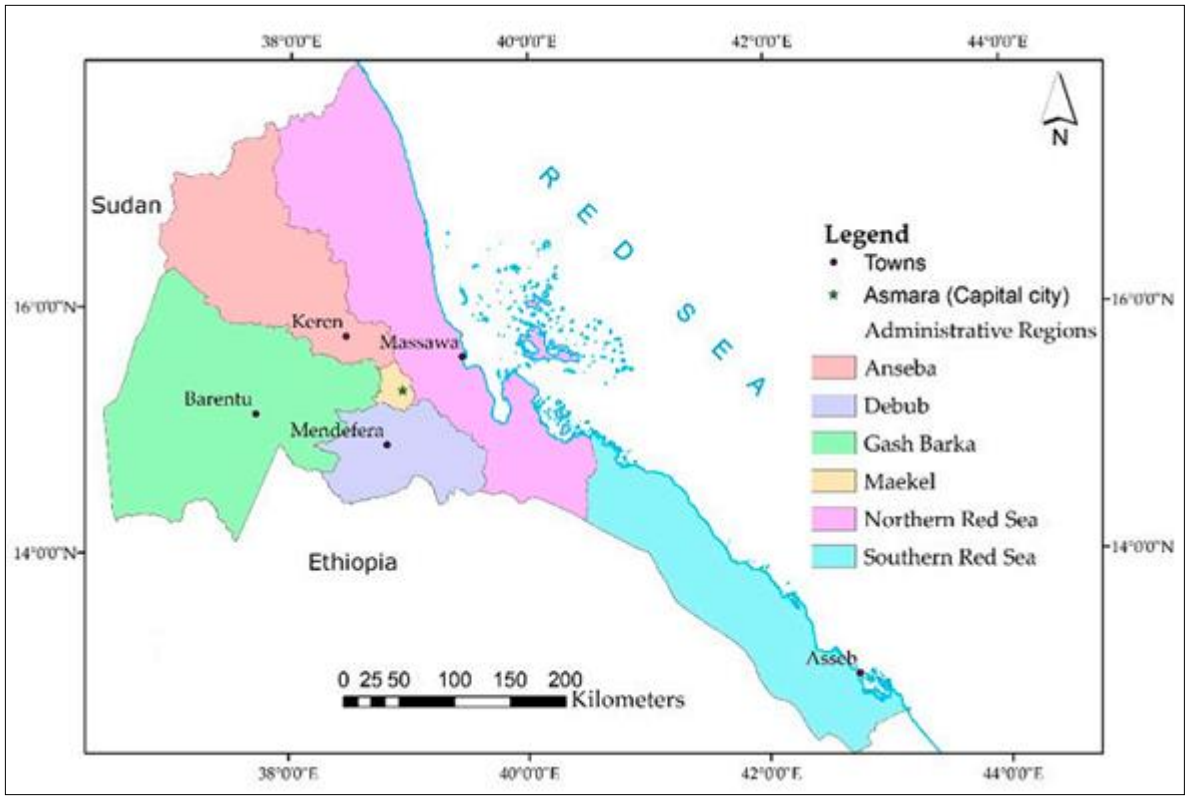

Figure 1.1: Administrative Regions of Eritrea

1.4. LAND USE

The Land Law Proclamation No.58/1994 (MoLWE, 1998), and Land Use Planning Regulatory Framework, (MoLWE, 1999) are the basis for Eritrea's land use policy. Piloting the land use plan which started in the central region of Eritrea is being up-scaled to other administrative regions of the country. Based on the land Proclamations, a pilot project on sustainable land management was carried out in *Zoba Maekel* using combination of remote sensing data and conducting discussion with key local informants using participatory rural appraisal tools and methods. The pilot project has proved to be successful; and Ii is expected to be expanded to cover the whole country in order to generate a much detailed and comprehensive land use plan for the country. Hence, a comprehensive land use plan for the country is in progress.

Meanwhile, the Ministry of Agriculture (MoA, 2002) identified seven land use categories. These are: i) Settlement Land, ii) Forest Land, iii) Crop Land, iv) Grass and Shrub Land, v) Grazing Land, vi) Wetland and vii) Bare and Other Land. Grazing land and bare land and other land altogether accounts for the largest proportion of the land cover system in the country Figure 1.2.

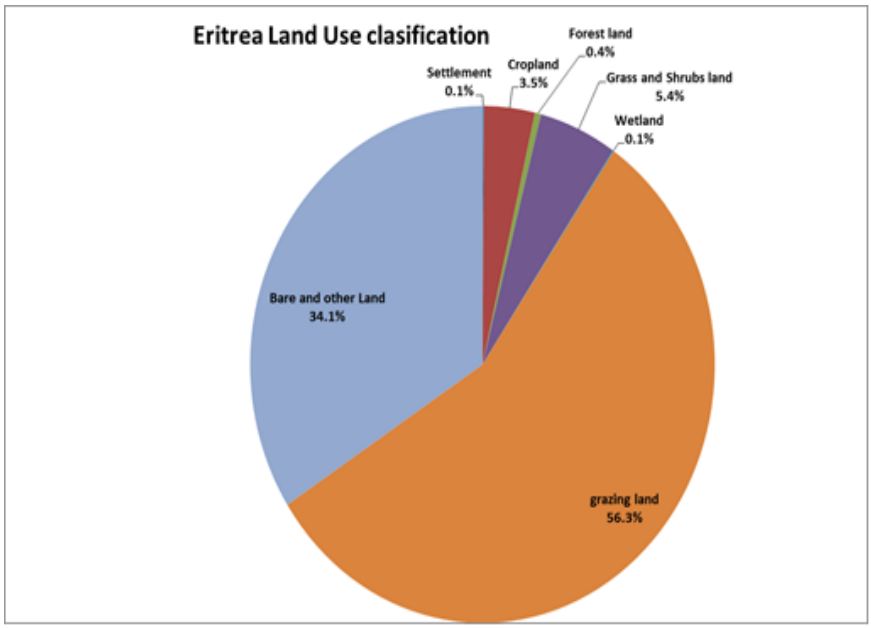

Figure 1.2: Eritrea Land Use Classification

Eritrea is predominantly an agrarian country with a large proportion of its population depending on traditional farming for sustenance. This being the reality, agriculture plays critical role in the local livelihoods and the national economy, although highly constrained by depletion of land productivity. Land degradation caused mainly by human activities is worsened by the changes in the environmental system. Overgrazing by livestock, inherently infertile soils, inappropriate resource management practices and inadequate measures for sustainable land management accelerate the land degradation processes. In an effort to create a green economy, the Government of the State of Eritrea has adopted strategies for environmental reclamation, which are incorporated into the National Action Programs (NAPs). Despite substantial efforts in soil and water conservation activities, land and forest degradation still remains one of the major environmental problems in the country.

1.5. ECOSYSTEMS

The ecosystems of Eritrea are grouped into two major categories. These are terrestrial and marine coastal and island ecosystems. Terrestrial ecosystems include agro ecosystems, forests, woodlands, scrublands and riverine areas. On the whole, the Eritrean ecosystems are divided into six agro-ecological zones (MoLWE, 1997). These are i) semi desert, ii) arid lowlands, iii) moist lowlands, iv) moist highlands, v) arid highlands and vi) sub-humid agroecological systems (Figure 1.3), The description of these ecosystems is summarized in Table 1.1.

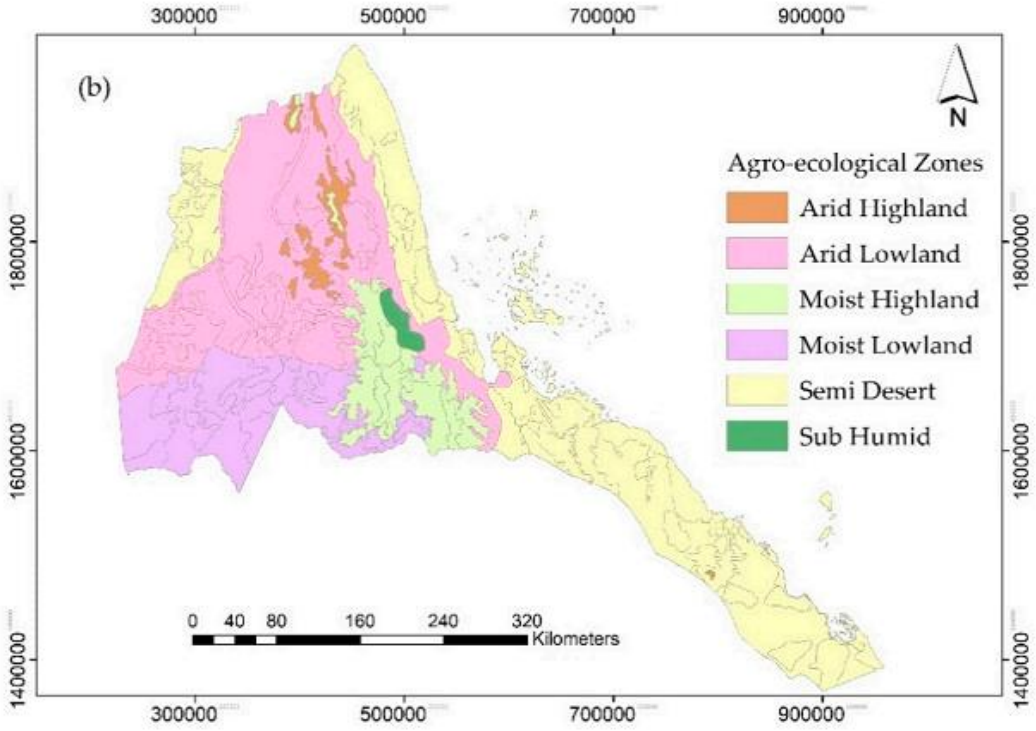

Figure 1.3 Agro-Ecological Zones of Eritrea (MoLWE, 1997)

Table 1.1: Description of the six agro ecological zones in Eritrea

Agro - ecosystems	**Description**
Semi-Desert ecosystems	Occupies the largest area of the country (39 %) ranging from hot to very hot climate. The dominant form of land use in this agro-ecological zone is flood irrigation and nomadic pastoralist.
Arid Lowland ecosystems	Occupies the large part of the north-western lowlands and covers 34% of the total land surface of the country. High temperatures and irregularity in precipitation characterize the climatic conditions of this zone, which imply factors of unpredictability. Livestock rearing is the main economic activity.
Moist Lowland ecosystems	It covers an area of about 16 %of the total land surface of the country. It consists of some the most productive agricultural lands in the country, which are suitable for rain-fed and irrigated agriculture.
Moist Highland ecosystems	It accounts for33% of the total cultivated land in the country and for 26 %of the total annual crop production. Rain-fed agriculture is the dominant form of economic activity.
Arid Highland ecosystems	It is sparsely populated zone that covers 3 %of the land surface of the country. It is characterized by deficiency in rainfall and a short growing season. Rain-fed agriculture and pastoralist form the basis for livelihood.
Sub-Humid ecosystems	A small stretch of land covering only 0.8 %of the total land area of the country. It is located in the Eastern Escarpment receiving bi-modal rainfall. The zone is commonly referred to as the Green Belt Zone and biologically it is the most diversified part of the country.

1.6. POPULATION AND DEMOGRAPHIC PROFILE

Based on a population studies by the National Statistics Office (NSO), the total resident population of Eritrea was about 3.2 million (MoND, 2010). Accordingly, the population density is estimated to be 0.04 km^2/ Person. The population is essentially rural with about 65 %of the people living in the countryside. The urban population is characterized by rapid growth as the result of rural-urban migration and urbanization. The population of Eritrea is not uniformly distributed throughout the country. About 50-60 %of the population lives in the highlands. Eritrea is a multi-ethnic society with nine different ethnic groups speaking nine different languages.

The country's population is essentially young, with children below age 15 years accounting for 41 %of the total. Dependency ratio is high, which indicates high fertility rates. The rate of population growth is higher in the rural areas than urban areas as there are strong inclinations among both men and women in the countryside for having as many children as possible, with no preference of one sex for another. The geographic distribution of the population shows that highlands are densely populated than the lowlands. The distribution of household by sex in % of the six regions of the country is different. Overall, in the six zoba's the % of male is higher than that of female (Table 1-2). Significant improvements in early childhood mortality rates have been observed in both rural and urban areas, which as a result, Eritrea's population is expected to grow rapidly in the coming decades. The rapid population growth rate, in turn, will have implication for the country's development.

Table 1.2: House hold composition (Source: MoND, 2010)

Characteristic			Zoba						
	Residence		Debubawi Keih Bhri	Maekel	Semienawi Keih Bhri	Anseba	Gash Barka	Debub	Total
	Urban	Rural							
Household Head									
Male	47.0	56.0	50.9	47.4	62.3	57.4	62.0	43.2	52.8
Female	53.0	44.0	49.1	52.6	37.7	42.6	38.0	56.8	47.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1.7. THE EDUCATION SECTOR

Eritrea made significant efforts to ensure equitable access of education across all of its regions. The number of students, teachers and schools has increased at all levels. Many previously unreached and disadvantaged areas benefited from investments in infrastructure, curriculum improvement and deployment of trained teachers. A complementary primary education program has been developed to provide catch-up education for children who missed the opportunity for formal education. Though Eritrea made quite a remarkable progress in terms of increasing school enrolment, the Gender Parity Index is slightly skewed towards male students. The most critical challenges that limit girls' education are related to economic and social conditions. A major strategy to enhance women's participation in education focuses on alleviating social barriers that hinder the participation of girls in education. In view of this, the National Gender Plan of Action (2003 - 2008) identified critical constraints to girls' education and outlined strategic objectives and plan of actions to

address the problems. Furthermore, the country has accomplished well in expanding adult literacy, which is part of the country's basic education system.

1.8. THE HEALTH SECTOR

Eritrea adopted the National Health Care Policy (NHCP) and Health Sector Strategy (HSS) to provide basic health services to the wider sections of the population. The outcome has been an increase in accessibility to the health facilities within short distance. Eritrea made extensive progress in terms of building health infrastructure with the aim of promoting access to health services. In general, the main contributing factors for the progress in the health sector of the country are increased number of professional health workers and expanded facilities. A further improvement in the sector is the reduction in the prevalence rate of HIV, TB, and Malaria. The rate for HIV has lowered substantially, while malaria has been put under control as the country moves toward pre-elimination phase. Morbidity and mortality from measles have also gone down. Building on the progress to date, infant immunization has also shown a remarkable success in terms of coverage at a national level. Eritrea is one of the few countries to have achieved the Millennium Development Goals (MDGs) for health before the timeline set. Maternal Mortality Rate (MMR) has been reduced significantly.

1.9. CLIMATE

Extreme precipitation changes over Eastern Africa including Eritrea such as droughts and heavy rainfall events have been experienced more frequently during the last 30-60 years. The risk of loss of rural livelihoods and income due to climatic hazards is particularly real in arid and semi-arid regions, largely inhabited by communities engaged in agriculture and pastoral livelihood systems. In addition to drought and climate related hazards, Eritrea, face a number of other challenges which include resources scarcity, land degradation, low productivity (both livestock and crops), overgrazing and deforestation. In Eritrea, it is estimated that 74.77% GHG emissions comes from AFOLU which are highly dominated by livestock sector.

1.9.1 TEMPERATURE

The climate of Eritrea is most influenced by altitude and topography causing variations in temperature. Average temperature varies considerably with the eastern lowlands and western lowlands having average annual temperatures of 31^{o}C and 25^{o}C, respectively, while in the highland regions the annual mean is 21^{o}C. Since 1960, historical records show that the mean annual temperature has increased by 1.7°C which is an evidence of the effect of climate change (MoLWE, 2018).Based on the following network of the weather channels of Atlas (https://www.weather-atlas.com/en/eritrea/massawa-climate), it indicated that the eastern lowland mean the representative of Massawa is very high in Temperature as compared the high land representative of Asmara in Figure 1-4 and 1-5.

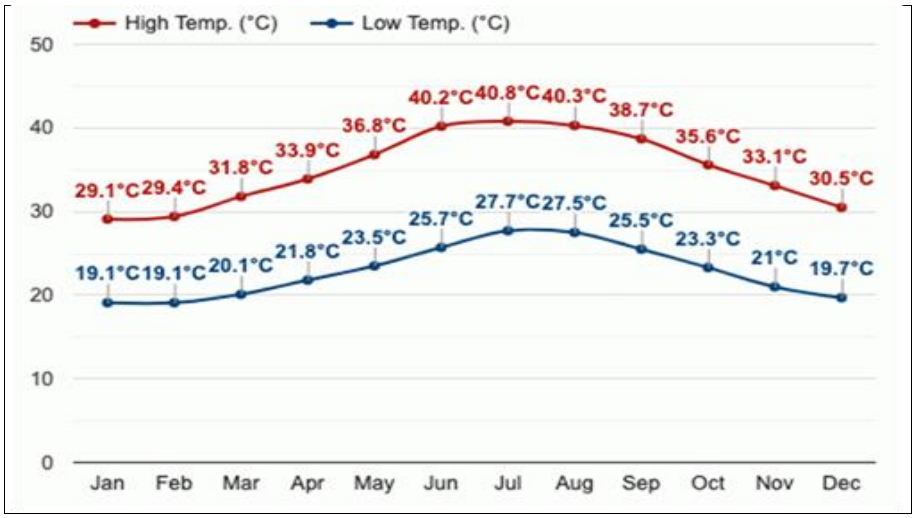

Figure 1.4: The Daily Average High (Red Line) and Low (Blue Line) Temperature of Massawa

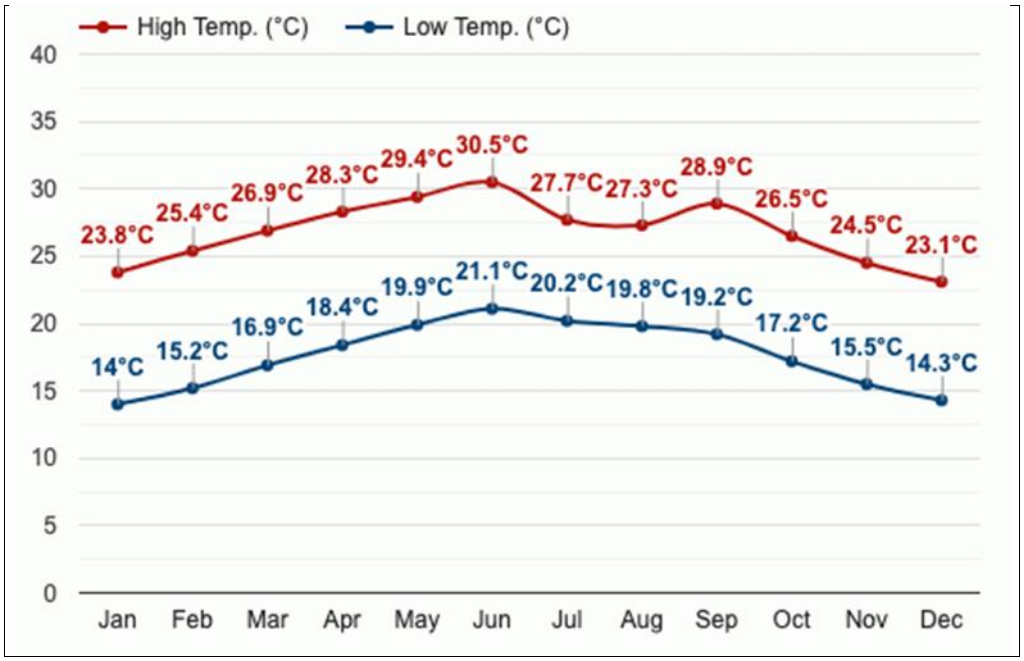

Figure 1.5: The daily average high (red line) and low (blue line) temperature of Asmara

1.9.2 RAINFALL

In Eritrea, there are two major rainfall regimes namely summer and winter rainfall regimes. The summer rainfall regime (big rains) starts in late June and lasts up to early September. It is normally preceded by small rains traditionally called *Akeza* in the highlands as indicated in Figure 1-6. This rainfall regime covers most of the south, middle and northern highlands, western and south western and north western Lowlands. While the mean annual rainfalls in the south western lowlands range from 400 to 700mm (Figure 1-6) of Asmara representing the average rainfall of the highlands. In the north western lowlands, the rains are less than 300mm.

The Eastern escarpment and Lowlands receive rains in winter rainfall regime that occurs between October and March sees Figure 1-7 of Massawa as representative of the eastern

lowland average rainfall. In this region, the amount of rainfall varies in space and time. It ranges from less than 50mm and 200mm in the coastal areas to more than 1000mm.

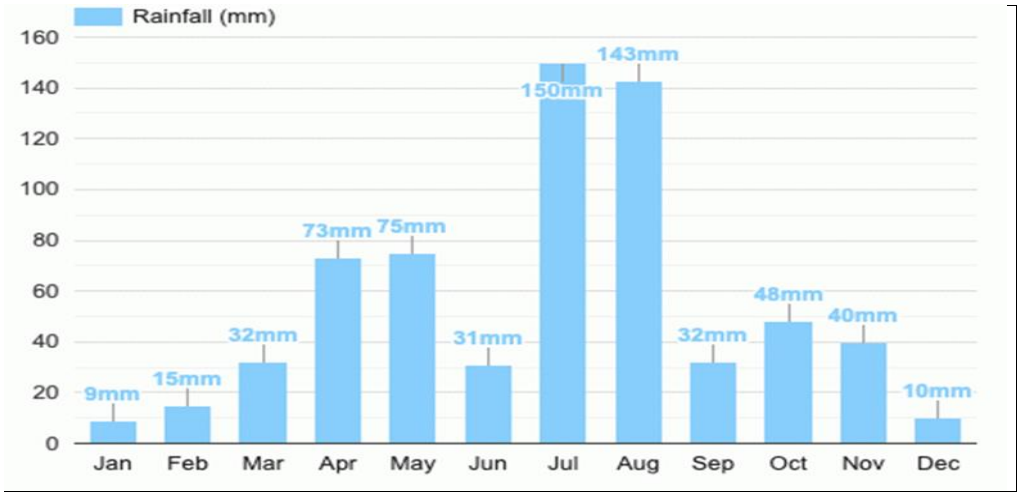

Figure 1.6: Asmara Average rainfall

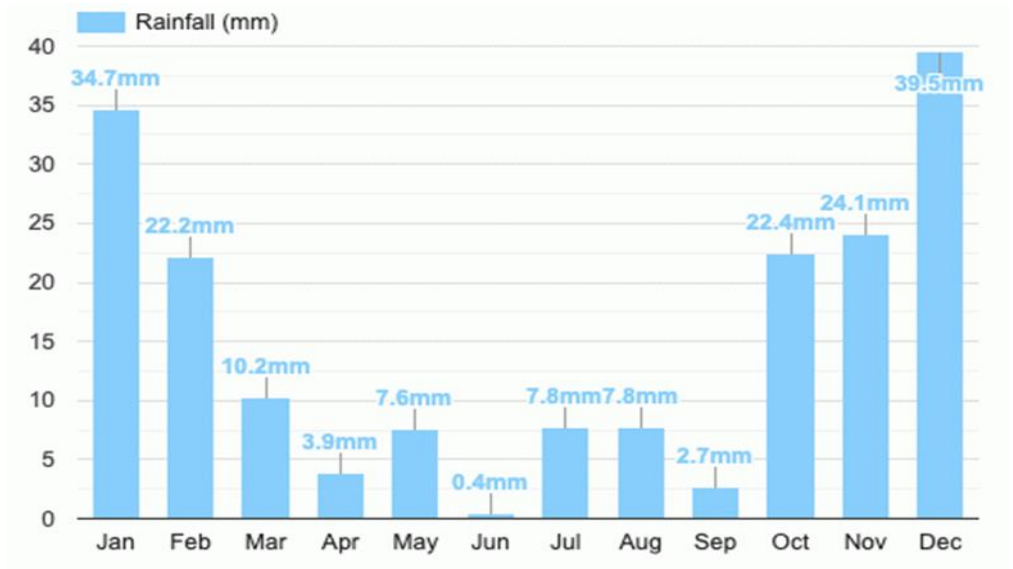

Figure 1.7: Massawa average rainfall

1.9.3 AIR POLLUTION

The draft preliminary study on Asmara Ambient Air Quality indicates that some concentration of pollutant gases in the ambient air of the atmosphere and the average concentration of CO_2 is 309.3 ppm. The study particularly targeted the high populated and industrial city of the country and the systematic ambient air data recording undertaken in eight locations. The study was conducted from May-December, 2019 and the results of these eight months are compiled and converted to AQI to compare with the World Health Organization (WHO) standards. The maximum and minimum as well as the mean averages concentrations of the target pollutant gases of the eight locations are as shown in Table 1-3. Generally, it shows that there is a slightly composition of the pollutants in the atmosphere of the city.

Table 1.3 Asmara air Pollution

Types of pollutants	Overall Records		
	Min	Max	avg
CO (ppm)	0.011	2.075	0.256
NO_2 (ppm)	0.121	0.193	0.152
PM10 (mg/m^3)	0.026	0.277	0.087
PM2.5 (mg/m^3)	0.011	0.092	0.025
SO_2 (ppm)	0.002	3.201	0.077
CO_2 (ppm)	247.617	472.064	309.300

Based on WHO air quality index standard, some of the pollutants are hazardous related to health especially $SO_2$and PM2.5 around the waste dump site of Skarico as it indicated in Figure 1-8.

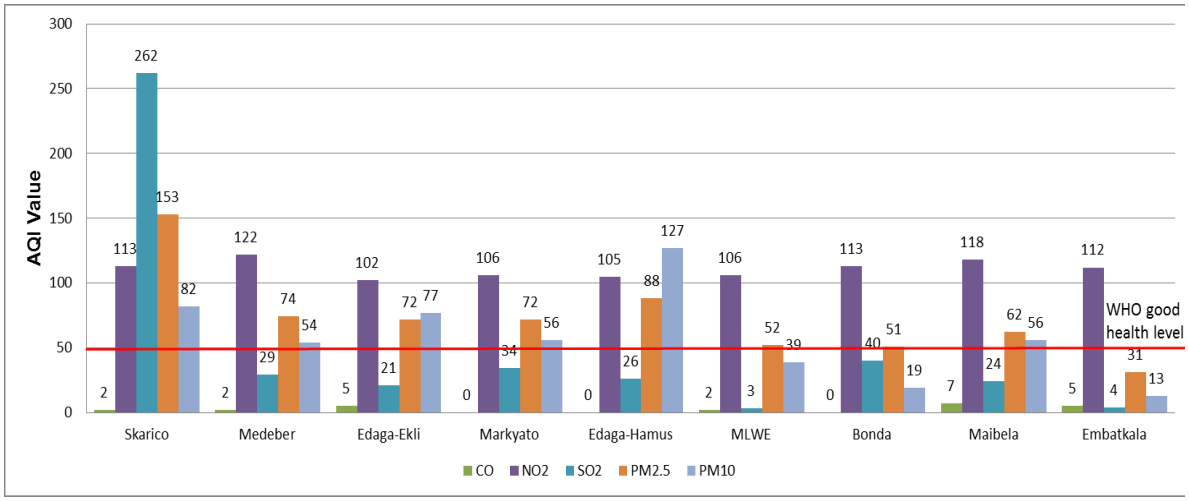

Figure 1.8: Comparison of Pollutants in Asmara with WHO AQI Standard

1.9.4 EXTREME EVENTS

In Eritrea, most of the time is a dry weather but sometimes extreme weather events like flooding and hails occur at different seasons in the highlands of the country and rainstorms in the western and eastern lowlands of the country. For example, in August 2001, high flooding occurred, in Asmara l and likewise in May 2015 violent hail storm occurred in the same place which damaged infrastructure and created transport congestion (Figure 1-9).Also other events like volcanic eruption happened in southern red sea region.

Figure 1.9: Flood in August 2001 and Hail in May 2015 at Asmara

1.10. ECONOMIC PROFILE

Eritrea's immediate development priorities have been set to meet the basic needs of the population. To this effect, on the onset, the GOSE formulated Macro Economic Policy, which clearly stipulates the need to enhance national economic development and to monitor the changes in the natural environment. It also prepared the National Economic Policy Framework to optimize resource use and sustain human development. Moreover, the country's Interim Poverty Reduction Strategy Paper (I-PRSP) has been a milestone in directing development interventions (MoND, 2004). The long-term objective of the I-PRSP is to attain rapid and widely shared economic growth with a steady and sustainable reduction in poverty. I-PRSP is based on the following pillars (i) Provide strength to economic growth; (ii) Create income earning opportunities for the poor; (iii) Enhance access to essential services for human development; and (iv) Promote economic, social and political participation of the population by creating an enabling environment. The I-PRSP further states that the private sector, non-governmental and community-based organizations all have vital roles to play in meeting the challenges of poverty reduction.

1.11. AGRICULTURE

Agriculture has been a cornerstone of the Eritrean economy and still is the main source of income and food security for the largest proportion of the population. It plays significant role in reducing poverty and support industrialization. Further, it is critical for achieving export growth, employment generation, and supply of raw materials for agro-industrial processing. Today, agriculture's contribution to the country's Gross Domestic Product (GDP) is estimated at 20.3% (MOA, 2016).

More than 73%of the population is directly or indirectly engaged in either subsistence or commercial agricultural activities. From a biodiversity perspective, the agricultural sector has considerable importance both in global and local terms. The diversity of crop, forage, shrub and tree browse landraces found in Eritrea has global conservation significance because Eritrea is primary and secondary centre of diversity for a number of cultivated crops. More importantly, the genetic diversity of these and other crops and forages in Eritrea plays vital

role in the agricultural strategy of farmers, especially those practicing rain-fed agriculture. Cultivation of a range of different landraces provides on-farm conservation of the crops and securing total failure of crops and livestock under harsh conditions.

1.11.1 CROP PRODUCTION

The farmers produce cereal crops, oil crops, pulses, fruits and vegetables primarily for subsistence use, but they also sell a small portion of their produce at the local markets. The farm sizes are small and highly fragmented, particularly in the densely populated Central Zone of the country. Farming practices remain traditional and the use of mechanization and modern agricultural inputs are highly limited. In addition, agriculture suffers from unpredictable weather conditions and wide seasonal price fluctuations. As a result, domestic food production, even in good years, remains well below the requirements forcing the country to rely on commercial imports. Other critical challenges impeding the development of agriculture includes limited availability of water resources, insufficient modern farming inputs, poor marketing channels, and limited access to credit. Female-headed households represent a typical group within the vulnerable segment largely because they lack sufficient labour and own fewer assets.

1.11.2 LIVESTOCK PRODUCTION

Livestock occupy a place of significant importance in the economic and social lives of rural communities in Eritrea. They are sources of food in the form of meat and milk. They acquire cultural significance as indicators of a person's social status and play a crucial role in agriculture as plough animals and as a means of transport in rural areas. Besides, the country generates significant revenue through export of live animals and frozen meat. Since recent times, Eritrea suffered from sharp fluctuations in livestock production. The causes are linked to human factors and to the changes in climate. Livestock are kept in traditional grazing systems with low level of productivity. Shortages of pasture and water points, caused mainly by climate change and deteriorating land quality also hamper livestock economy of the country.

The Veterinary Institute of Asmara, though it went through a gradual decline during the colonial times, is currently playing crucial role in tackling animal health problems. Veterinary facilities have been expanded and a large number of assistant veterinarians have been trained during post-independence period. The outcome has been a substantial reduction in the outbreaks of major livestock diseases. The institute, at present, is engaged in diagnosis services to plant and animal diseases, and in monitoring food safety and quality services. It provides research support to prospective graduates from the various colleges in the country. At present, the institute is working hard to come up with viable vaccine production.

1.11.3 FISHERY

Eritrea has extensive and underexploited marine and fishery resources. Extensive continental shelf and the coral reefs along the coastline and islands are rich in marine organisms and biodiversity. There are around 1,000 known species of fish of which 250 species are of commercial importance. Small pelagic fish account for 62 % of the total fish catch. The Maximum Sustainable Yield (MSY) of Eritrea Red Sea fisheries is estimated at about 80,000 tons per year (MoMR, 2018). But, the annual domestic fish production is much lower than

the potential. It should be noted, however, a relatively large quantity of fish and fishery products from the artisanal fisheries are informally exported to neighbouring countries.

The Macro-Economic Policy of Eritrea provides wider legal context for the development of the fishery sector. The policy, more specifically, aims to attain the following strategic objectives:

- Increase the profitability of artisanal fisheries by strengthening the fishers' cooperatives;
- Enhance food security and the provision of employment opportunities for the coastal population;
- Increase foreign exchange earnings through the export of fish and fish products, and
- Encourage domestic fishing market through promoting local fish consumption.

At present, problems concerning lack of data regarding the precise fishery stock and inadequate market linkages are the main challenges that constrain the development of the sector. The Ministry of Marine Resources in collaboration with International Food and Agriculture Development (IFAD) is working to enhance the productivity of the artisanal fishery.

1.12. ENERGY AND MINES

Eritrea has favourable geology for mineral resources which largely remained unexplored by modern exploration methods. Its geological formation is made up of tertiary geological formation. Several high-grade volcanic massive sulphide (VMS) discoveries were made in the past few years. It is endowed with significant precious minerals, base metals and, industrial and construction materials that can support the development of a viable mining industry. There are rich deposits of gold, copper, iron ore, lead, magnesium, nickel, potash, silver, zinc and chromium. In addition, the country possesses proven reserves of industrial and construction materials that include basalt, cement, clay, coral, granite, gravel, gypsum, limestone, marble, salt, sand, and silica. The development of the mining sector is believed to have a good prospect to the economic development of Eritrea.

1.13. WIND AND SOLAR ENERGY

At present, the energy requirement of the households is met from biomass sources that account for huge proportion of the total energy consumption. Estimate shows that 83 % of total energy is extracted from bio-fuels. Excessive dependence on biomass has, however, significantly contributed to the clearing of forests and woodlands. Such unsustainable practices have led to the overall reduction of Eritrea's terrestrial biodiversity. The large share of biomass in the total energy balance is partly due to low energy consumption by vehicles and industries. As part of a long term development strategy, the Government in collaboration with its development partners piloted a wind energy project in 2010 in the Southern Red Sea region, which consists of a wind farm with a capacity of 750 kilowatts. Five small stand-alone decentralized wind turbines were installed in the villages of *Rahayta*, *Gahro*, *Barasole*, *Edi*, and *Beylul* Figure 1-10. The Government has also embarked on solar projects that provide modern, affordable and sustainable energy to the previously off-grid villages and

rural towns. A good example is the solar power project that aims to serve over 40,000 residents in the southern part of the country (Ministry of Energy and Mines ARMA Project). This is expected to improve the livelihoods of the rural population through increased income and access to social services. The project will also contribute to the Sustainable Development Goal 7 (Affordable and Clean Energy). The project is anticipated to reduce carbon emission substantially.

The country has also huge development of prospect for the geothermal energy. There are many renewable energy (e.g. solar PV) projects and energy efficiency projects implemented or planned to improve the supply and accessibility to modern energy.

Figure 1.10: Wind Energy practice around Asseb

The energy sector of Eritrea is constrained by Excessive and inefficient consumption of wood fuel for domestic usage, old energy infrastructure, including power plants, transmission and distribution systems, and low level of awareness and information about energy conservation practices. As a matter of policy, the energy sector is determined to provide an efficient, economic, reliable and sustainable supply of affordable energy throughout the country. The primary objective in the energy sector is to avail ample, dependable and sustainable energy for the growing needs of all economic and social sectors at an affordable price. Generally in Eritrea, the most liquid fuel consumption is in Electricity generation followed by transport sector as indicated in Figure 1-11 and from fuel type the biomass is highly used in the country as shown in Figure 1-12 for heat production and cooking food.

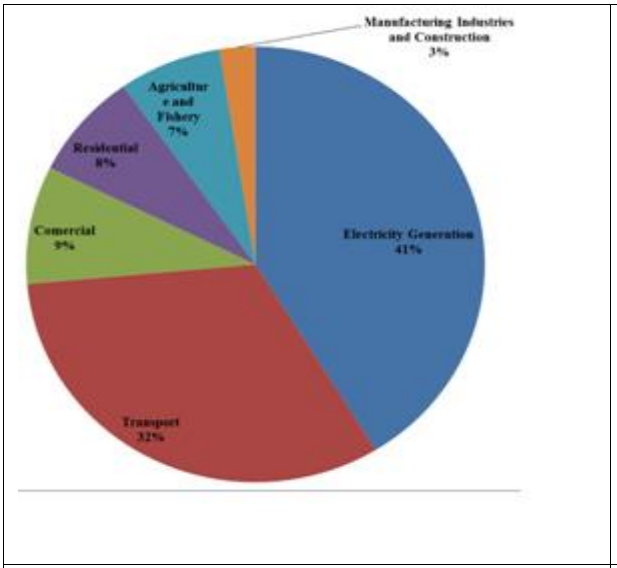

Figure 1.11: Share of Energy Consumption by sector

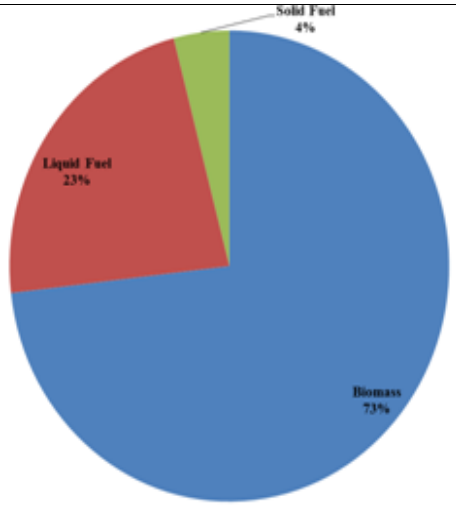

Figure 1.12**:** Share of Energy Consumption by Type

Although much is done to generate energy from various sources; there are considerable losses (22%) all along the lines of production and consumptions (Figure 1-13). There are also stride to improve the traditional stoves used in the countryside and small towns (Figure 1-14)

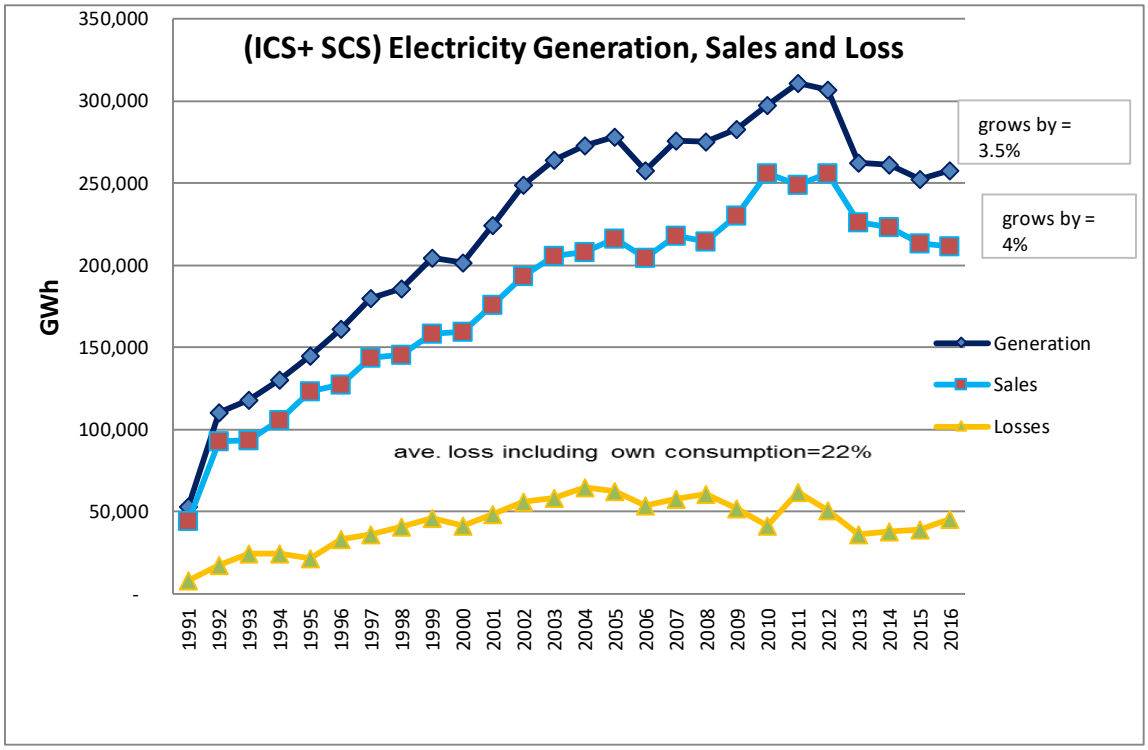

Figure 1.13: ICS + SCS) Electricity Generation Sales and Losses

Figure 1.14 Traditional Improved stove (Adhanet Mogogo) training and demonstration in Eritrea

1.14. TRANSPORTATION

The main modes of transport in Eritrea comprise road, railway, water and air. The road transport, in particular, is critical as it meets much of the demand for passenger and freight services; and hence has a significant contribution to the overall development of the country. Road transport has undergone improvement as a result of the rehabilitation work and the opening up of new routes and terminals. The Eritrean highway system is categorized into primary, secondary and tertiary levels. The tertiary level is the lowest level in the road category, and serves mainly the rural areas. It is a dry weather road that makes travel during the rainy season difficult. The next higher level in the road classification system is secondary, which is an all-weather gravel road that connects district centres with the regional capital centres. Primary roads are those that are fully asphalted throughout their entire length. They carry traffic between all the major towns in the country. Table 1-4 presents the total of 15,023km of road in the country of which 33.7%consist of asphalt and all weather roads (MoTC, 2016). The most fuel consumption in transport sector is passenger cars that are 54% of the road fuel consumption as it indicated in Figure 1-15(DOE, 2019).

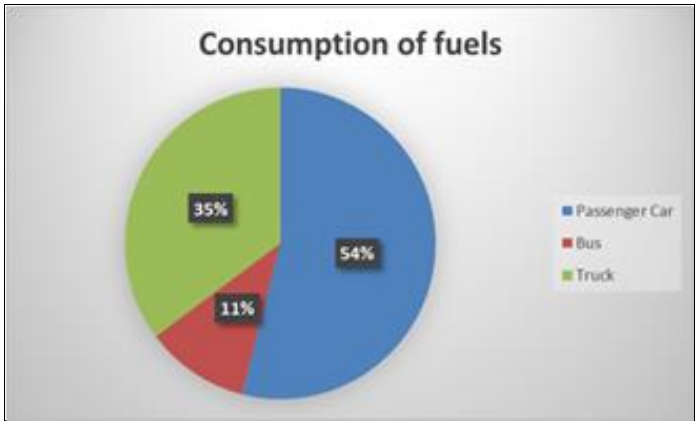

Figure 1.15: Fuel consumption in the transport sector

The International airport in Asmara manages all international flights into the country as well as being the main airport for domestic flights.

Table 1.4: Updated data on Total number/length of Transport Infrastructure transport infrastructure

SN	Type of Road	Km	Per cent
1	Asphalt Roads	1,271	8.5
2	All Weather Roads	3,787	25.2
3	Dry Weather Roads	9,942	66.2
4	Airports (Landings And Take-Offs) international airports (no)	3	0.1
5	Landing Strips(domestic air ports (no)	11	0.1
	Total	**15,023**	**100**

Source: Ministry of Transport and Communication, 2018

The railway transport system of Eritrea began with the advent of the Italian colonization carrying both passengers and freight at a limited capacity. There was a total of 317 km narrow gauge rail line linking Asmara with major towns linking the port city of Massawa and Akordet. However, the rail transport remained non-operational from 1978 due to the intensification of the liberation war until it was reopened in 1994. Some rehabilitation works took place in recent years, and as result, the line from Massawa to Asmara had been restored. Currently, there are no railway links with neighbouring countries. The sea transport, the country possesses ships that consist of a bulk carrier, a cargo ship, a liquefied gas, a petroleum tanker and a Roll-on Roll-Off ship with a total gross tonnage of 16,069 tons.

In TNC, it is indicated that transportation sector is significantly contributes to the GHG emission to the environment compared with the other sectors except AFOLU and electricity generation. It emits toxic gases to the environment mainly due to the fact that most of the vehicles in the country are old vehicles especially the trucks and buses. The Road Vehicle Exhaust Gas Analysis Using Environmental Combustion Analyser (ECA 450) study in Eritrea indicates that the trucks, buses and passenger cars emit toxic gases to the environment. Based on the study and analysis carried for the gasoline vehicles, the average concentration of toxic pollutant gases; CO, HC, and NO_x measured at the exhaust emission are 158.56 g/km, 55.67 g/km and 5.52 g/km respectively. Whereas the average concentration of emission of these same gases from diesel vehicles are 11.52 g/kWh, 6.57g/kWh and 0.92 g/kWh respectively. Generally comparing these national tested vehicles emission of toxic gases with the standards of other countries, it indicates that 51.8% of the gasoline vehicles and 24% of the diesel vehicles are above standards. The study also reflects the emission of sulphur dioxide (SO_2) through the exhaust stack and the result indicated that 272.28 ppm from Gasoline vehicles and 74.47 ppm from diesel vehicles. The %of toxic emission through the exhaust stack of the engine from the study is shown in Figure 2-16.

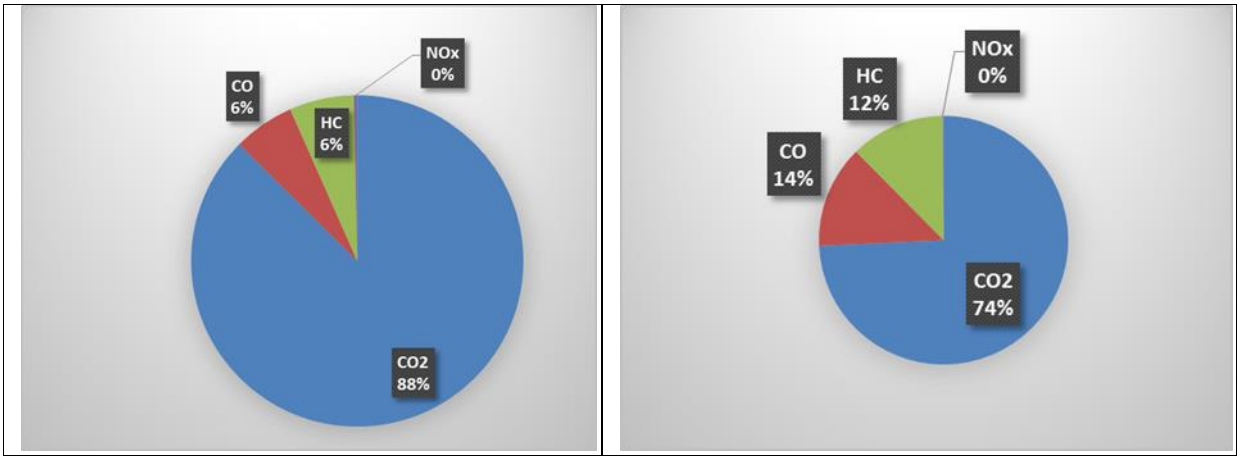

Figure 1.16: % of measured pollutants from a) diesel vehicles b) gasoline vehicles

1.15. INDUSTRY

Manufacturing industry has the potential to become a significant contributor to Eritrea's growth and development. The country's strategic location along the world's busiest shipping route offers opportunity for accessing export markets, while there is large potential for import substitution. During the Italian colony, the country had a well-developed industrial economy in Africa. The long war for independence and the border conflict with Ethiopia that followed, however, had an adverse effect on the country's manufacturing sector. Eritrea possesses manufacturing sectors that range in type from food and textile to chemicals and construction materials (Table 1.5). However, the industries operate below capacity for reasons including lack of raw materials. The country imports a wide range of agricultural and industrial items from Asian, European, African and the Middle East countries (Table 1.6). The import values for food, textile and garment account for the largest amount of expenditures compared to all other items imported. Similarly, the country earns substantial amount of revenue from its exportable items that mainly include textile, and leather and shoe. Since recently, the mining sector is increasingly becoming a driving force to the economic growth of Eritrea.

Table 1.5 Manufacturing Sectors of Eritrea

SN	Sub-sector	Number of Establishment	Capacity in per cent
1	Food and Beverage	83	41
2	Textile and Leather	33	42
3	Paper and Printing	15	29
4	Chemicals, Paints & Pharmaceuticals	23	27
5	Rubber and Plastic	11	39
6	Construction Materials	32	48
7	Metal	17	26
8	Furniture	32	41
	Total	246	36.63

Source: Ministry of Trade and Industry, 2019

Table 1.6. Main Agricultural and Industrial items partner for Import and Export

Serial no	Sub-Sector	Partner Countries
1	Food	Asia, Europe, Africa and Middle East
2	Textile and Garment	“
3	Tobacco	“
4	Leather and Shoe	“
5	Paper and Printing	“
6	Chemicals	“
7	Plastic and Rubber	“
8	Furniture	“
9	Construction Materials	“
10	Metal	“

Source: Ministry of Trade and Industry, 2019

1.16. WASTE

There are four types of wastes. These are (i) municipality waste including household wastes, commercial wastes and demolition wastes, (ii) hazardous wastes including industrial wastes, (iii) biomedical wastes such as clinical wastes (iv) special wastes including radioactive, explosive, and electronic wastes. In Eritrea, solid waste is generated by domestic, agricultural, commercial and industrial activities; whereas waste water is generated predominantly through domestic, commercial and industrial activities. As in most countries, waste generation in the country is attributed to population growth, industrialization rate and urbanization trend. In addition, GHG emission in the waste sector is affected by the type of treatment exercised and disposal mechanisms in the country.

Solid wastes are generated from households, offices, shops, markets, restaurants, public institutions, industrial installations, water works and sewage facilities, construction and demolition sites, and agricultural activities. Municipal wastes are those wastes collected by municipalities or through other local authorities. In Eritrea, the waste management is not well controlled except those collected by the municipality in the urban areas that disposed, without any segregation process, to the land disposal site. These wastes deposed at the land disposal also practiced open burning without any treatment except the medical waste that are burned in the pit and after it finish the ashes and other remaining materials were buried. The other waste generators that lack trucks discard their wastes everywhere and use open burning by collecting during the sanitation program particularly during weekends.

More than 60% of the population of Eritrea lives in the rural areas and discards their daily waste around the rivers and farm lands. The managed waste generation from the urban areas by the municipality is increasing from the base year of 2000 as shown in Figure 1-17. This is because of the urbanization and there is no any practice and initiate of 3R (Recycle, Reuse and Reduce) in the country.

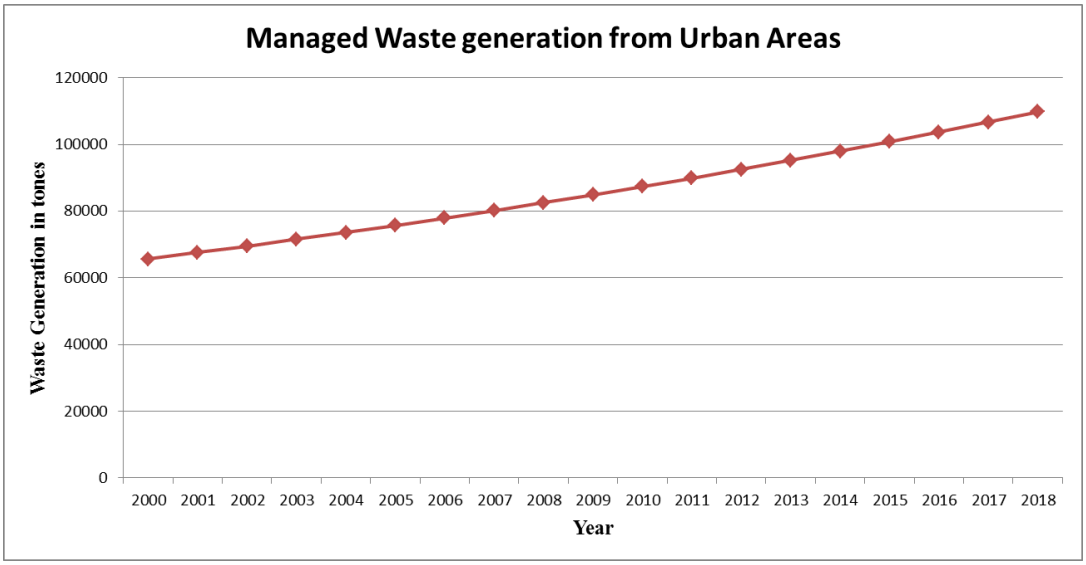

Figure 1.17: Trend of Urban Waste Generation

1.17. NATIONAL DEVELOPMENT PRIORITIES AND OBJECTIVES

As indicated in the Nationally Determined Contribution (NDC) document, the national development priorities relevant to climate change, Eritrea will raise the share of electricity generation from renewable energy qualitatively and quantitatively medium plans.

Qualitatively, Eritrea will diversify the electricity generation from various sources including wind, solar and geothermal energy sources. Quantitatively, the country will significantly increase from the current fossil fuel based energy generation to 70% penetration to the total electricity generation mix using renewable sources. Furthermore, it intends to reduce transmission and distribution losses at least by 50%. On the other hand, to enhance energy conservation, it will introduce rapid bus transit system (rail transportation) to cover about 2000 km for mass transportation of passenger and freight; as well as use of big buses for passenger transport to long distances. The ultimate goal is to reduce the GHG emission there by safeguarding the environmental and human health (MoLWE, 2018).

Parallel with the on-going climate mitigation actions mentioned in the previous paragraph, adaptation activities especially on intensive greening and coastal area management will continue to protect and restore the ecosystems to enhance the resilience of the environment as well as improve the coping mechanism of the population. In this regards, Eritrea has been undertaking different efforts of afforestation, reforestation, Soil conservation and plantation on terrestrial ecosystems. It will also focus on the mangroves around the coastline and undertake effective and efficient integrated coastal area management to protect coastal erosion.

1.18. ENVIRONMENTAL CONTEXT

Eritrea suffers from intense environmental degradation as a result of a complex set of factors including long and short-term climate changes, expansion of settlements, agricultural encroachments and excessive use of fuel wood. Loss of plant cover through continued deforestation has affected the hydrological conditions making the water supply unreliable. The problem is further aggravated by the use of animal dung as source of domestic fuel and absence of input replacement for the nutrient loss. Land degradation is prevalent throughout

the country particularly in the central, northern highlands and southern plateau. The most visible impact of such environmental crisis is reflected in the decline in crop yield. The long-term changes in the country's ecosystem are expected to have serious adverse impacts on the human health, forestry, and coastal and marine environments.

Eritrea is one of the most vulnerable countries of the world to the adverse effects of climate changes due, primarily, to its geographic location in the *Sahelian* Zone. Human activities have led to unsustainable land use practices such as clearing of land for farming. Moreover, heavy dependence on wood for energy needs had adversely impacted the forest cover of the country, which, in turn, has reduced crop yield and livestock production. Overall, the changes in climate have seriously impacted livelihoods and socio-economic systems of the country.

1.19. MARINE AND COASTAL RESOURCES

Eritrea's coastal beaches are relatively pristine, which provide an excellent opportunity for developing fishery and tourism industries. At present, the MoMR has a regulatory mechanism for monitoring fishing activities. The Ministry's policy prohibits fishing during the months of July to October to avoid over-exploitation of the marine resources and to allow sufficient time for breeding. The MOMR has set a plan for adapting climate smart technologies to counteract the adverse impacts of climate changes. In this respect, relevant intervention strategies that include Integrated Coastal Zone Management have been established with the aim of protecting coral reefs, coastal areas and settlements.

1.20. WATER RESOURCES

Eritrea is not endowed with surface water resources due to its inherent geographical location and its vulnerability to recurrent droughts. Consequently, there is scarcity of water supply for human settlements, agriculture and mining sectors.

In order to meet the demand for clean potable water, the per capita consumption for both the rural urban populations needs to be increased significantly to satisfy the societal basic needs. In the urban areas, there is a dire need for expanding the supply of clean affordable water supply to the expanding urban population.

In the agricultural sector, besides irrigation, the future water demand for livestock will also increase by 1% annually. Accordingly, the livestock water requirement is expected to increase. The mining projects that are on the operational phase are also expected to expand in the future; and the demands for water will correspondingly increase.

At present, besides scarcity, the water resource of Eritrea faces a number of challenges including inadequate regulatory mechanism for proper water use allocation and severe environmental degradation.

1.21. FOREST RESOURCES

One hundred years ago, about 30% of the total land area of Eritrea was covered by closed to open forest. While the highlands were covered by undifferentiated montane vegetation types, the moist lowlands were covered by undifferentiated acacia woodlands of various types. At both the eastern and western escarpments, evergreen and semi-evergreen bush land and tickets dominated. At the foot of the escarpments, deciduous bush lands dominated. The dry lowlands are mainly covered by grasslands and bush lands (Figure 1.8).

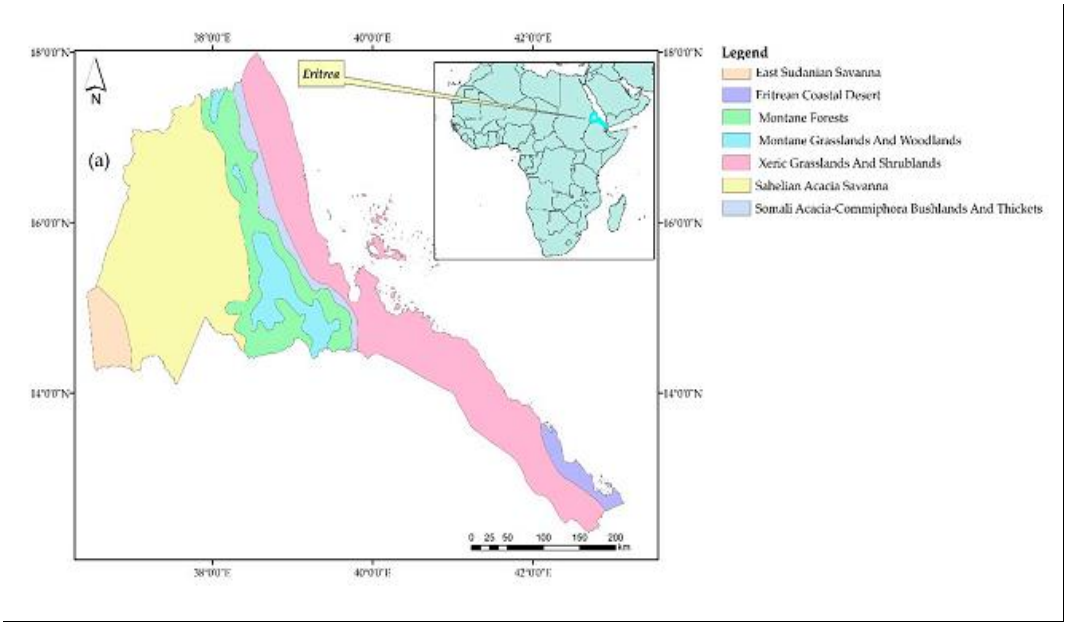

Figure 1.18: Vegetation types of Eritrea, adapted from the vegetation map of Africa (White, 1983)

Since, the last five decades, however, the vegetation cover (Forest cover) of Eritrea has been altered significantly as the result of a number intricately related human-induced and natural factors. Deforestation ion for agriculture, extraction of wood for various purposes and overgrazing had significantly reduced the forest cover. Climate change particularly drought and increased temperature had also its toll. Due to climate change the montane forest is gradually being replaced by lowland vegetation type; the evergreen and semi-evergreen vegetation has almost vanished and replaced by other deciduous vegetation types.

2. INSTITUTIONAL ARRANGEMENT RELEVANT TO MEASUREMENT, REPORTING AND VERIFICATION (MRV)

This section provides an overview on the institutional structures used for the compilation and submission of international and national reports particularly relevant to climate change including the National Communications, Biennial Updated Reports (BUR), GHG inventory, mitigation actions and support received and needed.

In view of the aforementioned background, projects and programs are fully aligned with existing government policies, strategies, plans, and legal frameworks. To enhance effective, efficient and sustainable implementation of national reports and communication, the documents are updated periodically in accordance with the requirements of the parties. In addition to the previous national communications, the Third National Communication (TNC) and National Adaption Plan of Action (NAPA) were prepared with the full participation of the various stakeholders involved in climate mitigation activities directly or indirectly. For the details, see Figure 2-1 the institutional structure to develop and report national projects relevant to environment particularly on climate change.

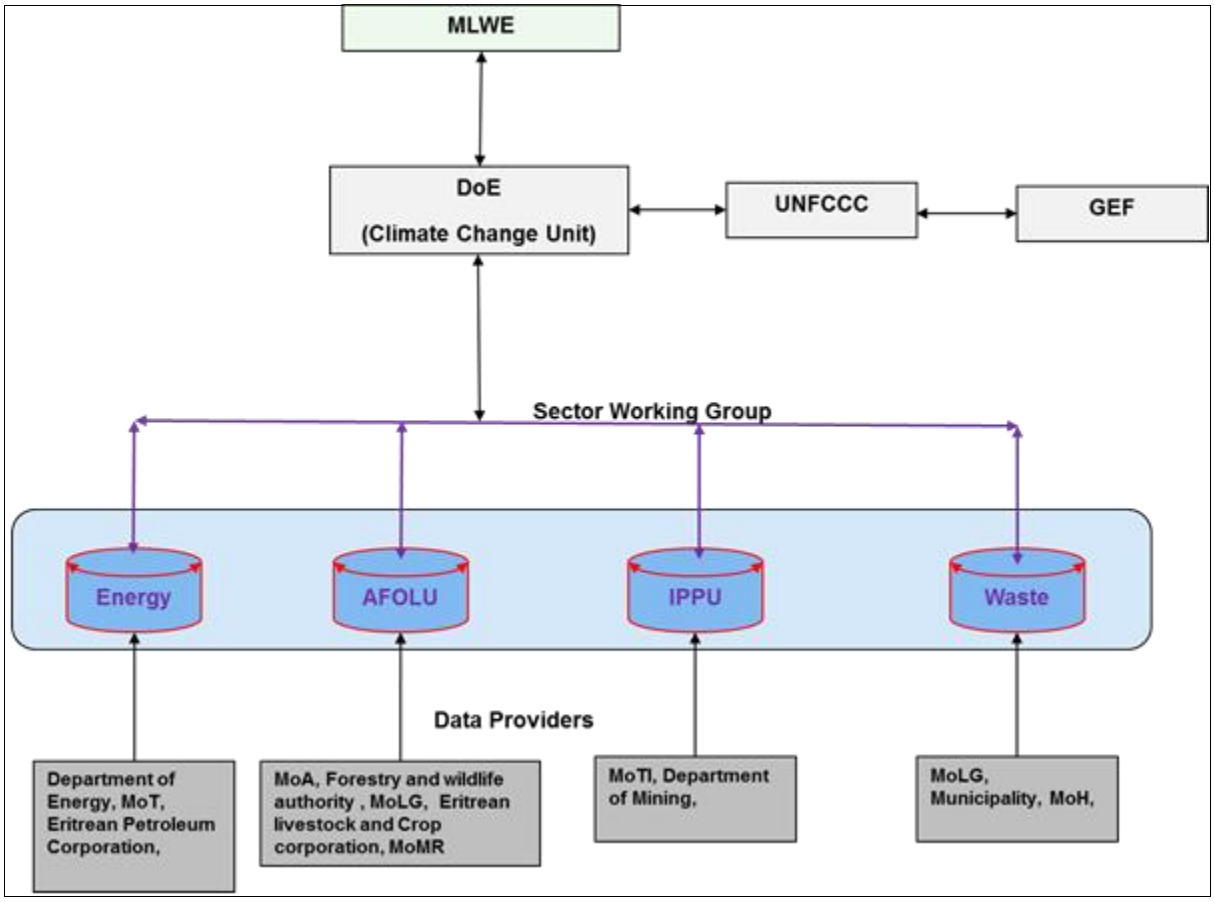

Figure 2.1: Institutional Structure relevant to MRV

The MoLWE plays the leading role in approving and implementation of the climate related project by referring to the national policy and communicate with the relevant ministries for their contribution on climate change issues. Within the ministry, the DoE is responsible for any contracting environmental projects and has the mandate to select stakeholders to participate/ engage in its implementation and finally verify and report the project document in accordance with the national commitments as stipulated in the UNFCCC.

The climate change unit within the DoE has the responsibility to coordinate and manage the data and other deliverables according to the TOR of the project. It is also responsible to arrange capacity building platforms for the stakeholders and validation workshop of the project. The national steering committee plays key role in the consistent review and evaluation process of the mitigation actions that the country has been undertaking. However, demands capacity building to further enhancing its contribution.

To pave the way for implementation, the key sectors of Energy, IPPU, AFOLU and Waste sectors participated in the thematic groups and were requested to provide activity data, explanation about their strategic plans including goals, objectives, activities and expected outputs and outcomes. Their respective plans were analysed in view of the short-term and extrapolated to medium and long-term perspectives. Therefore, climate related projects and programs take advantage of the confidence built during the first phase of the consultative processes. Hence, it is confirmed that project documents are invariably developed with active stakeholder engagement and full commitment of government officials at national and regional levels.

2.1. DESCRIPTION OF DOMESTIC MRV ARRANGEMENTS

This section covers Measurement, Reporting and Verification (MRV) arrangements, and the roles, responsibilities and the processes for the overall coordination, compilation and submission of the National Communications in general and the , BUR1 in particular. In addition, it presents details related to the GHG inventory, mitigation actions and support received .In Eritrea, until now, the domestic MRV as a system is not yet set up. However, by understanding the use of domestic MRV to assist in institutionalizing the activities related to reporting on climate change, it is planned as indicated in Figure 2-2; and put the roles and responsibilities of each sectors as shown in Table 2-1.

2.2. MRV OF MITIGATION ACTION

The DoE of the MoLWE proposed to set the MRV system of Mitigation action to coordinate and follow the implementation of the strategies and projects to achieve the goals in NDC projects.

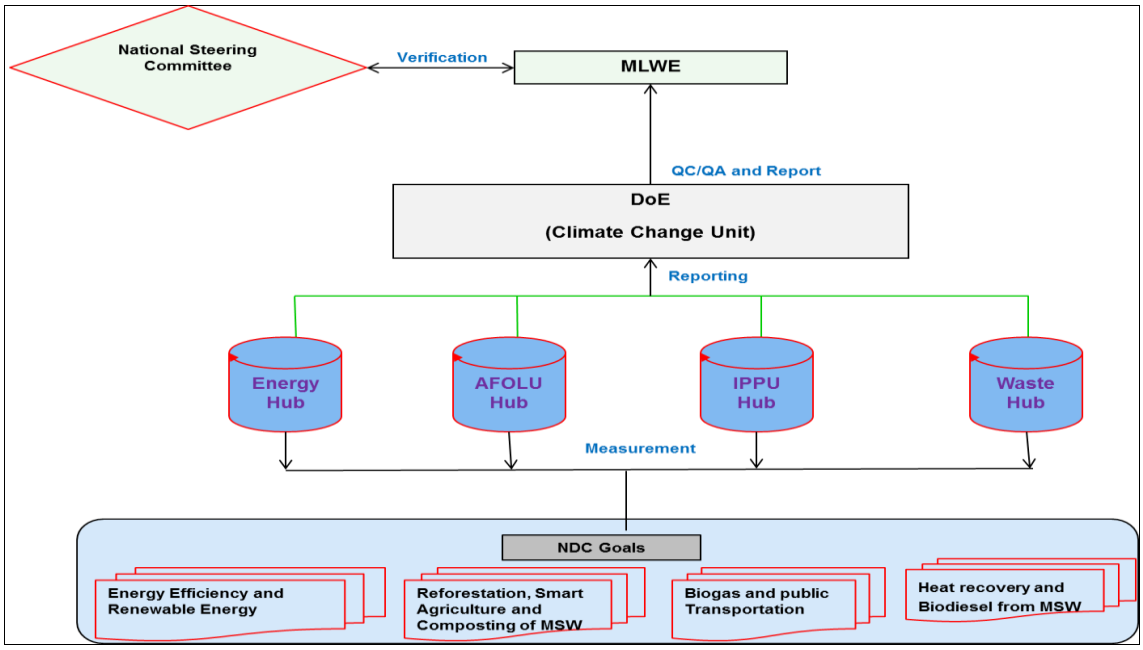

Figure 2.2: Proposed MRV System set up

Table 2.1: Roles and Responsibilities of the implementing agency and stakeholders

Agency/Sector	**Roles and responsibility**
National Steering Committee (NSC)	The NSC on Climate Change is responsible for the final approval and verification of the national GHG emissions reduction and mitigation action and its effects of the project in the country report which will later be included in the Biennial Update Report (BUR) and National Communication (NC).
MLWE	The MLWE is the representative of the convention that approves and raises the budget allocation of the project. It also leads the DoE for any designated project coordinator and communication with the line ministries.
DoE (Climate Change Unit)	The DoE is the focal point of the UNFCCC and responsible to manage and supervise the implementation of the project and financial disbursement. It also contracting for any consultancy when accept and approved implementation of the project by the MLWE and UNFCCC convention. The climate change unit also responsible to coordinate the project and compiled data relevant to GHG emission and modeling and quality control of the project.
Energy Hub	The department of Energy and MoTC are the responsible agencies for providing data related to fuel and biomass consumption in power plants, road transport, civil and marine aviation also in commercial and residential consumption. These agencies also have responsibility to assess the status of mitigation action and its effects in the country.
AFOLU Hub	MoA is the main responsible sector to provide the overall agriculture information relevant to mitigation and adaptation programs and GHG

Agency/Sector	Roles and responsibility
	relevant data. The crop and livestock corporation and forest and wildlife authority are the two institutions to provide the relevant information on crop, livestock, forest and wildlife of the country. These institutions have also responsibility to assess the status of mitigation and adaptation progress on agriculture.
IPPU Hub	MoTI is the responsible sector to provide the industrial information including the production, consumption, and import and export volume of the industrial material. It also has responsibility to assess the status of industrial mitigation action.
Waste Hub	MoLG is the lead agency of the national municipality to provide the waste generation of the country and other relevant information in use and change of wastes.

3. THE NATIONAL GREENHOUSE GAS INVENTORY

3.1. INTRODUCTION

This chapter presents the Greenhouse Gas (GHG) inventories for Eritrea for the period 2015 to 2018 for the general sectors such as (i) Energy, (ii) Industrial Process and Other Products Use (IPPU), (iii) Agriculture, Forestry and Land Use (AFOLU), and (iv) Waste for which data were available. It was prepared in line with articles 4 and 12 of UNFCCC and the Guidelines for National Communications of non-Annex I Parties to the UNFCCC.

In line with its obligations under UNFCCC, Eritrea submitted its Initial National Communication (INC) in 2000, the Second National Communication (SNC) in 2012 and currently the Third national communication report is being submitted in 2021. GHG inventory was compiled for the year 1994 for INC, 2000 for the SNC and 2015for TNC.

This chapter assesses the GHG inventory for BUR1 report. It covers the years 2018.The GHG inventories for TNC and for BUR1 have been conducted almost in the same period.

3.2. INSTITUTIONAL SET UP

The members of the GHG inventory Technical working group have been drawn from various Institutions comprising of National Higher Education and Research Institutes (NHERI) and key Government Ministries including, inter alia, the Ministry of Energy and Mines (MoEM), Ministry of Agriculture (MoA), Forestry and Wildlife Authority (FWA), Ministry of Trade and Industry (MoTI), Ministry of Transport and Communication (MoTC), Ministry of Marine Resources (MoMR), Ministry of Local Government (MoLG) and Ministry of Health (MoH) Figure 3-1. The NGHGITEWG has been entrusted with to get actively data, generating relevant information, and reporting, planning for subsequent preparation of documentation, and other key activities necessary for the completion of national GHG inventory and biannual reports. This institutional arrangement for NGHGITEWG is part of the national effort of the government to enable the inventory preparation a continuous and participatory process.

The DoE of the MoLWE, as the focal point of UNFCCC and the executing agency for the preparation of National Communications and BURs in Eritrea, has established a National GHG Inventory Technical Expert Working Group (NGHGITEWG), in order to facilitate and institutionalize the national GHG inventory process. The NGHGITEWG has been entrusted with collecting data, generation of relevant information, planning, data compiling and subsequent preparation of documentation and other key activities necessary for the completion of national GHG inventory and biannual reports. The project coordinator supervises and undertakes quality control for all the data and information collecting and analysis of the output of the GHG inventory.

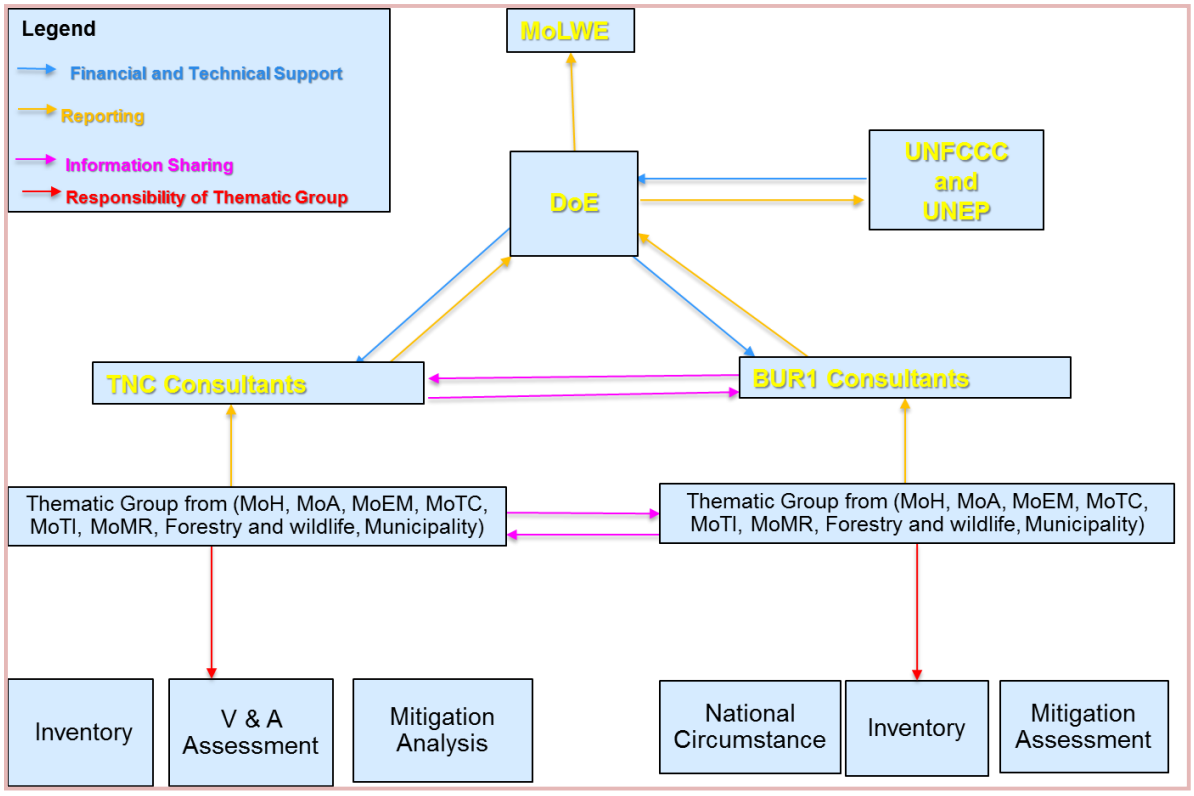

Figure 3.1 Institutional project implementation arrangement

3.3. BRIEF DESCRIPTION OF METHODOLOGY

The GHG inventory and estimation in TNC covered all four sectors that contribute the GHG emissions; and included the direct GHG gases; and other gases which are included in the Montreal protocol like F-Gases. The finding indicated that the GHG emission are increasing slightly from all the categories, specifically from Waste and IPPU sectors dramatically increased from the inventory base year of 2000.

GHG emissions were estimated in compliance with the UNFCCC guidelines. In the BUR1 report, the greenhouse gas inventory have been made in accordance with 2006 IPCC guidelines for national GHG inventories using Tier 1 methodology tool as there is no country specific values or factors. The GHG emissions reported include: the direct greenhouse gases (e.g. carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)) and the F-gases included in Montreal protocol but the indirect GHG/ precursor gases (carbon monoxide (CO), oxides of nitrogen (NO_X) and non-methane volatile organic compounds (NMVOC)) are not included with this inventory because the 2006 IPCC software version 2.691.7327.20936 could not support for these emissions. The Second Assessment Report (SAR) were used for the calculating the GWP of CH_4 and N_2O to change CO_2-eq.Hence, emission factors from the IPCC Guidelines were used for all categories.

3.4. ACTIVITY DATA

The inventory was prepared using a mix of data from national and international sources. Priority was given to data that have been generated in the country; and in the event where the required data was unavailable, data from international organizations such as FAO and

regional studies were used. National activity data were collected through questionnaire and survey (e.g. Energy, IPPU, AFOLU and Waste). It was done by sectoral working group representatives under the guidance of the consulting group drawn from the national Higher Education and Research Institute (NHERI). While the Ministry of Energy and Mines, and Ministry of Transport and communication provided activity data for accounting the GHG emissions from the energy sector; the Ministry of Trade and Industry supplied the activity data source for the IPPU. The Ministry of Agriculture, Forestry and Wildlife Authority both were the activity data source for accounting of GHG emissions AFOLU. The most recent available data on forest and livestock has been obtained from Forestry and wild Life Authority (FWA) and the Global Forest Resources Assessment (FRA, 2015) reported to the World's Forests FAO as official government document and the MoA respectively. The Municipalities of the main cities and towns of the country provided data for the GHG emissions from the waste sector.

3.5. AGGREGATED EMISSIONS FOR 2018

The overall GHG emission in Eritrea in 2018 of the BUR1 is 3,992.20 GgCO2-eq. The sectorial GHG emissions of this total are Energy, IPPU, AFOLU and Waste sector that emits 783.43 GgCO2-eq, 190.56 GgCO2-eq, 2985.15 GgCO2-eq and 33.07 GgCO2-eq respectively (Table 3.1).

Eritrea's GHG emissions and removals by sinks for the year 2015 as a2000 base year have been reported in TNC. Accordingly taking the year 2015 as a base of the BUR1 calculated for the inventory year of 2018 and the result according the 2006 IPCC guideline, Eritrea the GHG emission is increasing by 3.24% (Table 3.1).Particularly, the GHG emissions from IPPU and Waste sectors highly increased within the three years span of time mainly due to change in lifestyle; and increased urbanization and extraction of minerals. In the Energy sector, the GHG emission is reduced by 0.09% mainly due to the use of renewable energy and energy efficient technologies in the country introduced in the country.

Table 3.1 Figure: GHG Emissions and removals by year and sector

Year	2000	2006	2010	2015	2018	Percent change b/n 2015 and 2018
Sector	**Gg of CO2-eq**					
Energy	757.70	649.95	663.71	784.15	783.43	-0.09%
IPPU	18.37	21.88	24.28	169.56	190.56	12.39%
AFOLU	2510.04	2608.52	2725.02	2884.80	2985.15	3.48%
Waste	0.66	12.97	20.04	28.26	33.07	17.01%
Total	**3286.76**	**3293.31**	**3433.05**	**3866.76**	**3992.20**	**3.24%**

All aggregate GHG emission by gases from the different sectors increased from the base year of 2015 wherein the highest increment was that of $CO_2$with an increase of 6.22% from the base year (Table 3.2).

Table 3.2: Total aggregate GHG emissions and removals by year and gas

Year	2000	2006	2010	2015	2018	Percent change b/n 2015 and 2018
Gas	Gg of CO2-eq					
CO2	401.24	307.43	313.02	568.55	603.89	6.22%
CH4	2759.26	2859.14	2986.10	3154.89	3241.31	2.74%
N2O	126.26	126.75	133.93	143.33	147.00	2.57%
Total	**3286.76**	**3293.31**	**3433.05**	**3866.76**	**3992.20**	**3.24%**

In 2018, the AFOLU sector was the highest contributor of GHG emission which accounted for 74.77% followed by the Energy sector 19.62% (Figure 3.2) and the least was the waste sector.

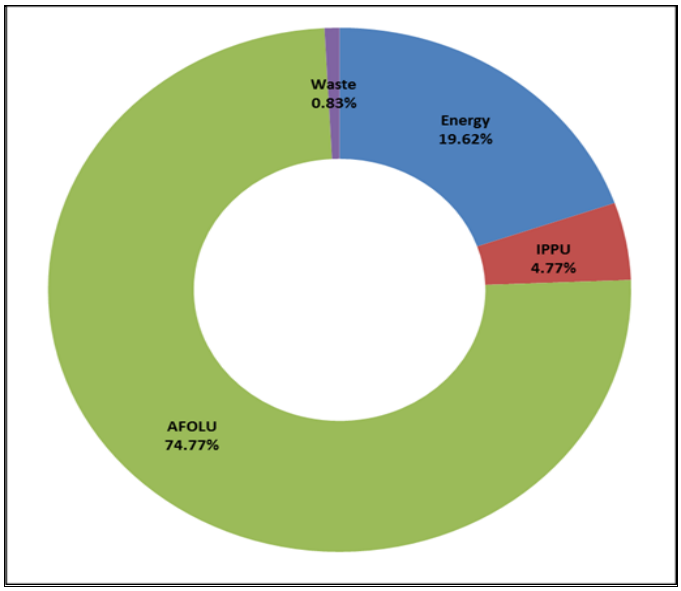

Figure 3.2 Share of GHG Emission by Sector in 2018

Deforestation and use of biomass are the main source of energy for domestic sector especially for commercial and residential sectors and the GHG emission from the biomass consumption are reported separately in the Memo items that emits 2404.52 Gg of CO2. A summary of the net GHG emissions estimate for the 2018 inventory year is indicated in Table 3.3.

Table 3.3: net GHG emissions in 2018

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2
Total National Emissions and Removals	603.8948	154.348	0.4742	21.2358	0	0	0	0	0	0	0	0
1 - Energy	617.2437	6.487025	0.09665	0	0	0	0	0	0	0	0	0
1.A - Fuel Combustion Activities	617.2437	6.487025	0.09665						0	0	0	0
1.B - Fugitive emissions from fuels	0	0	0						0	0	0	0
1.C - Carbon dioxide Transport and Storage	0								0	0	0	0
2 - Industrial Processes and Product Use	190.5583	0	0	21.2358	0	0	0	0	0	0	0	0
2.A - Mineral Industry	190.5583	0	0						0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use	0	0	0						0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances				21.2358	0			0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0						0	0	0	0
3 - Agriculture, Forestry, and Other Land Use	-205.011	146.3389	0.37756	0	0	0	0	0	0	0	0	0
3.A - Livestock		146.3389	0.37756						0	0	0	0
3.B - Land	-205.011		0						0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sourc	0	0	0						0	0	0	0
3.D - Other	0	0	0						0	0	0	0
4 - Waste	1.103512	1.52202	0	0	0	0	0	0	0	0	0	0
4.A - Solid Waste Disposal		1.52202							0	0	0	0
4.B - Biological Treatment of Solid Waste		0	0						0	0	0	0
4.C - Incineration and Open Burning of Waste	1.103512	0	0						0	0	0	0
4.D - Wastewater Treatment and Discharge		0	0						0	0	0	0
4.E - Other (please specify)	0	0	0						0	0	0	0
5 - Other	0	0	0	0	0	0	0	0	0	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3			0						0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
Memo Items (5)												
International Bunkers	13.08393	9.15E-05	0.00037	0	0	0	0	0	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers) (1	13.08393	9.15E-05	0.00037						0	0	0	0
1.A.3.d.i - International water-borne navigation (Internatio	0	0	0						0	0	0	0
1.A.5.c - Multilateral Operations (1)(2)	0	0	0	0	0	0	0	0	0	0	0	0

(1) CO_2 net emissions (emissions minus removals)
(2) Total amount of CO2 captured for long-term storage is to be reported separately for domestic storage and for export in the documentation box
(3) The other halogenated gases for which the CO2 equivalent conversion factor is not available should not be included in this column. Such gases should be reported in the column 'other halogenated gases without CO2 equivalent conversion factors'.
(4) When this column is used, gases should be listed separately in IPPU background Tables and Table 2.11 and the name of the gas should be given in the document box.
(5) Emissions that are not included in the national total should be reported as memo items.
** Cells to report emissions of NOx, CO, NMVOC and SO2 have not been shaded although the physical potential for emissions is lacking for some categories*

3.6. EMISSIONS TREND

The GHG emission in Eritrea has increased (Figure 3.3). Overall, GHG emissions from the base year of the TNC inventory year in 2000 increased from 3,286.76 Gg of CO2-eq to 3,992.2 Gg of CO2-eq in 2018 inventory year which reflects to need for concerted national effort to reduce GHG emissions.

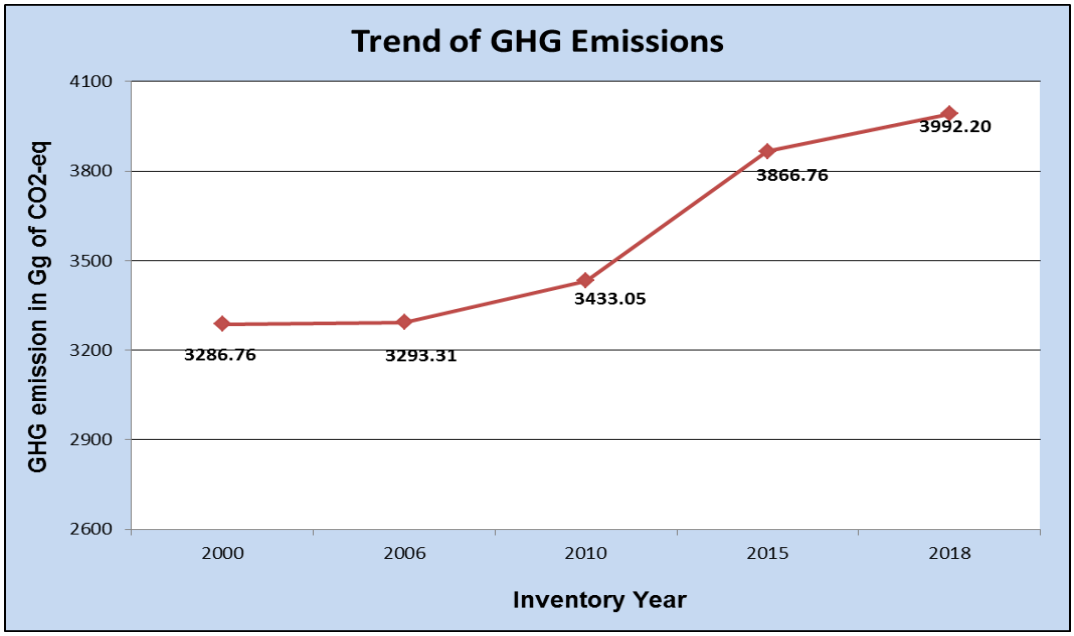

Figure 3.3: Trend of GHG Emissions

The trend of GHG emissions of all sectors, from the base year of TNC inventory year, slightly increased for most sectors except for IPPU which dramatically changed from 2010 following the installation of the Eritrean cement factory that use coal consumption for its process and some fluctuation of the energy sector (Table 3.4).

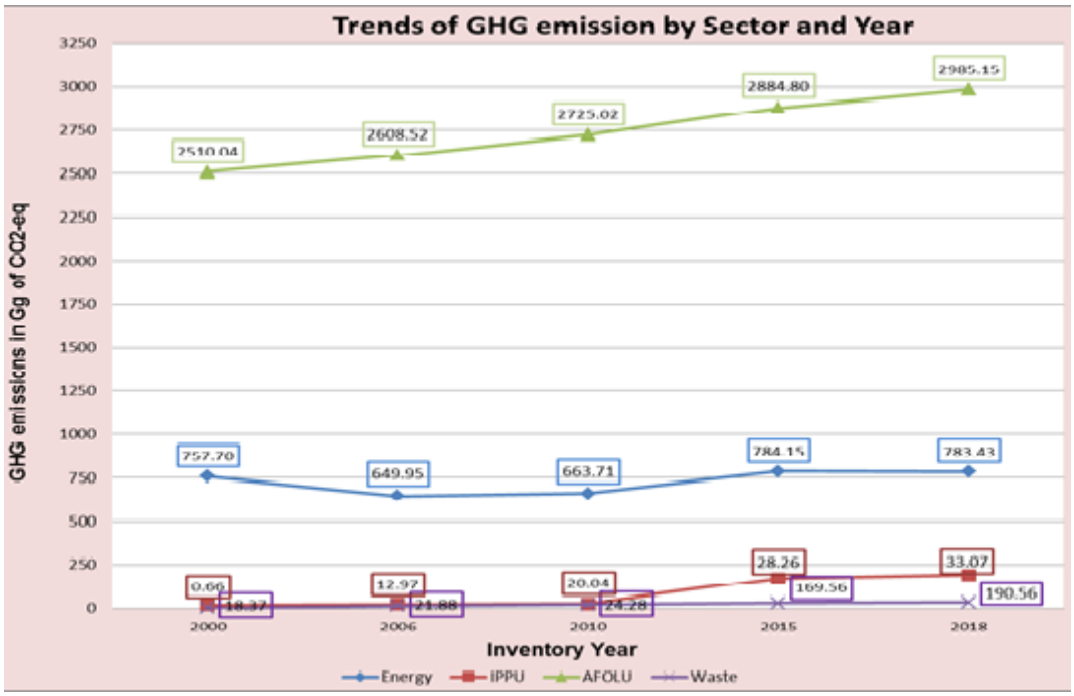

Figure 3.4: Trends of GHG Emission by Sector and Year

Looking at the gas by gas emission, in 2018 inventory year, CH_4 emission was the highest contributor covering 81.81.19% followed by CO_2 of 15.13% (Figure 3.5).The CH_4 emission is mainly from livestock sub-sector and some of the Energy activities. Generally, the CH_4 and N_2O emissions are mainly from livestock, Energy activities and solid waste disposal in the

country. The higher CO_2 contributions came from the energy sector some of which were sequestrated by the forest land.

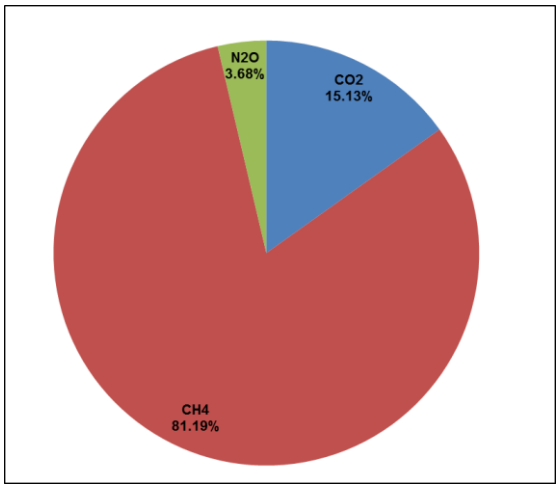

Figure 3.5 Share of GHG emission by Gas

3.7. EMISSIONS OF HFCS, PFCS AND SF6

Hydro-fluorocarbons (HFCs), Per-fluorocarbons (PFCs) and sulphur hexafluoride (SF6) are direct GHGs. Anthropogenic emissions by sources of PFCs and SF_6 from production activities did not occur in the country in 2018 inventory year; and consequently in this inventory year, only the emission of HFCs from the use of refrigeration and air conditioning both for Refrigeration and stationary air conditioning and mobile air conditioning were estimated to be about 21.24 Gg CO2-eq in 2018(Table3.4).

Table 3.4: Emissions of HFCs, PFCs and SF6

	Emissions CO2 Equivalents (Gg)			
Categories	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2 - Industrial Processes and Product Use	21.23582	0	0	0
2.A - Mineral Industry				
2.B - Chemical Industry	0	0	0	0
2.C - Metal Industry	0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use				
2.E - Electronics Industry	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	21.23582	0		
2.G - Other Product Manufacture and Use	0	0	0	0
2.H - Other				

3.8. SECTORIAL GHG EMISSIONS

3.8.1 ENERGY SECTOR

Eritrea is a net importer of refined petroleum products. Energy industries of Eritrea are based mainly on thermal power plants that utilize fossil fuels for electricity generation. The main secondary energy sources are from liquid, gaseous and biomass fuels. Liquid fuels consist of

petroleum products, such as diesel, gasoline, heavy fuel oil, Jet-kerosene, Liquefied Petroleum Gas (LPG) and lubricants that were used for combustion and non-energy activities.

Biomass consisting wood fuel, charcoal, animal dung and agricultural-residue still remain the main sources of biomass are used to satisfy domestic household demands, commercial and small-scale industrial activities. Emissions arise from these activities by combustion and as fugitive emissions i.e. escape without combustion. Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the GHGs released in the combustion of fuels. In addition, the GHG pre-cursors carbon monoxide (CO), nitrogen oxides (NO_x), and non-methane volatile organic compounds (NMVOCs) are also released in the process.

In Eritrea, in 2018, the total direct GHG emissions from the Energy sector were estimated to be 783.43 $GgCO_2$-eq. The total GHG emissions in the energy sector were generated from fuel combustion activities. In the energy sector, the highest emission contribution came from the energy industry and other sectors that contributed 42% and 35% respectively of the total emission followed by transportation (Figure 3.6).Other sectors include the commercial, residential, agriculture and fishing of energy consumption.

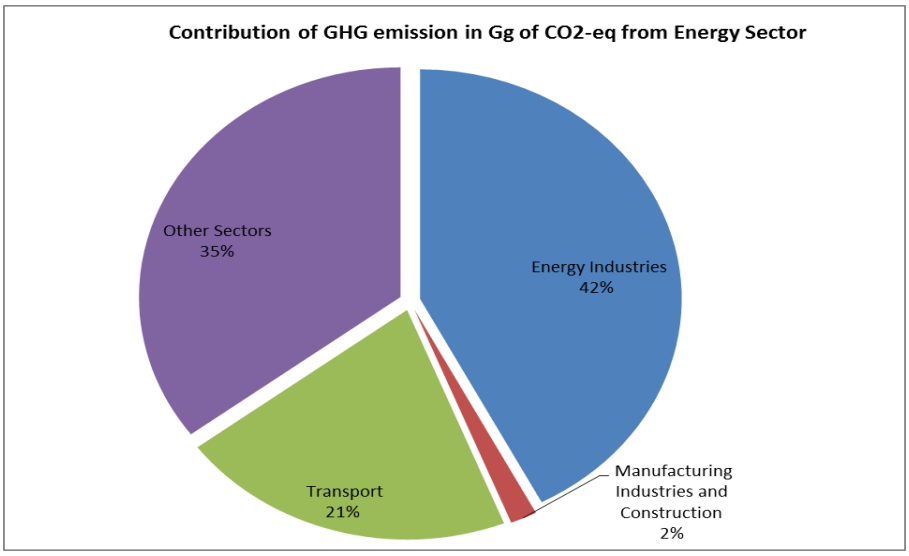

Figure 3.6: Contribution of GHG emissions in $GgCO_2$-eq from energy sector in 2018

In energy sector, while the most dominant gas emitted to the environment is CO_2 covering 79% of the total emission, the second is CH_4 contributing 17% of the total emission. N_2O emission accounts for a small fraction of the total emission (Figure 3.7).

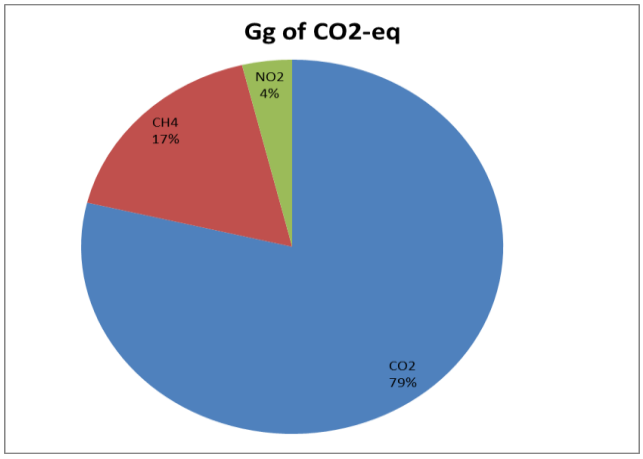

Figure 3.7: Share of gases emission from energy sector

The Reference Approach and the Sectorial approach often have different results mainly due to the fact that the Reference Approach is a top-down method using a country's energy supply data; and it has no detailed information on how the individual fuels are used in each sector while the sectorial or the bottom-up approach looks at the actual consumption of the specific sub-sectors including (i) the energy industry (Power generation or energy production), (ii) transportation, (iii) manufacturing industry and Service Sector (public and commercial) (iv) and residential. The difference between the two approaches is -4.88% in Energy consumptions and -5.39% in CO_2 emissions as shown in Table 3.5. This difference arises as the result of data lose in the recording system of the activity data providers (stakeholders); and some illegal importation of liquid fuels like gasoline and diesel from the neighbouring countries.

Table 3.5: Reference and Sectorial Approach

	Reference Approach				Sectoral Approach		Difference	
Fuel	Apparent Consumption (TJ)	Excluded consumption (TJ)	Apparent Consumption (excluding non-energy use and feedstocks) (TJ)	CO2 Emissions (Gg)	Energy Consumption (TJ)	CO2 Emissions (Gg)	Energy Consumption (%)	CO2 Emissions (%)
Crude Oil	0.0000		0.0000	0.0000			0.0000	0.0000
Orimulsion	0.0000		0.0000	0.0000			0.0000	0.0000
Natural Gas Liquids	0.0000	0.0000	0.0000	0.0000			0.0000	0.0000
Motor Gasoline	533.1676		533.1676	36.9485	533.1676	36.9756	0.0000	-0.0734
Aviation Gasoline	0.0000		0.0000	0.0000			0.0000	0.0000
Jet Gasoline	0.0000		0.0000	0.0000			0.0000	0.0000
Jet Kerosene	-466.2252		-466.2252	-33.3351	0.0000	0.0000	100.0000	100.0000
Other Kerosene	358.7220	0.0000	358.7220	25.7802	367.2542	26.4056	-2.3233	-2.3685
Shale Oil	0.0000		0.0000	0.0000			0.0000	0.0000
Gas/Diesel Oil	2893.2120	0.0000	2893.2120	214.2906	2775.3563	202.3231	4.2465	5.9150
Residual Fuel Oil	2616.3848		2616.3848	202.4210	2616.6666	202.5300	-0.0108	-0.0538
Liquefied Petroleum Gases	242.2706	0.0000	242.2706	15.2792	242.2706	15.2873	0.0000	-0.0528
Ethane	0.0000	0.0000	0.0000	0.0000			0.0000	0.0000
Naphtha	0.0000	0.0000	0.0000	0.0000			0.0000	0.0000
Bitumen	240.4764	240.4764	0.0000	0.0000	135.8760	10.9652	-100.0000	-100.0000
Lubricants	210.2460	0.0000	210.2460	7.7090	107.1623	7.8550	96.1939	-1.8584
Petroleum Coke	0.0000	0.0000	0.0000	0.0000			0.0000	0.0000
Refinery Feedstocks	0.0000		0.0000	0.0000			0.0000	0.0000
Refinery Gas	0.0000	0.0000	0.0000	0.0000			0.0000	0.0000
Paraffin Waxes	0.0000	0.0000	0.0000	0.0000			0.0000	0.0000
White Spirit and SBP	0.0000	0.0000	0.0000	0.0000			0.0000	0.0000
Other Petroleum Products	0.0000		0.0000	0.0000			0.0000	0.0000
Anthracite	0.0000		0.0000	0.0000			0.0000	0.0000
Coking Coal	1214.6304		1214.6304	114.9040	1214.6078	114.9019	0.0019	0.0019
Total	7842.8846	240.4764	7602.4082	583.9974	7992.3615	617.2437	-4.8791	-5.3863

Memo Items

The international Bunkers include the emissions of GHG from the international aviation and marine bunker fuels and the multilateral operations include the emissions of GHG from biomass. Emission estimates from these sources were not included in the national total in accordance with the Revised 2006 IPCC guidelines. The estimated GHG emission from International Aviation Bunker in 2018 came from the use of Jet Kerosene which produced 13.19 Gg CO_2-eq. It also estimated the GHG emissions from the multilateral operations of biomass based on the revised 2006 IPCC software and the result of the emission were 2404.52 GgCO_2as indicated in Table 3.6.

Table 3.6: GHG emissions from international bunkers and multilateral operations

Greenhouse gas source and sink categories	Net CO2 (Gg)	CH4 (Gg)	N2O (Gg)	CO Gg	NOx (Gg)	NMVOCs (Gg)	SOx (Gg)
Memo Items							
International Bunkers	13.083933	9.15E-05	0.00036598	0	0	0	0
1A3a1 - International Aviation	13.083933	9.15E-05	0.00036598	0	0	0	0
1A3d1 - International Marine (Bunkers)	0	0	0	0	0	0	0
Multilateral operations	0	0	0				
CO2 emissions from biomass	2404.5192						

Fugitive Emissions from Fuels

Fugitive emissions come from all intentional and unintentional emissions from extraction, processing, storage and transport of fuel to the point of final use. According to the Revised 1996 IPCC Guidelines, in Fugitive Emissions should be considered the following categories: i) CH_4 Emissions from Coal Mining and Handling, ii) CH_4 Emissions from Oil and Natural gas Activities, iii) Emissions of Ozone Precursors and SO_2 from Oil Refining. Therefore, as these activities didn't occur in Eritrea they are not estimated in this report.

3.8.2 INDUSTRIAL PROCESSES AND PRODUCT USE SECTOR

Greenhouse gas emissions arise during chemical or physical transformation of materials. In the iron and steel industry, for example, ammonia and other chemical products manufactured from fossil fuels are used as chemical feedstock and the cement industry, as a result, of which significant amount of CO_2 is released. During these processes, other greenhouse gases, methane (CH_4), nitrous oxide (N_2O), Hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs), are produced (IPCC, 2006 Guidelines). Other gases emitted in different sub categories include Sulphur hexafluoride (SF_6) and Non-Methane Volatile Organic Compounds (NMVOCs).

Under the Industrial Processes and Product Use (IPPU) sector, cement production, lime production, and limestone and dolomite were estimated. Emissions from these three sources are noted as they are the only active industries in the IPPU, even though they are not operating at their full capacity.

In Eritrea, in2018, the total direct GHG emissions from IPPU sector were 190.56 GgCO_2-eq out of which the majority of GHG emissions, in this sector, were attributed to mineral production. While the cement production accounts for 97.24% of the total emissions the remaining emissions came from the lime production. The GHG emission from cement production dramatically increased from 2010 for the reason that the new cement industry was

installed in the country while the lime production emission slightly increased from the base year of the TNC in 2000 (Figure 3.8).

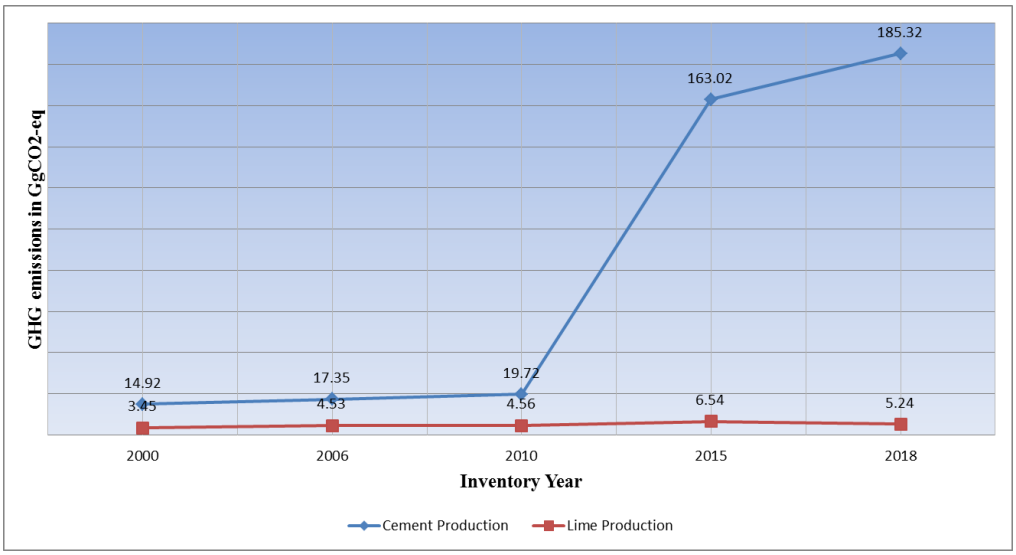

Figure 3.8 Trend of GHG emission from Cement and Lime Production

3.8.3 AGRICULTURE, FOREST AND OTHER LAND USE (AFOLU) SECTOR

The AFOLU sector comprises activities responsible for emissions and removals linked to Agriculture (e.g. crops and livestock), and changes in land use categories namely Forest land, Cropland, Grassland, Wetland, Settlement, and Other land uses. Emissions and removals were estimated for activity areas falling under those IPCC categories. Emission factors for the livestock and forestry activities were largely adopted from the 2006 IPCC Guideline. Some amendments have been made to better represent the land sub-categories within the national context due to lack of sufficient data on land classification in Eritrea based on the IPCC land change categories. This is a serious gap that calls for updating the land use categories using remote sensing and Geographic Information systems.

In 2018, the total Net GHG emissions from the AFOLU sector were 2,985.15 $GgCO_2$-eq. It was also estimated the net CO_2 removal from the sector account 205.01 Gg, whereas the total CO_2-eq emission specifically from livestock sub-sector accounts 3,190.16 Gg (Figure 3.9). In the same year about 207.99 $GgCO_2$ was sequestered by the forest land and wetlands. The relative contribution of the sub sector is given in Figure 3.9 in which the negative sign indicates the removal of CO_2 from the atmosphere which clarified the role of forest land and wetland in carbon sequestration $GgCO_2$ in 2018. Hence, in Eritrea, it can be safely concluded that the GHG emission, essentially comes from the livestock sub-sector. Livestock rearing is an economic activity in the country which contributes significantly to the national and household food security.

In this inventory, the dominant domestic animals considered were cattle followed by goats, sheep, Equines (Asses and mules), camels and swine. Commercial and non-commercial poultry production is also a part of economic activity. Information from annual surveys of animal population carried out by the MoA was used in the estimation of methane and nitrous oxide gases using emission default factor of the 2006 IPCC software.

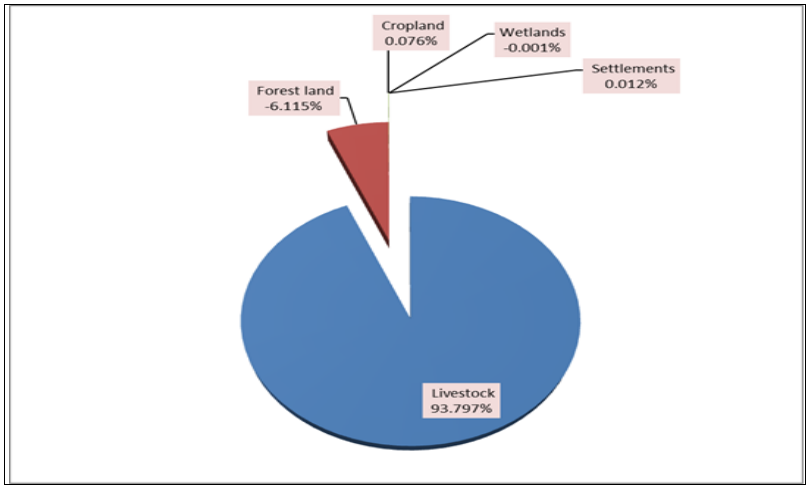

Figure 3.9: Share of GHG emission in AFOLU

The GHG emission from enteric fermentation is dominant; and remained the highest contributor in AFOLU sector in all the inventory years; and it increased by 3.03% from the 2015 inventory year; while the second contributor i.e. manure management increased by 4.09% from the same inventory year. Figure 3.10 present the aggregate emission estimates from the TNC base year of 2000 for livestock (enteric fermentation and manure management) and land subcategories.

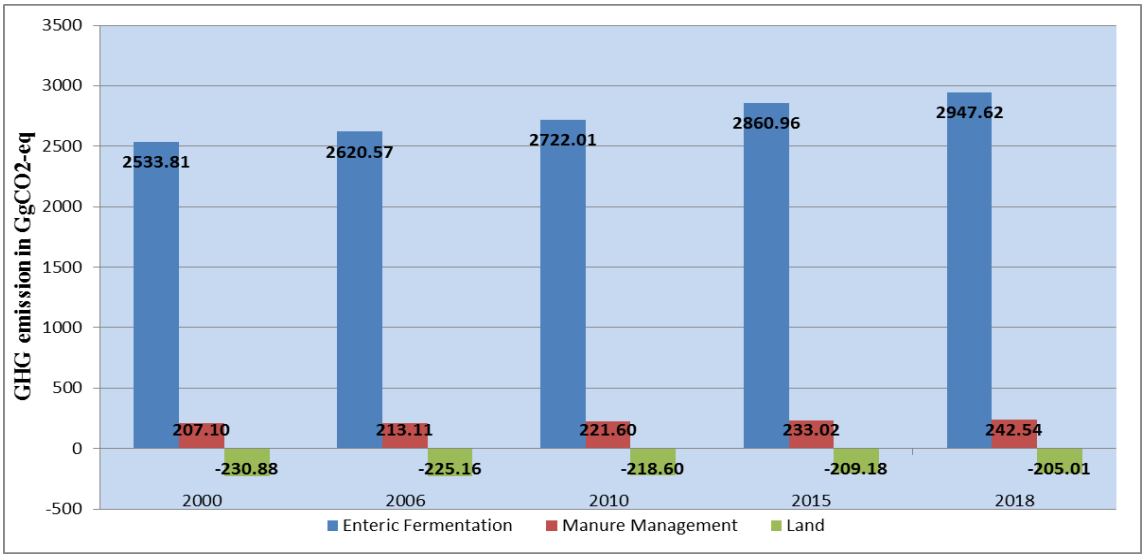

Figure 3.10 Trend of GHG emission from AFOLU

In 2018 inventory year, enteric fermentation contributed about 2947.62 Gg CO2-eq; and the manure management accounted for 242.54 Gg CO2-eq of the total emission. The evolution of emissions of the two gases namely CH_4 and N_2O released by the livestock category are depicted in Figure 3-11. From the figure it can be noted that there is high emission of CH_4 from the enteric fermentation; and highly contributor as compared from the other gases that is 91% of the GHG emission from AFOLU is methane. N_2O is emitted mainly from manure management.

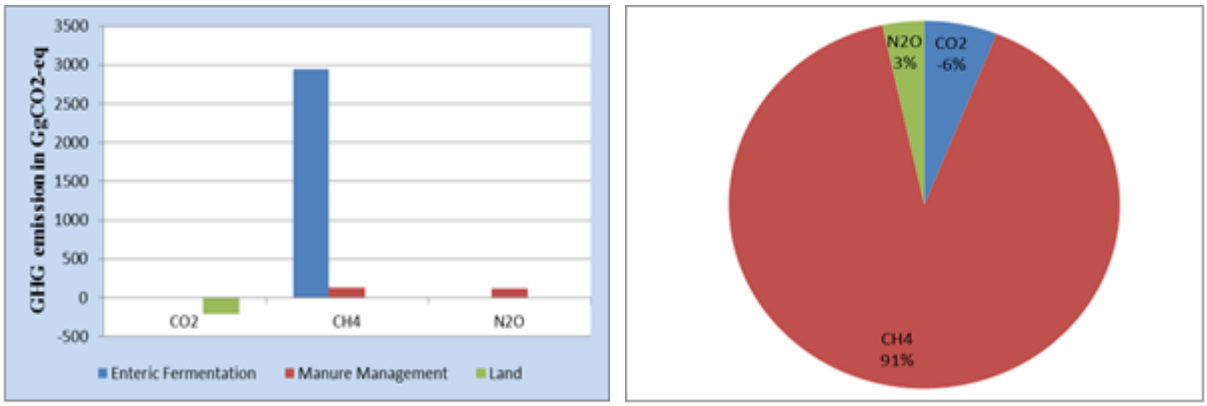

Figure 3.11 Livestock GHG emission and Gas Contribution

3.8.4 THE WASTE SECTOR

The scope of the IPCC 2006 Guidelines for the Waste sector gives methodological guidance for estimation of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions from Solid waste disposal, Biological treatment of solid waste, Incineration and open burning of waste, and Waste water treatment and discharge emissions from the Municipal Solid Waste (MSW). GHG emissions originating from the Waste Sector were estimated using a Tier 1 approach as per the IPCC, 2006 Guidelines and default emission factor for National GHG Inventories. The estimation of GHG emission from waste sector considers only the solid waste disposal and open burning of waste in this inventory. The result of aggregate GHG emission from waste sector in 2018 is 33.07 $GgCO_2$-eq. the highest GHG emission contributor came from the solid waste disposal accounting for 97% and the remaining 3% was from open burning of waste (Figure 3.12).

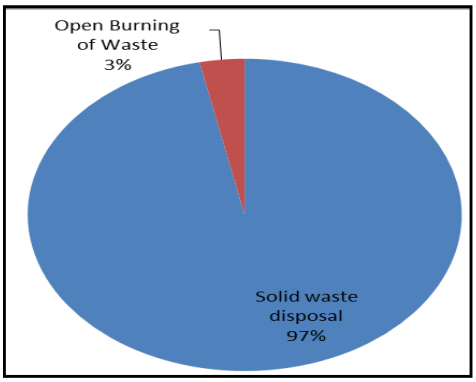

Figure 3.12 Share of GHG emission from waste sector

According the increasing of the waste generation from both the solid waste disposal and open burring of waste, the GHG emission increased from the TNC base year of 2000 inventory (Figure 3.13). The emissions of gases are different according to the subcategories that are CH_4 emits from solid waste disposal and CO_2 from open burring of wastes. The highest emission from the waste sector is CH_4 that contributed 97% in 2018 as parallel indicated in Figure 3-13.

Figure 3.13 Trend of GHG emission from the waste sector

3.9. UNCERTAINTY ANALYSIS

These inventories, prepared in accordance with the 2006 IPCC guidelines for calculating the uncertainty of GHG emission by input the confidence of raw data gathered from the different stakeholders. Uncertainty management in national GHG inventories typically contains a wide range of emission calculations that minimum and maximum data confidence contributed from ±5% to ±40%. For the year, 2018 the uncertainty analysis of GHG inventories includes both level and trend assessment. The trend assessment was undertaken the 2015 base year. Based on that, the average result of uncertainty analysis of Eritrea's national GHG inventory of the data were approximately 10.081% for level assessment and 9.597% for trend assessment. For more information see Annex-H of the Level and Trend Uncertainty.

3.10. KEY CATEGORY ANALYSIS (KCA)

Key category analysis (KCA) presents the importance of emission sources and sinks. Key categories are defined based on IPCC guidelines as being the emission sources and sinks that constitute 95% of total annual emissions when ranked from greatest to lowest contribution. A key source has a significant influence on the national inventory of direct GHG emissions in terms of the absolute emissions level.

KCA reported, in the 2018 inventory were estimated for both level and trend assessment. The results are presented in Table3.7 for level assessment and in Table3.10 for trend assessment by taking 2015 base year. Accordingly, there are nine key categories in the level assessment by considering the gas emission. These are i) Enteric fermentation, ii) Energy industry liquid fuels, iii) Forest land remaining forest land, iv) Cement production v) Road transport vi) other sectors-Biomass vii) manure management(methane) viii) manure management (nitrous oxide) ix) energy industries.

In trend assessment, the KCA slightly changed as shown in Table 3.9; and the energy industry and road transport are the lead sub-sectors based on the 2015 base year as reported in the TNC.

Table 3.7: Key Category Analysis in 2018, Approach-1 Level Assessment

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2018 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.A.1	**Enteric Fermentation**	**METHANE (CH4)**	**2947.6200**	**2947.6200**	**0.6683**	**0.6683**
1.A.1	**Energy Industries - Liquid Fuels**	**CARBON DIOXIDE (CO2)**	**215.2460**	**215.2460**	**0.0488**	**0.7171**
3.B.1.a	**Forest land Remaining Forest land**	**CARBON DIOXIDE (CO2)**	**-207.9816**	**207.9816**	**0.0472**	**0.7642**
2.A.1	**Cement production**	**CARBON DIOXIDE (CO2)**	**185.3173**	**185.3173**	**0.0420**	**0.8062**
1.A.3.b	**Road Transportation**	**CARBON DIOXIDE (CO2)**	**160.3433**	**160.3433**	**0.0364**	**0.8426**
1.A.4	**Other Sectors - Biomass**	**METHANE (CH4)**	**135.2872**	**135.2872**	**0.0307**	**0.8733**
3.A.2	**Manure Management**	**METHANE (CH4)**	**125.4972**	**125.4972**	**0.0285**	**0.9017**
3.A.2	**Manure Management**	**NITROUS OXIDE (N2O)**	**117.0427**	**117.0427**	**0.0265**	**0.9283**
1.A.1	**Energy Industries - Solid Fuels**	**CARBON DIOXIDE (CO2)**	**114.9019**	**114.9019**	**0.0261**	**0.9543**
1.A.4	Other Sectors - Liquid Fuels	CARBON DIOXIDE (CO2)	113.8710	113.8710	0.0258	0.9801
1.A.4	Other Sectors - Biomass	NITROUS OXIDE (N2O)	26.1292	26.1292	0.0059	0.9860
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs	21.2358	21.2358	0.0048	0.9909
4.A	Solid Waste Disposal	METHANE (CH4)	13.3244	13.3244	0.0030	0.9939
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CARBON DIOXIDE (CO2)	12.8815	12.8815	0.0029	0.9968
2.A.2	Lime production	CARBON DIOXIDE (CO2)	5.2410	5.2410	0.0012	0.9980
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	2.5639	2.5639	0.0006	0.9986
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	2.4974	2.4974	0.0006	0.9991
4.C	Incineration and Open Burning of Waste	CARBON DIOXIDE (CO2)	1.1035	1.1035	0.0003	0.9994
1.A.1	Energy Industries - Solid Fuels	NITROUS OXIDE (N2O)	0.5648	0.5648	0.0001	0.9995
1.A.1	Energy Industries - Liquid Fuels	NITROUS OXIDE (N2O)	0.5195	0.5195	0.0001	0.9996
1.A.3.b	Road Transportation	METHANE (CH4)	0.4449	0.4449	0.0001	0.9997
3.B.5.b	Land Converted to Settlements	CARBON DIOXIDE (CO2)	0.3978	0.3978	0.0001	0.9998
1.A.4	Other Sectors - Liquid Fuels	METHANE (CH4)	0.2832	0.2832	0.0001	0.9999
1.A.4	Other Sectors - Liquid Fuels	NITROUS OXIDE (N2O)	0.2170	0.2170	0.0000	0.9999
1.A.1	Energy Industries - Liquid Fuels	METHANE (CH4)	0.1759	0.1759	0.0000	1.0000
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	NITROUS OXIDE (N2O)	0.0323	0.0323	0.0000	1.0000
3.B.2.a	Cropland Remaining Cropland	CARBON DIOXIDE (CO2)	0.0264	0.0264	0.0000	1.0000
1.A.1	Energy Industries - Solid Fuels	METHANE (CH4)	0.0255	0.0255	0.0000	1.0000
3.B.4.a.i	Peatlands remaining peatlands	CARBON DIOXIDE (CO2)	-0.0172	0.0172	0.0000	1.0000
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	METHANE (CH4)	0.0108	0.0108	0.0000	1.0000

The trend analyses shows the following sequence; i) Energy industries-liquid fuels ii) Road transportation iii)Other sectors –liquid fuels iv)cement production v) enteric-fermentation vi) other sectors –Biomass vii) energy industries-solid fuels viii) manufacturing industries and construction –liquid fuels ix)solid waste disposal x) refrigerators and air conditioning and xi) forest land remaining forest land

Table 3.8: Key Category Analysis in 2018, Approach-2 Trend Assessment

A	B	C	D	E	F	G	H
IPCC Category code	IPCC Category	Greenhouse gas	2015 Year Estimate Ex0 (Gg CO2 Eq)	2018 Year Estimate Ext (Gg CO2 Eq)	Trend Assessment (Txt)	% Contribution to Trend	Cumulative Total of Column G
1.A.1	**Energy Industries - Liquid Fuels**	**CO2**	**158.2133**	**215.2460**	**0.0120**	**0.2497**	**0.2497**
1.A.3.b	**Road Transportation**	**CARBON DIOXIDE (CO2)**	**196.5285**	**160.3433**	**0.0101**	**0.2094**	**0.4591**
1.A.4	**Other Sectors - Liquid Fuels**	**CO2**	**129.8377**	**113.8710**	**0.0048**	**0.0998**	**0.5589**
2.A.1	**Cement production**	**CARBON DIOXIDE (CO2)**	**163.0200**	**185.3173**	**0.0039**	**0.0803**	**0.6392**
3.A.1	**Enteric Fermentation**	**METHANE (CH4)**	**2860.9616**	**2947.6200**	**0.0034**	**0.0706**	**0.7098**
1.A.4	**Other Sectors - Biomass**	**CH4**	**143.8536**	**135.2872**	**0.0032**	**0.0663**	**0.7761**
1.A.1	**Energy Industries - Solid Fuels**	**CO2**	**101.0769**	**114.9019**	**0.0024**	**0.0498**	**0.8259**
1.A.2	**Manufacturing Industries and Construction - Liquid Fuels**	**CO2**	**21.5049**	**12.8815**	**0.0022**	**0.0456**	**0.8714**
4.A	**Solid Waste Disposal**	**METHANE (CH4)**	**4.5684**	**13.3244**	**0.0020**	**0.0417**	**0.9132**
2.F.1	**Refrigeration and Air Conditioning**	**HFCs, PFCs**	**14.2343**	**21.2358**	**0.0015**	**0.0315**	**0.9447**
3.B.1.a	**Forest land Remaining Forest land**	**CARBON DIOXIDE (CO2)**	**-212.1389**	**-207.9816**	**0.0008**	**0.0162**	**0.9609**
1.A.4	Other Sectors - Biomass	N2O	27.8089	26.1292	0.0006	0.0129	0.9739
3.A.2	Manure Management	NITROUS OXIDE (N2O)	111.2049	117.0427	0.0004	0.0092	0.9831
2.A.2	Lime production	CARBON DIOXIDE (CO2)	6.5360	5.2410	0.0004	0.0074	0.9905
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	3.0842	2.4974	0.0002	0.0034	0.9939
3.A.2	Manure Management	METHANE (CH4)	121.8151	125.4972	0.0001	0.0030	0.9970
1.A.1	Energy Industries - Liquid Fuels	N2O	0.3823	0.5195	0.0000	0.0006	0.9976
1.A.4	Other Sectors - Liquid Fuels	N2O	0.2962	0.2170	0.0000	0.0004	0.9980
1.A.4	Other Sectors - Liquid Fuels	CH4	0.3511	0.2832	0.0000	0.0004	0.9984
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO2)	2.5493	2.5639	0.0000	0.0004	0.9987
1.A.3.b	Road Transportation	METHANE (CH4)	0.4918	0.4449	0.0000	0.0003	0.9991
4.C	Incineration and Open Burning of Waste	CARBON DIOXIDE (CO2)	1.0128	1.1035	0.0000	0.0003	0.9993
1.A.1	Energy Industries - Solid Fuels	N2O	0.4968	0.5648	0.0000	0.0002	0.9996
1.A.1	Energy Industries - Liquid Fuels	CH4	0.1295	0.1759	0.0000	0.0002	0.9998
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	N2O	0.0521	0.0323	0.0000	0.0001	0.9999
3.B.5.b	Land Converted to Settlements	CARBON DIOXIDE (CO2)	0.3978	0.3978	0.0000	0.0001	0.9999
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CH4	0.0177	0.0108	0.0000	0.0000	1.0000
1.A.1	Energy Industries - Solid Fuels	CH4	0.0224	0.0255	0.0000	0.0000	1.0000
3.B.2.a	Cropland Remaining Cropland	CARBON DIOXIDE (CO2)	0.0264	0.0264	0.0000	0.0000	1.0000
3.B.4.a.i	Peatlands remaining peatlands	CARBON DIOXIDE (CO2)	-0.0172	-0.0172	0.0000	0.0000	1.0000

3.11. TIME SERIES

Activity data for each source category presented, in this inventory, include all the years starting from the TNC base year of 2000. The calculations used to find the missing data between the inventory years were interpolation and extrapolation methods. These activity data also used the 2006 IPCC software using the same emission factor to allow a consistent comparison of GHG emissions across time; and reflects the adequate emission trends.

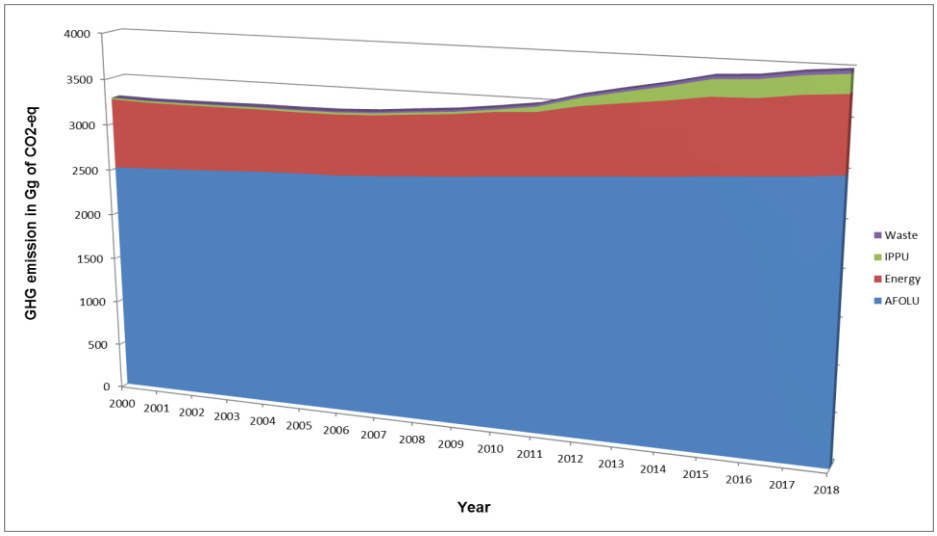

Figure 3.14 Time series of GHG emissions by sector

3.12. COMPLETENESS

The completeness of the 2018 inventory was conducted with each source category by extracting from the 2006 IPCC software analysis. The Results of the assessment for the Energy, IPPU, AFOLU and Waste sectors are presented in Table 3.9. The foremost lack of completeness of data in this inventory was in IPPU in which more than half of the subcategories are not applicable as Eritrea is in transition development period; and most of the previous industries were destroyed by successive colonial regimes. The second lack of completeness was detected in the non GHG gases that do not occur for the emission of gases in the application of 2006 IPCC software explained its version in the methodology.

Generally the lack of completeness particularly for the non GHG gases and not estimated data would be considered in the next inventory report; and are thoroughly explained in the improvement plan.

Table 3.9: Completeness of the Inventory in 2018

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO2
Total National Emissions and Removals	603.8948351	154.348	0.474	21.236	NO	NO	NO	NO	NO	NO	NO	NO
1 - Energy	617.2437126	6.48702	0.097	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A - Fuel Combustion Activities	617.2437126	6.48702	0.097	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1 - Energy Industries	330.1479399	0.00959	0.003						NO	NO	NO	NO
1.A.2 - Manufacturing Industries and Construction	12.8814829	0.00051	1E-04						NO	NO	NO	NO
1.A.3 - Transport	160.3432863	0.02119	0.008						NO	NO	NO	NO
1.A.4 - Other Sectors	113.8710035	6.45573	0.085						NO	NO	NO	NO
1.B - Fugitive emissions from fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.C - Carbon dioxide Transport and Storage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2 - Industrial Processes and Product Use	190.5583003	NO	NO	21.236	NO	NO	NO	NO	NO	NO	NO	NO
2.A - Mineral Industry	190.5583003	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.A.1 - Cement production	185.3173003								NO	NO	NO	NO
2.A.2 - Lime production	5.241								NO	NO	NO	NO
2.A.3 - Glass Production	NA								NA	NA	NA	NA
2.B - Chemical Industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.C - Metal Industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D - Non-Energy Products from Fuels and Solvent Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E - Electronics Industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE	NE	NE	21.236	NE	NE	NE	NE	NE	NE	NE	NE
2.F.1 - Refrigeration and Air Conditioning				21.236				NE	NE	NE	NE	NE
2.F.2 - Foam Blowing Agents				NE				NE	NE	NE	NE	NE
2.F.3 - Fire Protection				NE	NE			NE	NE	NE	NE	NE
2.F.4 - Aerosols				NE				NE	NE	NE	NE	NE
2.F.5 - Solvents				NE	NE			NE	NE	NE	NE	NE
2.G - Other Product Manufacture and Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

3 - Agriculture, Forestry, and Other Land Use	-205.0106901	146.339	0.378	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.A - Livestock	0	146.339	0.378	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.A.1 - Enteric Fermentation		140.363							NO	NO	NO	NO
3.A.2 - Manure Management		5.97606	0.378						NO	NO	NO	NO
3.B - Land	-205.0106901	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.B.1 - Forest land	-207.9816216								NO	NO	NO	NO
3.B.2 - Cropland	2.590331517								NO	NO	NO	NO
3.B.3 - Grassland	NO								NO	NO	NO	NO
3.B.4 - Wetlands	-0.017233333		NO						NO	NO	NO	NO
3.B.5 - Settlements	0.397833333								NO	NO	NO	NO
3.B.6 - Other Land	0								NO	NO	NO	NO
3.C - Aggregate sources and non-CO2 emissions sources on land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3.C.1 - Emissions from biomass burning		NE	NE						NE	NE	NE	NE
3.C.2 - Liming	NE								NE	NE	NE	NE
3.C.3 - Urea application	NE								NE	NE	NE	NE
3.C.4 - Direct N2O Emissions from managed soils			NE						NE	NE	NE	NE
3.C.5 - Indirect N2O Emissions from managed soils			NE						NE	NE	NE	NE
3.C.6 - Indirect N2O Emissions from manure management			NE						NE	NE	NE	NE
3.C.7 - Rice cultivation		NA							NA	NA	NA	NA
4 - Waste	1.103512271	1.52202	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.A - Solid Waste Disposal	NO	1.52202	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.B - Biological Treatment of Solid Waste	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4.C - Incineration and Open Burning of Waste	1.103512271	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.D - Wastewater Treatment and Discharge	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
International Bunkers	13.08393286	9.1E-05	4E-04	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.A.3.a.i - International Aviation (International Bunkers) (1)	13.08393286	9.1E-05	4E-04						NO	NO	NO	NO
1.A.3.d.i - International water-borne navigation (International bunkers) (1)	NE	NE	NE						NE	NE	NE	NE

- NA = Not Applicable, NO = Not Occurring, NE = Not Estimated.

3.13. QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

According to the 2006 IPCC guidelines, the Quality Assurance (QA) and Quality Control (QC) constitute a part of inventory development cycle; and should be conducted at different steps. Currently, under the GHG inventory process, there was no Quality Assurance / Quality control (QA/QC) system put in place to ensure routine and consistent checks required for data integrity, correctness and completeness from different data sources. Nonetheless, meanwhile Eritrea placed its own quality control (QC) system for data collected by different ministries and institutions.

The validity of the collected data was checked by the project coordinator of the DoE at different stages from data collection to compiling and the methodology used for data analysis and processing. Hence, at all steps of the inventory development, the consistence of data was checked by comparing the total annual consumption figures with the production, or imports data. In addition, the data used were verified and validated during stakeholder's representatives meetings. Whenever there were inconsistencies or possible transcription errors, the responsible institution 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; and technical and scientific reviews of data used, methods adopted and results obtained.

The QA was undertaken by independent reviewers who were not involved in preparation of the inventory (annex-A). The experts are national GHG inventory expert and registered at UNFCCC roster of expert which has undertaken the quality Assurance by putting the activity data in the 2006 IPCC software to check the quality of emissions and KCA. The **UNEP** Global Support Program also reviewed and commented on the overall reporting requirements and its contents with the aim of:

- confirming data quality and reliability;
- reviewing the activity data and emission factors adopted for each source category as a first step;
- reviewing and checking the calculation steps in the software; and
- Ensuring the consistency over the time series.

3.14. ARCHIVING

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

3.15. CONSTRAINTS, GAPS AND NEEDS

Eritrea, as a developing country, has specific constraints and gaps that need to be addressed to produce better quality reports for own planning and reporting to the Convention. Climate change study in the country has been constrained by weak institutional capacity in most sectors coupled with limited financial resources. Further, the other major constraint is lack of central point for data management, storage and retrieval or data unavailability and low quality. The main technical and capacity constraints and gaps identified was the low level of knowledge, skills and awareness of the climate change issues among the national stakeholders. Therefore, some of the problems encountered during the preparation of the national inventory of GHG emissions were:

- Information required for the inventory from the various sources were not in the required format for feeding the IPCC software to make the emission estimates;
- Sectorial data unavailability particularly in the AFOLU sector. Reliable Land use and Land use change data were not available and had to be derived from statistical analysis of international data and research papers on land use change of Eritrea. Information on the production from different industries was not available which led to overestimation or under estimation of emissions. Emissions for a few categories and gases have not been estimated due to lack of data.
- There were frequent inconsistencies when data were collected from different sources. Expert judgment estimations had to be made in many instances hence this introduced high levels of uncertainty in the results.
- Lack of solid waste characterization data which had been derived on the basis of percentage of production from default values on the IPCC guidelines for this assessment.
- Appropriate national emission factors are not available so that default IPCC factors which do not necessarily reflect national conditions have been extensively used;
- High staff and expertise turnover affected continuity and consistency in the study approach.

In view of the above mentioned setbacks, there is a need to: (i) enhance research capacity in public and private sector as well as NHERI (ii) build capacity in managing national database and archives for systematic observation in all sectors involved in climate change and (iii) develop a comprehensive system of data storage and retrieval, a mechanism for quality control, and an easily accessible user-friendly retrievable electronic system, and establish an elaborate national and global network of systematic observation stations for effective and efficient exchange of data and information at all levels. Last but not least, there is a need for continuous training on the 2006 IPCC Guidelines and inventory software to improve the capacity of national experts for a better reporting of the inventory from Eritrea. Finally, the implementation of climate change activities to mitigate the impact of climate change requires funds from public budget and/or bilateral and multilateral development partners.

3.16. NATIONAL GHG INVENTORY IMPROVEMENT PLAN

Based on the constraints and gaps encountered during the preparation of the national inventory, a list of improvement plans are proposed in Table 3-10. The gaps related with the GHG inventory and mitigation measures could be also addressed during the preparation of the fourth National Communication (FNC) and Biennial Updated Report 2 (BURII).

Table 3.10 Improvement plan for Next Inventory

Category code and name	Issue	Improvement Option	Priority of Improvement	Responsibility sector
National Circumstance	Macroeconomic such as Gross domestic product, Population size	Population census, population growth, Urban rural population and GDPs Provide additional training to NSO staff	High	NSO of the MoND, MoA, MoTI, MoH, MoMR, MoEM
Institutional Arrangement	Limited technical and institutional capacity of the national UNFCCC focal point to setup institutional arrangement and network communication with the national institutions.	Develop network communication with the national institutions and establish Domestic MRV system at national level for accuracy, transparency, consistency and completeness of the inventory which also helpful for QA/QC system. To do that the national UNFCCC focal point appointed the department of environment focal point in every relevant ministry.	High	DoE of the MoLWE
Capacity building	Limited capacity of stakeholder experts data compilation, processing and analysis through the IPCC 2006 guideline	• train stakeholder experts on the use of IPCC 2006 guidelines • enhance the capacity of project coordination unit on quality control and quality assurance procedures	High	MoLWE, DoE
Emission Factor	Lack of National Emission Factor	Provide training on the determination of Country emission factor and use of tools energy, waste and IPPU	High	MoLWE, DoE, MoEM and MoLG
1.A.4.c-ii off-road vehicles and other machinery	Activity data not include separately with this inventory	For more accurate and completeness of the GHG inventory, the activity data gathered separately from transportation	High	MoA, Wildlife and forestry authority and MoTC
1.A.3.d.i - International water-borne navigation (International bunkers)	The consumption of fuel and technology used were not consider with this inventory	It is understood the international water borne reported separately but for better communication and taken action the requirement of this is	Low	Ministry of transport and Communication and Eritrean Navy
1.A.3.d.ii-domestic water-borne navigation	The consumption of fuel by the domestic water-borne is key to the national GHG inventory but due to lack of data and confidentiality could not include within this report separately.	The consumption of fuel would be included in the next inventory and the technology used with the domestic water-borne	Medium	Ministry of marine resource and the Eritrean Navy
2.D.1 lubricant use	The Consumption and use of Lubricants were not untaken any surveyed in this inventory.	The consumption and use of lubricants will be including in the next inventory.	Low	Custom office and MoTI

Category code and name	Issue	Improvement Option	Priority of Improvement	Responsibility sector
2.D.2 Paraffin wax use	The consumption and use of paraffin wax were not consider in this inventory	The consumption and use of paraffin will be including in the next inventory.	Low	Custom office and MoTI
2.F.2 foam blowing agents and 2.F.3 fire protection	The municipality were used both foams and fire protection, however, due to lack of data recording were not included in this inventory. Generally the emissions of gases from this category are included within the Montreal protocol but better for separately report.	Enhance the capacity of the municipality for data recording and prepared models and tools that helpful for the data recording.	Medium	Municipality
2.G.1.b-use of electrical equipment and 2.G.1.c-disposal of electrical equipment	The use and disposal of electrical equipment were not consider in this inventory due to data recording system	The department of energy responsible for the data recording especially out of use equipments and disposal.	Low	Department of Energy
3.A.2 –Manure management	The characterizing of national manure managements in this inventory was not clearly identified and was used by technical expert assumption.	Identify and characterize the national manure management system by using questionnaire during survey.	High	Eritrean Crop and livestock corporation
3.B.1.a –Forest land	All the national land clarification of 2002 studied by the ministry of agriculture were used	Within these 19 years there is a high intervention on land use particularly reforestation and expansion of crop land at national level. Therefore, for more accurate and transparency of the GHG inventory the ministry of Agriculture and other relevant institutions required to update the land use classification and artificial changes.	High	Ministry of Agriculture, Department of Land and Forestry and wildlife authority
3.B.2.a-Cropland			High	MoA, MoLG, Department of Land, Livestock and crop corporation.
3.B.4 Wetlands			High	MoA and MoLG
3.B.5-Settlements			Medium	Municipality, Cadastral Office and Department of Land

Category code and name	Issue	Improvement Option	Priority of Improvement	Responsibility sector
4.A - Solid Waste Disposal	All the waste compositions were used from the IPCC default factor and other lack of data that disposed to land disposal.	Develop national waste recording system and classification of waste composition and industrial waste that disposed to land disposal	High	Municipality
4.C.1-Waste Incineration	The ministry of health were used incineration to incinerate the medical waste but not included within this inventory due to lack of data record system.	Develop and capacity building for the incinerators skill to use daily data recording system.	High	Ministry of Health and Municipality
4.C.2 – Open Burning of Waste	There is no any classification of open burning waste and fraction of population used open burning.	Classify and identify the amount of open burning waste (Clinical, Hazardous and industrial) and update fraction of population used open burning	High	Municipality and MoH
4.D.1 – Domestic Wastewater Treatment and Discharge	Generally there is no waste treatment at national level but there is the discharge of domestic waste to the sewer system and were not include in this inventory due to lack of data.	The municipalities estimate the daily waste drainage to the sewer and identify the final ends and usage of sewage.	High	Municipality and MoTI
4.D.2-Industrial Wastewater Treatment and discharge	Overall in the country there is no waste treatment but there is the discharge of industrial waste to the sewer system and were not include in this inventory due to lack of data.		High	Ministry of Trade and Industry

4. MITIGATION ACTIONS

4.1. NATIONAL MITIGATION POLICIES AND TARGETS

The, GoSE has already taken concrete steps to mainstream climate change mitigation issues into sectorial policies. Energy Development Framework and Strategy (EDFS) are instances in the right direction. Further, the country mainstreamed and integrated climate change issues, including mitigation actions into its development strategies and action plans. To-date, Eritrea implemented various economic activities that contribute to the reduction GHGs emissions. The country has also promoted removals through various reforestation and afforestation measures under the AFOLU sector.

4.2. PROMOTION OF RENEWABLE ENERGY

The TNC report provided analysis of measures to limit and reduce the GHGs emissions with limited measures to enhance the GHG mitigation and sinks. The report sets the GHG reduction along with national priorities for mitigating GHG emission from all energy supply and demand sectors contributing to national GHG emission. The report identified household, public or commercial and transport as the highest priority sectors due to their high energy consumption as well as to their low efficiencies. On the other hand, power generation was identified as the main source for GHGs due to its significant contribution to national GHG emission. Additionally, the report built on Mitigations assessment findings to identify national target to be achieved by 2030; and identifies mitigation measures to meet the country intended target. In that context, the TNC report identifies the year 2000 as the reference for baseline and mitigation scenarios of GHG emission; and also identifies emission projections for 2030 for the two scenarios. These projections were the reference of policy makers in defining 2030 emission reduction target of Eritrea which is included in the TNC.

The National emission target- as reported in the TNC- referred back to NDC, calls to curb GHG emission incurred by the current Business as Usual Case (BAU) policy with aim at promoting energy resilience and achieving 14% reduction of energy-related GHG emissions in 2030. These targets are proposed to be realized through four strategic options respectively dealing with ***Energy efficiency***, ***Fuel*** **switching** and introduction of ***renewable energy*** in the electricity generation mix and forest enhancement through plantation and natural regeneration..

i. Enhancing Energy Efficiency

The Energy efficiency target calls for increase in the efficiency of exiting power generation systems and improvements in transmission and distribution facilities; the introduction and widespread penetration of efficient LED lamps and efficient refrigeration as well as dissemination of improved traditional biomass and electric stove in the household sector; the introduction of fuel economy *standards* for light and heavy duty vehicles accompanied by increase vehicle load factor (use of mass transport) rehabilitation and development of land transport system and introduction of importation policy.

ii. Fuel Switching

The fuel switching target includes switching from traditional biomass fuel to LPG for cooking and from kerosene wick lamps to electricity and solar lanterns in household. It also

involved fuel switching from traditional biomass to diesel fired for commercial bakeries and to LPG other commercial food catering businesses and electric to solar water heaters.

iii. Penetration of Renewable Energy

The penetration of renewable energy in the electricity generation mix will effectively include the development of small to medium scale, grid connected geothermal, wind and solar PV system. In addition, there is widespread introduction of micro-mini scale standalone solar PV systems and water pumps to replace diesel pumps in shallow wells were considered.

iv. Forest enhancement

The mitigation actions under the forestry sector focuses on Forest Management and silviculture regeneration through afforestation and reforestation activities as well as assisted regeneration through area closure.

Table 4.1 Summary of Mitigation action progress

No. of mitigation actions (Total)	**12**	
GHG emission reduction in total of all listed mitigation actions over a given period of time (*If possible)* [e]		
Mitigation actions by sector		
Short description of mitigation actions	**Status**	**Impact [estimated GHG emission reduction, quantified in ktCO₂] over a given time** [e]
Energy(**Renewable Energy)**		
Installation of Grid connected Solar PV system (50 MW)	*Planning phase (2018-2030)*	Reduction of 14 k tons of CO_2 per year
Installation Mini-Grid Solar PV system 15 MW	*On-going (2018-2030)*	Reduction of 4.2 ktons of CO_2 per year
Off-grid solar PV promoted in rural areas	*On-going (2014-2025)*	Reduction of 24.4 ktons of CO_2 per year
Wind farm for wind diesel hybrid and standalone system	*Planning phase (2018-2025)*	Reduction of 0.0064 ktons of CO_2 per year
Geothermal power plants developed and interconnected into existing national grid	*Planning phase (2018-2030)*	Reduction of 70.4 ktons of CO_2 per year;
Total		***113 ktons of CO_2***
Energy (**Energy Efficiency)**		
Power Distribution Rehabilitation (Efficiency Improvement)	*On-going (2018-2025)*	*Reduction of 16.5 ktons of CO_2 per year*
Demand Side Energy saving through Efficiency improvement (use of energy efficient devices)	*On-going (2018-2025)*	*Reduction of 33.2 ktons of CO_2 per year*
Program of Dissemination of improved traditional biomass stove	*On-going (2018-2030)*	*Reduction of 0.0006 ktons of CO_2 per stove per year in its service time*
Promotion and Distribution of Solar Water Heaters in household and Commercial sectors	*On-going (2018-2030)*	*Estimated reduction of 0.00013 ktons of CO_2 per year per heater*
Total		***49.7 ktons of CO_2***
Transport		

Promotion and Encouragement of energy efficient mass transportation and Vehicle importation control	*On-going (2018-2030)*	*2.6 ktCO2/year emission reduction*
Promotion and Encouragement of solar pumps	*on-going*	*Estimated reduction of 0.00195 ktons of CO_2 per year*
AFOLU (Forestry)		
Forest Management and silvicultural activities: (regenerations, afforestation and reforestation)	*Under implementation*	*117.6 ktCO2 sequestrated over the targeted year*

[e]*Annual and cumulative over a defined time period; whether the estimate is ex-ante or ex-post; description of methodologies and assumptions*

The introduction of renewable energy option aims to improve security of electricity supply system, minimize dependence on unsustainable imported fossil fuel use and reduce GHG emissions from national power generation system through the following renewable policy options and renewable energy targets:

- the introduction of 50 MW of Solar PV Power systems into existing national grid by 2030;
- the introduction of 15MW mini-grid hybrid system in rural towns and surrounding villages by 2030;
- the integration of 40 MW of Wind farms power plants into existing national grid by 2025;
- the integration of 30 MW of geothermal power plants national generation mix by 2030;and
- The promotion of individual solar home systems (SHS) in rural areas to cover every rural household by 2025.

4.3. MITIGATION ACTIONS (RENEWABLE ENERGY)

The information on Mitigation actions in the energy sector includes the following: 1. Installation of Grid connected Solar PV system (50 MW), 2. Installation Mini-Grid Solar PV system 15 MW, 3.Off-grid solar PV promoted in rural areas, 4 Wind farm for wind diesel hybrid and standalone system and 5 Geothermal power plants developed and interconnected into existing national grid (Table 4.2).

Mitigation Action-1

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts)*	*GHGs covered*
Installation of Grid connected Solar PV system	*Planning Phase*	*Ministry of Energy and Mines*	*2018-2030*	*Energy Sector (Eritrean Electricity Corporation and Renewable Energy Centre)*	*National*	*Reduction of 14 k tons of CO_2 per year*	*CO_2*
Objective	*"The objective of the mitigation action is to diversify the energy generation mix by fostering Grid connected renewable energy projects to diverse the energy sector and reduce national reliance on fossil fuel powered energy generation to achieve energy national reliance security with less import dependence and to contribute to the long-term development of the renewable energy industry secure sustainable energy to the growing demand and reduce emissions from fossil fuel fired power plants "*						
Brief description and activities planned under the mitigation action	*Carry out feasibility studies, project development and soliciting funds, as per availability of finance implement modular grid connected PV systems in different localities which can support the grid system simultaneously reduce GHG emission from fossil fuelled power generation*						
Estimated out come and estimated emission reductions	*By 2030, total capacity of 50 MW of solar PV installed in at least three sites across the country and is expected to deliver 60 GWH of electricity, being about 2.0% of national generation mix in the target year, and Saving of 5500m^3/year of fuel oil and associated CO_2 emission and foreign currency*						
Methodologies and assumptions	*methodology used to estimate GHG emission reduction; estimated electricity generation is multiplied by calculated national grid emission factor (0.64kg/kWh)*						
General description of the monitoring and reporting system							
Name of the	*Unit*	*Indicator*	*Indicator*	*Year baseline and*	*Indicator value*	*Reporting year*	*Most relevant*

indicator		*baseline value*	*target value*	*target value relate to*	*in the last reporting year*		*data sources for indicator value*
	Progress indicators						
Total installed capacity of Grid connected Solar PV system	*MW*	-	*50MW*	*2030*	*2MW*	*2018*	*EEC*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	-	*14 $ktCO_2$*	*2030*	*0.0934$ktCO_2$*	*2018*	*Ministry of Energy*

Mitigation Action-2

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts)*	*GHGs covered*
Installation Mini-Grid Solar PV system 15 MW	*2.25 MW on-going and 12.75 MW Planning*	*Ministry of Energy and Mines in cooperation with development partners*	*2018-2030*	*Energy Sector (Eritrean Electricity Corporation and Renewable Energy Centre)*	*Regional in 5 Zones of the country*	*Reduction of 4.2 k tons of CO2 per year;*	*CO_2*
Objective	*"The objective of the mitigation action is to diversify the energy generation mix by fostering Mini-grid renewable energy projects to diverse the energy sector and reduce national reliance on fossil fuel powered energy generation to achieve energy national reliance and security with less import dependence (and to contribute to the long-term development of the renewable energy industry secure sustainable energy to the growing demand of rural electrification and reduce emissions from fossil fuel fired power plants "*						
Brief description	*Ministry of Energy and Mines with its development partners carry out feasibility studies, project development and*						

and activities planned under the mitigation action	*soliciting funds, as per availability of finance implement modular Mini-grid PV systems in different localities which can support the mini-grid system simultaneously reduce GHG emission from fossil fuel fired power generation*						
Estimated out come and estimated emission reductions	*By 2030, a total of 15MW mini-grid solar PV hybrid system installed in at least four rural towns which can serve 16, 000 rural households connected with systems in these rural towns and surrounding villages and Saving of 1500m^3 of Diesel oil and associated CO_2 emission and foreign currency*						
Methodologies and assumptions	*methodology used to estimate GHG emission reduction; estimated electricity generation is multiplied by calculated national grid emission factor (0.64kg/kWh)*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Mini-Grid Solar PV system	*MW*	-	*15MW*	*2030*	*2.25MW*	*2018*	*EEC and DoE*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	-	*4.2 k tCO_2*	*2030*	*0.121$ktCO_2$*	*2018*	*Ministry of Energy*

Mitigation Action-3

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector1and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts)*	*GHGs covered*
Off-grid solar PV promoted in rural areas	*Nearly 400,000 households will be equipped*	*Ministry of Energy and Mines, Local administrations*	*Since 2014 -2025*	*Local Gov't and Renewable*	*National*	*Reduction of 24.4ktons of CO_2 per year*	*CO_2*

	with solar lanterns			*Energy Centre*			
Objective	*"to promote renewable energy and reduce GHG emissions through the introduction of solar lantern or individual solar home systems (SHS) to shift from kerosene wick lamps and reduce emissions from kerosene consumption for lighting"*						
Brief description and activities planned under the mitigation action	*Ministry of Energy and Mines encourage individual households and public institutions to introduce renewable energy systems through setting nominal or exempting importation tax.*						
Estimated out come and estimated emission reductions	*By 2025, every rural household equipped with solar lantern or with individual solar home systems (SHS) to replace kerosene wick lamps and for charging mobile cell phone.*						
Methodologies and assumptions	*methodology used to estimate GHG emission reduction; estimated kerosene saved is multiplied by kerosene emission factor as stated in the 2006 IPCC guidelines*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Dissemination of Off-grid solar home system	*HH*	*-*	*400,000 households*	*2025*	*60%*	*2018*	*EEC and DoE, Local Government*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	*-*	*24 k tCO_2*	*2030*	*0.0144$ktCO_2$*	*2018*	*Ministry of Energy*

Mitigation Action-4

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts*	*GHGs covered*
Wind farm for wind diesel hybrid and standalone system	*Planning*	*Ministry of Energy and Mines, Local administration*	*Since 2018 - 2025*	*Energy Sector (Corporation Electricity Eritrea and Renewable Energy Centre)*	*National*	*Reduction of 0.0064ktons of CO_2 per year;*	*CO_2*
Objective	*"The objective of the mitigation action is to diversify the energy generation mix by fostering Mini-grid renewable energy projects ; and to contribute to the long-term development of the renewable energy industry secure sustainable energy to the growing demand and reduce emissions from fossil fuel fired power plants"*						
Brief description and activities planned under the mitigation action	*Ministry of Energy and Mines with its development partners carry out feasibility studies, project development and soliciting funds, as per availability of finance implement modular Mini-grid wind diesel hybrid systems in different localities which can support the mini-grid system simultaneously reduce GHG emission from fossil fuel fired power generation*						
Estimated out come and estimated emission reductions	*By 2025, a total capacity of 10 MW of wind farms installed in 2 sites across the country and is delivering 10 GWH of electricity per year, being about 4% of National generation mix in target year, and Saving of 2500m^3 of Diesel oil and associated foreign currency*						

Methodologies and assumptions	*methodology used to estimate GHG emission reduction; estimated electricity generation is multiplied by calculated national grid emission factor (0.64kg/kWh)*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Wind farm for wind diesel hybrid and standalone system	*MW*	-	*10MW*	*2025*	*Project Planning phase*	*2018*	*EEC and MoLWE (DoE), Ministry of Local Government*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	-	*6.4 k tCO_2*	*2025*	*Project Planning phase*	*2018*	*Ministry of Energy*

Mitigation Action-5

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts)*	*GHGs covered*
Geothermal power plants developed and interconnected into existing national grid	*Planning*	*Ministry of Energy and Mines, Local administration*	*Since 2018 - 2030*	*Energy Sector (Eritrean Electricity Corporation and Renewable Energy Centre)*	*National*	*Reduction of 70.4 k tons of CO_2 per year;*	*CO_2*
Objective	*"The objective of the mitigation action is to diversify the energy generation mix by fostering geothermal power generation project to support base load and to contribute to the long-term development of the renewable energy industry secure sustainable energy to the growing demand and reduce emissions from fossil fuel fired power plants"*						
Brief description and activities planned under the mitigation action	*Ministry of Energy and Mines with its development partners carry out feasibility studies, exploration test, project development and soliciting fund;, as per availability of finance implement pilot project of geothermal systems in potential sites to support the national grid simultaneously reduce GHG emission from fossil fuel fired power generation*						
Estimated out come and estimated emission reductions	*By 2030, a total capacity of 30 MW of geothermal power plant installed at potential sites (Alid) across the country and is delivering 110GWH of electricity per year, being about 20% of National generation mix in target year, and saving of 27500m^3 of Diesel oil and associated foreign currency*						
Methodologies and assumptions	*methodology used to estimate GHG emission reduction; estimated electricity generation is multiplied by calculated national grid emission factor (0.64kg/kWh)*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator*

							value
	Progress indicators						
Geothermal power plants developed and interconnected into existing national grid		*Prefeasibility study*	*30MW*	*2030*	*Prefeasibility study*	*2018*	*Ministry of Energy and Mines*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	-	*70.4 k tCO_2*	*2030*	-	*2018*	*Ministry of Energy and mines*

4.4. MITIGATION ACTIONS (ENERGY EFFICIENCY)

The EEC aims at increasing energy efficiency by 2030 in power distribution by 50%, compared to 2010. Specific mitigation measures identified by the strategy to achieve this target include the improve efficiency in power distribution network Asmara area. Additionally, the Energy sector aims at improving energy efficiency through improving efficiency of cooking stoves, and replacement lighting systems in domestic sector, introduction of solar pumps in irrigation and domestic water supply, also solar water heaters, power factor correction in government installations, industrial energy audits, standardization and labeling and introduction of time of use tariffs can be considered.
In the energy sector, the mitigation actions are i) Power Distribution Rehabilitation(Efficiency Improvement), ii) Demand Side Energy saving through Efficiency improvement (use of energy efficient devices) iii) Program of Dissemination of improved traditional biomass stove iv) Promotion and Distribution of Solar Water Heaters in household and Commercial sectors and v) Promotion and Encouragement of solar pumps.

Mitigation Action-6

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts)*	*GHGs covered*
Power Distribution Rehabilitation(	*On-going*	*Ministry of Energy and*	*Since 2018 -2025*	*Energy Sector (EEC and*	*Asmara area*	*Reduction of 16.5 ktons of*	*CO_2*

Efficiency Improvement)		*Mines + EEC*		*DoE)*		*CO_2 per year;*	
Objective	*" to rehabilitate and improve electricity distribution network to improve distribution losses; contribute to secure sustainable energy to the growing demand and reduce emissions from fossil fuel fired power plants"*						
Brief description and activities planned under the action	*Ministry of Energy and Mines with Eritrea Electric corporation and its development partners carry out rehabilitation of the distribution networks in Asmara area and its suburbs so as to increase efficiency of distribution networks and reduce distribution losses and associated fossil fuel consumption. Simultaneously reduce GHG emission from fossil fuel fired power generation so as to improved environmental quality.*						
Estimated out come and estimated emission reductions	*By 2025, total capacity of 10 MW of generation capacity can be available and able to generate 30GWH of electricity per year which is about 10% of the current generation capacity. and Saving of 30GWh of electricity per year and associated Diesel oil and foreign currency expenditure*						
Methodologies and assumptions	*estimated electricity savings is multiplied by calculated national grid emission factor (0.64kg/kWh)*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Total electricity conserved	*GWh*	*-*	*30GWh*	*2025*		*2018*	*EEC*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	*-*	*16.5k tCO_2*	*2030*		*2018*	*EEC*

Mitigation Action-7

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts)*	*GHGs covered*
Demand Side Energy saving through Efficiency improvement (use of energy efficient devices)	*On-going*	*Ministry of Energy and Mines + EEC*	*Since 2018 -2025*	*Energy Sector (EEC and DoE)*	*National*	*Reduction of 33.2 k tons of CO_2 per year;*	*CO2*
Objective	*" to promote the distribution and use of energy efficient(<10 W LED lamp) instead of 60W incandescent lamp and improved traditional electric Mogogo stoves to improve saving of electricity consumption at household level"*						
Brief description and activities planned under the Initiative	*Ministry of Energy and Mines with Eritrea Electric corporation and its development partners, Small scale Manufacturing Enterprises (SME) and developers carry out research studies, encourage and distribute energy efficient (LED) lamps and improved traditional electric stoves (Electric Mogogo).*						
Estimated out come and estimated emission reductions	*By 2025, total capacity of 15 MW of generation capacity can be available and able to generate 44GWH of electricity per year which is about 10% of the current generation capacity from introduction of energy saving lamps. Similarly by 2025 the traditional electric Mogogo (stoves) will be replaced by efficient stove which enables to reduce the existing consumption by more than 50% or 200kWh per stove per year. and Saving of 52GWh of electricity per year and associated Diesel oil and foreign currency expenditure*						
Methodologies and assumptions	*estimated electricity savings is multiplied by calculated national grid emission factor (0.64kg/kWh)*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Total electricity conserved	*GWh*	*-*	*52GWh*	*2025*		*2018*	*EEC*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	*-*	*33.3k tCO_2*	*2030*		*2018*	*EEC*

Mitigation Action-8

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts*	*GHGs covered*
Program of Dissemination of improved traditional biomass stove	*On-going*	*Ministry of Energy and Mines, Local Administration and MoA*	*Since 2018 -2030*	*DoE, MoA, Local Administration, Stove producers*	*National*	*Reduction of 0.0006 ktons of CO_2 per stove per year in its service time;*	*CO_2*
Objective	*" to promote the distribution and improve energy use efficiency, Reduce forest degradation, improve kitchen environment and reduce GHG emission through use of improved stove"*						
Brief description and activities planned under the Initiative	*Ministry of Energy and Mines with Ministry of Agriculture, Local admin and Women's association promote and disseminate traditional Mogogo "Adhanet" to rural areas with no alternative).*						
Estimated out come and estimated emission reductions	*By 2030, dissemination of improved traditional biomass stove to 25% of the households saving potential of 50% of biomass consumption per stove. Saving of 50% of biomass consumption compared to existing traditional stove and avoid associated environmental and health problems including household drudgery.*						
Methodologies and assumptions	*estimated savings of biomass consumption per stoves per year and associated reduction of CO2 per stove per year (0.6ton/stove/year)which is calculated based on CDM - small scale methodology for energy efficiency measures in thermal applications of non-renewable biomass - AMS- II.G: Version 9*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						

Total biomass conserved	*per cent*	*65kg/Month/stove*	*50%*	*2030*	*6.6ktone/year*	*2018*	*DoE, MoA, LA, Stove producers*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	-	*0.0006 $ktCO_2$/stove /year*	*2030*	*11.5 ktone/year*	*2018*	*DoE, MoA, LA, Stove producers*

Mitigation Action-9

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector1and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts*	*GHGs covered*
Promotion and Distribution of Solar Water Heaters in household and Commercial sectors	*On-going*	*Ministry of Energy and Mines, Local Administration and entrepreneurs*	*Since 2018 -2030*	*DoE, Local Administration, Entrepreneurs*	*National*	*Estimated reduction of 0.00013 ktons of CO_2 per year per heater*	*CO_2*
Objective	*"to promote the distribution and active use of solar energy through use of solar water heaters instead of electric water heaters"*						
Brief description and activities planned under the Initiative	*Ministry of Energy and Mines with Local admin and entrepreneurs promote and encourage users to shift from electric heaters to solar water heaters.*						
Estimated out come and estimated emission reductions	*By 2018-2030, about 2,000 units of solar water heaters will be installed a year, being 2% of market potential in both household and commercial sector. and associated fuel saving is estimated to be about 50lt/heater per year*						
Methodologies and assumptions	*estimated savings of electricity consumption per heater per year and associated reduction of CO_2 per heater per year (0.64kg/kWh)*						

General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Total electricity saving from SWH	*GWh*	*-*	*5GWh*	*2030*	*0.4GWh*	*2018*	*DoE, LG*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	*-*	*0.00013 $ktCO_2$/heater /year*	*2030*	*0.246 ktone*	*2018*	*DoE, LG*

Mitigation Action-10

Name of the mitigation action (Energy Efficiency)	*Status*	*Implementing institution*	*Duration*	*Sector and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts*	*GHGs covered*
Promotion and Encouragement of energy efficient mass transportation and Vehicle importation control	*On-going*	*Ministry of Energy and Mines, Ministry of Transport and Communication*	*Since 2018 -2030*	*DoE,MTC, TI*	*National*	*Estimated reduction of CO_2 emission per passenger km transported is 23%.*	*CO2*
Objective	*"To promote and establish energy efficient, reliable and dependable transportation system through improving road network, use of public and or mass transport, vehicle inspection and importation control."*						
Brief description and activities planned under the Initiative	*Ministry of Transport and communication is introducing regulatory policy to improve transport services, safety and fuel consumption in the sector through mass transportation, road maintenance, vehicle inspection, and import control.*						

Estimated out come and estimated emission reductions	*By 2030, long distance transportation will covered by public and or mass transportation and ban importation of old model vehicles, improved road network.*						
Methodologies and assumptions	*An estimated savings of fuel consumption per year and associated reduction of CO_2 per year will be 23% less consumption and or emission.*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Total fuel saving fromthe intervention	*%*	*-*	*23%*	*2030*	*808 kton 0f Diesel*	*2018*	*DoE, LG*
	Indicators related to GHG impacts						
Annual emission reduction	*$ktCO_2$*	*-*	*23% of CO_2/passenger km*	*2030*	*2.6 kton CO_2*	*2018*	*DoE, LG*

Mitigation Action-11

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector1and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts)*	*GHGs covered*
Promotion and Encouragement of solar pumps	*on-going*	*MoEM + MoLG, MoA and MoLWE*	*Since 2018 -2030*	*DoE,MoLG, MoLWE*	*National*	*Estimated reduction of 1.95 tons of CO_2 per year per pump*	*CO2*
Objective	*"to promote and encourage widespread introduction of solar water pumps to replace diesel pumps in shallow wells for irrigation and domestic use."*						

Brief description and activities planned under the Initiative	*Ministry of Agriculture, Ministry of Land, Water and Environment, Ministry of Local Gov't and Development partners encourage and implement for the distribution of solar water pumps for irrigation in agriculture and in domestic use to improve the livelihood of the local communities.*						
Estimated out come and estimated emission reductions	*By 2030, 75% of diesel pumps supposed to be replaced by solar pumps and associated fossil fuel consumption will be reduced. and associated fuel saving is estimated to be about 720lt/pump per year*						
Methodologies and assumptions	*Estimated savings of fuel consumption per pump per year and associated reduction of CO_{2e} per year is estimated based on 2006 IPCC guidelines.*						
General description of the monitoring and reporting system							
Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year (20xx)*	*Most relevant data sources for indicator value*
	Progress indicators						
Total fuel saving fromthe intervention	*Tons of diesel/year*	*-*	*612lt*1000pump*	*2030*	*612lt*479pumps*	*2018*	*MoLWE (DoE), MoLG*
	Indicators related to GHG impacts						
Annual emission reduction	*tCO_2*	*-*	*1.95 tons of CO2/Pump/year*	*2030*	*1.95tons*479 CO2/year*	*2018*	*DoE, LG*

4.5. MITIGATION ACTIONS (AFFORESTATION AND REFORESTATION)

The mitigation actions under the forestry sector focuses on Forest Management and silviculture regeneration through afforestation and reforestation activities as well as assisted regeneration through area closure.

Mitigation Action-12

Name of the mitigation action	*Status*	*Implementing institution*	*Duration*	*Sector[1] and subsector*	*Scope*	*Quantitative targets (both GHG-related and non-GHG impacts, as applicable)*	*GHGs covered*
Forest Management and silvicultural activities: (regenerations, afforestation and reforestation)	*On-going*	*Forestry and Wildlife, Authority MoA, MoE, MoLWE & MoLG*	*Since 2006-2025*	*Forestry and Wildlife*	*National*	*117.6 ktons of Net CO_2 removal*	*CO_2,*
Objective	• *To rehabilitate degraded landscapes through intensive greening (reforestation, afforestation) and control run-off and loss of arable land on downstream areas through soil erosion.* • *Encourage individual households in communities to plant and own trees, through agro-forestry, park land agro-forestry to produce forage and produce sustainable perennial crops.*						
Brief description and activities planned under the mitigation action	*The forestry & wildlife authority, ministry of agriculture, ministry of education and local government have planted 49,103,634 tree seedlings up to the reporting year which covers an area of 21,041 ha.* *To promote assisted natural regeneration the forestry & wild life authority in collaboration with the local government have established enclosures of 314,062 ha nationally in different parts of the country up to the reporting year.* *Moreover, for the next five years anticipated to establish 80 million seedlings which is estimated to cover*						
Estimated out come and estimated emission reductions	*35,000 ha of barren land will be covered by tree seedlings assuming survival rate of 65% and potential harvest 3 ton per hectare estimated to sink 117.6ktons of CO_2 by 2030*						
Methodologies and assumptions	*The survival rate of the planted trees on average is assumed to be 65 %. Methodology used to estimate GHG emission (Assuming 3 ton/ha/an 4.7ton C/d *44/12)Gg*						
General description of the monitoring and reporting system							

Name of the indicator	*Unit*	*Indicator baseline value*	*Indicator target value*	*Year baseline and target value relate to*	*Indicator value in the last reporting year*	*Reporting year*	*Most relevant data sources for indicator value*
	Progress indicators						
Forest Management	*hectare*	--	*35,000 ha*	*2025*	*21,041 ha afforested area*	*2018*	*F&WLA*
	Indicators related to GHG impacts						
Annual CO_2 removal	*ktCO_2*		*350 tons of Net CO_2 removal*	*2030*	*70.6 ktons Net CO_2 removal*	*2018*	*F & WLA*

4.6. OTHER INFORMATION ON MITIGATION ACTIONS

It is worth recalling that the list of measures is not comprehensive due to the unavailability of data needed to quantify environmental impact associated with the shift of the Eritrean household to use improved stove, LPG, and solar PV, for meeting household energy needs; increase renewable electricity generation to back the national grid and mini-grid systems to enhance mini-grid supply and rural electrification; increase solar PV systems for domestic and agricultural water pumping; etc.

This is because, Eritrean households have suffered from frequent blackouts or power shading, which extend sometimes to more than 6 hours per day and due to shortage of kerosene supply households adopted an innovative coping strategy by which entails the shift to solar home systems to meet their energy demand for lighting and powering appliances. Moreover, households, and commercial activities shift to use LPG and improved stoves for cooking; similarly there are some rural electrification activities through mini-grid solar PV systems, PV systems feeding the grid and PV systems powering mining facilities but their generation is not studied yet.

Therefore, this report highly recommended conducting immediate surveys of household, public and commercial energy efficiency and solar PV systems voluntary introduced by people or entity; grid tide and mini-grid PV systems installed throughout the country. These are very necessary steps for quantifying emission reduction from these sources, which is anticipated to exceed the intended target planed by national strategies by 2035. Full sectoral description on mitigation actions undertaken with a description of objectives, coverage, achieved emission reduction, and calculation methodologies are provided in tabular format as per decision 2/CP.17.

5. FINANCE, TECHNOLOGY AND CAPACITY BUILDING NEEDS AND SUPPORT RECEIVED

Eritrea, as a developing country, has specific constraints and gaps that need to be addressed to produce better quality reports for its own planning and reporting to the Convention. The main technical and capacity constraints and gaps identified mainly revolved around the low level of knowledge, skills and awareness of climate change issues among stakeholders. In this regards, Eritrea needs to alleviate these constraints and gaps; and have transparency and synergies. Although the needs are huge, it is an indispensable step to enhance the research capacity and build institutional capacity in managing national database and archiving in all sectors involved in climate change. In parallel, there is dire need for the development of a comprehensive system of data storage and retrieval, a mechanism for quality control, and an easily accessible user-friendly retrievable electronic system. Correspondingly, it is important to establish an elaborate national and global network of systematic observation stations for effective and efficient exchange of data and information at all levels. What's more, continuous training is needed for new expert training particularly on the main thematic areas and training of trainers especially for project coordinators on the 2006 IPCC Guidelines and inventory software, climate change mitigation analyses to improve the capacity of national experts for a better reporting of the inventory. The implementations of climate change activities targeted to reduce or mitigate the impact of climate change solicit funds from the public budget and/or bilateral and multilateral development partners.

The GHG emission trends discussed in previous sections are by and large attributed to AFOLU. On the other hand, it is equally important to consider the critical role played by a number of drivers including, among others, low technology and limited technology transfer contributing to the continuing GHG emission increase from all supply or production and demand or economic sectors. The extensive use of biomass and high carbon content fuels requires immediate attention to replace biomass by other alternative greener energy technologies. Today, excessive use of inefficient technologies mainly in power generation, transport, household and industry are serious; and need to be addressed without delay.

5.1. SUPPORT NEEDS

Eritrea is the first experience to report BUR and have needs many technical and human capacity building to strengthen the capacity of expert groups and the national project coordinator to solve the gaps on GHG inventory and mitigation assessment including GHG emission and mitigation scenarios. The common constraints and gaps including improvement plan are identified within the TNC and BUR1 as list in Table 5.1

Table 5.1: Table List of Support Needs

Need Identified	**Support Needed**	**Specific type of support requested [technology transfer, capacity building, financial support]**	**When and for how long is support needed?**	**Where financial support is needed, please indicate**	
				National budget available in USD	**Financial support needed in USD**
Strengthen the Institutional Set - Up of the UNFCCC focal point (Arrangement)	Sector-specific data generation processes to improve the GHG inventory and Synergies for monitoring and evaluation.	Capacity Building and financial support	2022	20% (in kind)	50,000
Enhance institutional capacity	Promote Green Energy and Mitigation policies	Capacity Building and Financial support	2022-2025	20% (in kind)	200,000
Develop Policy and Legislative Framework	Develop national Climate and mitigation policies and legislative framework	Capacity Building and Financial support	2022	20% (in kind)	250,000
Develop national emission factor	Develop (Calibration) of emission factors for the Energy Sector	Capacity Building and Financial support, technology transfer	2022-2023	20% (in kind)	50,000
Conduct training courses on GHG inventory and update process (IPCC guideline methodologies for each of the sectors)	Enhancing technical capacity for GHG inventory, develop programmes and strategies to move in- tandem with the latest guidelines and tools on a regular and continuous basis). Enhancing technical capacity for the development of the GHG management system	 Capacity Building and Financial support	2022-2025	20% (in kind)	65,000

Need Identified	Support Needed	Specific type of support requested [technology transfer, capacity building, financial support]	When and for how long is support needed?	Where financial support is needed, please indicate	
				National budget available in USD	Financial support needed in USD
Develop training on quality assurance/ quality control process and methods, uncertainty analysis, key category analysis	Enhancing the capacity of UNFCCC focal point: project Coordinator and National Climate Change Unit to effectively and efficiently control the completeness of the processes and respective plans of QA/QC	Capacity Building and Financial Support	2022	20% (in kind)	30,000
Develop an effective and efficient Knowledge management system in the UNFCCC focal point	Establish sectorial and national data base and information system	Capacity Building, technology transfer and financial support	2022	20% (in kind)	50,000
Enhancing the capacity of national technical experts for tracking National Land-use Changes, and Land/forest Cover	Spatial and temporal satellite images to generate comprehensive and updated land use, vegetation cover change maps the AFOLU sector.	Capacity Building, transfer of technology and financial support	2022-2023	20% (in kind)	1,000,000
Strengthen the research capacity on mitigation (Clean Energy) and adaptation measure technologies	Technology transfer to the National Agriculture Research Institution, Renewable Energy Center of the Ministry Energy and Mines and National Higher Education and Research Institute	Technology transfer and financial support	2022-2025		1400000
Improving the capacity to use models and tools for emission and mitigation scenarios	Training on Simulation and Modeling: Best available models and tools **particularly** on LEAP, Cropwat and SimClim, LoClim, WEAP etc	Capacity building and financial support	2022-2026		250,000

Need Identified	Support Needed	Specific type of support requested [technology transfer, capacity building, financial support]	When and for how long is support needed?	Where financial support is needed, please indicate	
				National budget available in USD	Financial support needed in USD
Enhance Public awareness on Climate Change	Promote Public awareness on risk involved by climate change in all sectors including Agriculture, Water, and Marine, Land, Biodiversity and Human health and on measures of enhancing copping mechanism and vulnerability reduction through the production of awareness material (Videos, Posters, and Animated Presentations etc.).	Financial Support	2022-2023		120000
Total					**3,465,000**

5.2. FINANCIAL SUPPORT RECEIVED

As developing country, Eritrea is vulnerable to climate change. Most of the climate change related hazards are beyond the reach and capacity of the country; and required financial support to cope - up with the problems using adaptation and mitigation actions. During the past years, the country has developed 25 projects through grants (80%) and loans (16%) and the remaining are mix of loan and grants. While 56% of the projects are disbursed, the remaining 46% are committed in the process of implementation. These projects are implemented by the government, civil society, and local communities. Most of the small grand program (SGP) funded by GEF were executed through co-financing i.e. in-kind contribution. That far, the total grant committed and disbursed financial source for implementing these projects from 2000 - 2020 are 71.7745396 US dollar excluding the national in-kind contribution (Figure 5.1.).

In Eritrea, the support received was predominantly on Adaptation programmes focusing on Land Degradation projects that accounts for 52% followed by mitigation (20%) and mixture of both adaption and mitigation projects (12%); and 8% for capacity building. Since 2010, the GEF Small Grants Program (SGP) in Eritrea received financial support of US$ 1,034,998 on adaptation and mitigation activities as well as Biodiversity. During this period, climate specific projects accounted for only 19% indicating that there is a need for climate specific projects in the future to mitigate the adverse effects of climate change.

Apart from the above full -scale projects implemented by government institution, community based projects were also implemented during the period 2009-2019. Out of the 28 small - scale projects, seven were climate -specific projects implemented in Anseba, Maekel, Keih Bahri, and Debub regions. The relevant projects implemented so far are indicated in Table 5-2.

Table 5.2: Finance mobilized in Local currency NKF and USD, financial sources and focus of support during the period 2000-2021

	Reporting period (timeframe covered)							
	2000-2020							
	Climate-specific amount							
Finance mobilised	**Domestic currency ((ER_NKF) in Millions**	**USD equivalent in millions**	**Status (Commit-ted/ Disbursed)**	**Funding sources (ODA, OOF, etc.)**	**Financial instrument (Grant, Concessional loan, Non-concessional loan, Equity, Other)**	**Focus of support (Mitigation Adaptation Cross-cutting, Other)**	**Sector**	**Additional information**
Public finance support– bilateral	115.2841	7.685606	Disbursed	UNICEF	Grant	Adaptation	Water	
	88.454	5.8969336	Disbursed	UNICEF	Grant	Adaptation	Water	
	286.3013	19.08675	Committed	AfDB	Loan	Adaptation	Agriculture	75% Disbursed
	109.917	7.3278	Committed	AfDB	Loan	Adaptation	Agriculture	85% Disbursed
	393.2243	26.21495	Committed	AfDB	Loan	Adaptation	Agriculture	5% Disbursed
	444	29.60	Committed	AfDB	Loan	Adaptation	Agriculture	90% Disbursed
	570	38	Committed	IFAD	Loan-Grant	Adaptation	Agriculture	
	225	15	Disbursed	IFAD	Grant	Fisheries Develop-ment Program	Marine	
	1.365	0.091	Committed	IFAD	Grant	Adaptation	Marine	12% Disbursed
	225	15	Committed	JAICA				
	6.75	0.45	Committed	UNDP	Grant	Adaptation	Agriculture	

	27.75	1.85	Committed	UNDP	Grant	Adaptation	Agriculture	
Public finance support – Global Environment Facility	12.78	0.852	Committed	GEF, UNDP	Grant	Capacity Building	Preparation of TNC and BUR	
	29.25	1.95	Disbursed	GEF	Grant	Mitigation	Energy	
	2.04	0.136	Disbursed	GEF, UNEP	Grant	Mitigation, Adaptation and Capacity Building	Preparation of INDC and NDC	
	2.97	0.198	Disbursed	GEF, UNDP	Grant	Capacity Building	National capacity self-assessment	
	65.25	4.35	Disbursed	GEF, IFAD	Grant	Adaptation and Mitigation	SIP-Catchment and Land Manage-ment	
	27.3	1.82	Disbursed	GEF, UNDP	Grant	Adaptation and Mitigation	Sustainable Land Manage-ment Pilot Project	
	97.5	6.5	Disbursed	GEF, UNDP, AF	Grant	Adaptation and Mitigation	Water and Agriculture	
	173.25	11.55	Committed	GEF, UNDP	Grant	Adaptation	Water and Agriculture	
	133.5	8.9	Committed	GEF, UNDP	Grant	Adaptation	Land and forest	24.2% Disbursed
	75	5.00	Disbursed	GEF, UNDP	Grant	Adaptation	Marine and	

						and capacity Building	biodiversity	
	3.75	0.250	Disbursed	GEF, SGP	Grant	Adaptation	Water	
	0.255	0.017	Disbursed	GEF, SGP GoSE	Grant	Mitigation	Energy	
	0.735	0.049	Disbursed	GEF, SGP	Grant	Mitigation	Energy	
	5.25	0.350	Disbursed	GEF, SGP	Grant	Adaptation	Forest	
	15	1.00	Committed	GEF, UNDP	Grant	Mitigation		
	75	5.00						
	0.75	0.05						
Public finance support – Green Climate Fund	0							
Public finance support – other multilateral	229.05	15.27	Disbursed	EU, UNDP	Grant	Mitigation	Energy	
	480	32.00	Committed	IFAD, Government of German, Beneficiaries and Government contribution	Grant	Fisheries Resource Management Program		14% Disbursed
Public finance support – national (optional)		-						

SUBTOTAL Public finance support	**3921.676**	**261.4450396**						
Private finance mobilized (optional, only if available)		-						
TOTAL	**3921.676**	**261.4450396**						

5.3. TECHNOLOGY AND CAPACITY BUILDING SUPPORT RECEIVED

According the BUR1 and TNC assessment and the strategies of mitigation and adaptation actions in NDC report that have not yet been implemented, Eritrea has not received any technology supported to date except the MESA station. However, Eritrea received different capacity building support to enhance the national climate related reports especially on GHG inventory, mitigation action and its effects including institutional arrangement and MRV system. All the types of support are only capacity building through online and workshop process as indicated in Table 5.4.

Table 5.3: Technology transfer Support Received

Reporting period (timeframe covered)					
2015					
Type of support [technology transfer]	Support activity	Year(s) received	Status [ongoing, finalised]	Focus [mitigation, adaptation, unspecified]	Source of support
	Establishment of E-station	2010	Finalized	Adaptation	ICPAC

Table 5.4: Capacity Building Support Received

Reporting period (timeframe covered)					
2017-2021					
Type of support [capacity building]	**Support activity**	**Year(s) received**	**Status [on going, finalised]**	**Focus [mitigation, adaptation, unspecified]**	**Source of support**
Online	IPCC 2006 Guidelines Training Program (General and On Energy, IPPU, AFOLU, and Waste)	2019-2021	On going	GHG inventory	UNFCCC
Online	Review Experts For Technical Reviews BR And NC for Annex I Parties	2021	Finalized	Mitigation and adaptation	UNFCCC
Online	Technical Component of the E-Learning Course on Climate Transparency and the Enhanced Transparency Framework (ETF),	2021	Finalized	GHG inventory, Adaptation and Mitigation	UNFCCC
Online	Promotion of Comprehensive Economic Strength of Marine Time	2021	Finalized	Mitigation and Adaptation	Ministry of Commerce of the People's

Reporting period (timeframe covered)					
2017-2021					
Type of support [capacity building]	**Support activity**	**Year(s) received**	**Status [on going, finalised]**	**Focus [mitigation, adaptation, unspecified]**	**Source of support**
	Cities Via Integrated Coastal Management (ICM) For Developing Countries				Republic of China
Online	Institutional Arrangement for the Existing Measurement, Reporting And Verification (MRV) Arrangement and The Enhanced Transparency Frameworks	2021	Finalized	Mitigation	UNFCCC
Online	Making Data Speak-Demystifying Air Quality and Public Health Data for Effective Communication	2021	Finalized	Unspecified	Environmental Communication, Center for Science and Environment-INDIA
Online	FOSS - Free and Open Source Software For EO Data Analysis	2021	Finalized	Adaptation	ICAP-ICPA
Online	D&M Data - Digital & Mobile Data Collection For EO Data Analysis	2021	Finalized	Adaptation	IGAD-ICPAC
Online	Preparatory Meeting of the Ad pHoc Open-Ended Expert Group On Marine Litter And Micro plastics	2021	Finalized	Unspecified	IGAD-ICPAC
Workshop	The Application of GIS and Earth Observation Satellite (EO) Data In Environmental Monitoring and Hazard Assessment	2019	Finalized	Adaptation	IGAD-ICPAC
Workshop	African Region on Institutionalization of Data Management for Nation GHG Inventory	2019	Finalized	GHG Inventory	UNFCCC
Workshop	Eastern Africa Regional MRV Network Training and Peer Review	2019	Finalized	Mitigation	UNFCCC
Workshop	MESA Station System Administration And Thematic Application Training	2019	Finalized	Adaptation	IGAD-ICPAC

Reporting period (timeframe covered)					
2017-2021					
Type of support [capacity building]	**Support activity**	**Year(s) received**	**Status [on going, finalised]**	**Focus [mitigation, adaptation, unspecified]**	**Source of support**
Workshop	North West, East And Central Africa Countries Regional Workshop on Measurement, Report and Verification (MRV) Biennial Updates Reports (BURs) and National Communications (NCs)	2018	Finalized	Mitigation	UNFCCC
Workshop	Building of Sustainable National Greenhouse Gas Inventory Management Systems, and the Use of The 2006 IPCC Guidelines For National Greenhouse Gas Inventories for the African Region	2018	Finalized	GHG inventory	UNFCCC
Workshop	Preparation and Reporting of Mitigation Actions for the Africa Region	2017	Finalized	Mitigation	UNFCCC

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7. ANNEXES

ANNEX-A: LIST OF EXPERTS WHO ARE RESPONSIBLE FOR QUALITY ASSURANCE AND QUALITY CONTROL

Se no	Full Name	Contact information	Role	Organization
1	Mr. Kibrom Asmerom	kibromaw@gmail.com Tele:002917154731	Project Supervisor	MoLWE and National UNFCCC Focal Point
2	Dr. Woldeselassie Ogbazghi	wogbazghi@gmail.com	Consultant (Lead)	Hamelmalo Agricultural College, department of Land Resources and Environment, HAC
3	Prof. Woldeamlak Araia	woldearaiahac@gmail.com Tele: 002917154593	Consultant	NHERI, Hamelmalo Agricultural College, department of Agronomy,
4	Dr. Woldetnsae Tewolde	wolde1956@gmail.com Tel:002917195457	Consultant	NHERI, Adi Keih College of Business and Social Science, department of geography
5	Mr. Haben Haile	hbnhabte@gmail.com Tele:002917131730	Consultant	NHERI, College of Science, Department of Chemistry
6	Mr. Teame Tekleab	Teametek2016@gmail.com Tele: 002917266389	Quality Assurance	MoLWE
7	Mr. Robel Kibrom	Roki0404@gmail.com Tele:002917338151	Quality Assurance	MoLWE

ANNEX-B: LIST OF STAKEHOLDER EXPERTS AND CONSULTANTS PARTICIPATED IN BUR1 PREPARATION

Full Name	Contact information	Role	Organization
Mr. Michael Berhane	asmike06@gmail.com	Provide activity data and information used to assess the vulnerability of the Agricultural sector to climate change and related to the sector have been appropriately integrated, to the document GHG emission data, efforts that have been undertaken to adapt to climate change; validate data and information	Ministry of Agriculture, Department of Agricultural Extension
Mr. Solomon Sium	ssng73@gmail.com Tele: 002917131511	Gather information and data related to Industrial greenhouse gases emissions and emitting and all efforts that have been undertaken in the sector to minimize GHGs emissions. Ensure all information related to the sector appropriately captured in the document	Ministry of trade and Industry
Mr. Haile SelassieTsegai	Tele: 002917463219 haileman@gmail.com	Gather/Provide data on water resources and relevant information that are used to assess the vulnerability of water resources to climate change and ensure that the issues related to the sector have been addresses appropriately.	MoLWE, Department of Water resources
Mr. Tesfamariam Woldegebriel	Tele: 002917126006	Provide (gather) data and information related to the transport sector that is used in determining the GHGs emissions; and mitigations efforts of the sector. Fuel consumption by sector, number of vehicles by types, models, year of productions and related regulations that contribute to the reduction of GHgs emission. Information related to efforts that have been undertaken in the reduction of greenhouse gases.	Ministry of Transport and Communication
Mr. Tesfai Gebrehiwet	gtesfai@gmail.com	National fuel consumption of the sector, efforts that has been undertaken to improve electricity generation, consumption. On top of this, he was responsible to determine the GHGs emission from the inventory and perform the mitigation assessment and analyses; gave general training on the application of the different models for GHGs inventory and mitigation assessment and analyses. Participated in the preparation of draft reports on these components.	MoEM
Mr. Teklezghi Tekie		Provide information on land use and vulnerability of land resources to climate change. Provided activity data that contribute to GHGs emission and efforts used and efforts undertaken to reduce the vulnerability and GHGs emissions (AFOLU); and ensured that issues related to the sector are appropriately integrated.	Department of Land MoLWE
Mr. Tekie Abraha	Wediabraha06@gmail.com Tele: 002917454641	Provided information related to the vulnerability of the health sector and efforts that have been under the sector to mitigate and adapt to climate change. Prevalence of climate change induced human health problems such as Malaria, Dengue and Chikungunya)	Department of Public health, Ministry of Health
Mr. Petros Araia	petraraya@gmail.com Tele: 002917433460	Provide data related to Forestry and wildlife that is used the vulnerability of the sector (AFOLU); and the sub-sectors contributing in carbon sequestration (sinks) and the efforts, so far, carried out to combat climate change (mitigation and adaption) i.e. forest cover by type, reforested and afforested areas in ha, tree number, deforestation rate and other relevant data pertaining to climate change.	Forestry and Wildlife Authority

Mr. Andemicahel Hidru		Provide data and information on marine resources that is used to assess the vulnerability of the sector to climate change and ensure that the issues related to this sector have been addressed appropriately. He also availed activity data that is used foe estimating GHGs emissions and efforts that have been carried out so far to reduce vulnerability and emissions.	MoMR
Mr. Mulubrhan Gebreyohannes	mulexgb61@gamil.com	Provided /collected data and information on the waste sector that is used to assess the GHG emission from the sector; and availed feedback on the efforts that have been carried out to reduce greenhouse gases emissions. Prepared a concise report on national waste management i.e. (solid waste, liquid, etc.).	Ministry of Local Government
Mr. Dawit Berhane	danaasemahs@gmail.com Tele: 002917140670	Having prior training during the second national communication, he undertook training on the vulnerability of the water resources to climate change. He also assisted in identifying relevant water resources data and information; and prepared concise report on the water sector.	Segen Construction pt. Lt.
Mr. Michael Haile	Tel: 002917122406	Provided social, economic, data and formation relevant to assessment of climate change vulnerability, adaption, and mitigation components. Previous efforts and future plans of the sector and other relevant sectors that would contribute to the adaption and mitigation to climate change.	Ministry of Local Government
Mr. Mebrahtu Zewde	mebriez@gmail.com Tele: 002917176393	Logistical arrangements i.e. meetings seminars, and taking care of the management issues.	National Bureau of Standards and Evaluation, NHERI

ANNEX-C: KEY SUMMARY OF GHG EMISSION

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)				Emissions (Gg)				
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)	NOx	CO	NMV OCs	SO2
Total National Emissions and Removals	603.8948	154.348	0.4742	21.2358	0	0	0	0	0	0	0	0
1 - Energy	617.2437	6.487025	0.09665	0	0	0	0	0	0	0	0	0
1.A - Fuel Combustion Activities	617.2437	6.487025	0.09665						0	0	0	0
1.B - Fugitive emissions from fuels	0	0	0						0	0	0	0
1.C - Carbon dioxide Transport and Storage	0								0	0	0	0
2 - Industrial Processes and Product Use	190.5583	0	0	21.2358	0	0	0	0	0	0	0	0
2.A - Mineral Industry	190.5583	0	0						0	0	0	0
2.B - Chemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C - Metal Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use	0	0	0						0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances				21.2358	0			0	0	0	0	0
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0	0	0	0	0	0
2.H - Other	0	0	0						0	0	0	0
3 - Agriculture, Forestry, and Other Land Use	-205.011	146.3389	0.37756	0	0	0	0	0	0	0	0	0
3.A - Livestock		146.3389	0.37756						0	0	0	0
3.B - Land	-205.011		0						0	0	0	0
3.C - Aggregate sources and non-CO2 emissions sourc	0	0	0						0	0	0	0
3.D - Other	0	0	0						0	0	0	0
4 - Waste	1.103512	1.52202	0	0	0	0	0	0	0	0	0	0
4.A - Solid Waste Disposal		1.52202							0	0	0	0
4.B - Biological Treatment of Solid Waste		0	0						0	0	0	0
4.C - Incineration and Open Burning of Waste	1.103512	0	0						0	0	0	0
4.D - Wastewater Treatment and Discharge		0	0						0	0	0	0
4.E - Other (please specify)	0	0	0						0	0	0	0
5 - Other	0	0	0	0	0	0	0	0	0	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3			0						0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0	0	0	0	0	0
Memo Items (5)												
International Bunkers	13.08393	9.15E-05	0.00037	0	0	0	0	0	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers) (1	13.08393	9.15E-05	0.00037						0	0	0	0
1.A.3.d.i - International water-borne navigation (Internatio	0	0	0						0	0	0	0
1.A.5.c - Multilateral Operations (1)(2)	0	0	0	0	0	0	0	0	0	0	0	0

ANNEX-D: GHG EMISSION FROM ENERGY SECTOR

	Emissions (Gg)						
Categories	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
1 - Energy	617.2437	6.487	0.097	0	0	0	0
1.A - Fuel Combustion Activities	617.2437	6.487	0.097	0	0	0	0
1.A.1 - Energy Industries	330.1479	0.01	0.003	0	0	0	0
1.A.1.a - Main Activity Electricity and Heat Production	330.1479	0.01	0.003	0	0	0	0
1.A.1.a.i - Electricity Generation	215.246	0.008	0.002	0	0	0	0
1.A.1.a.ii - Combined Heat and Power Generation (CHP)				0	0	0	0
1.A.1.a.iii - Heat Plants	114.9019	0.001	0.002	0	0	0	0
1.A.1.b - Petroleum Refining				0	0	0	0
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	0	0	0	0	0	0	0
1.A.1.c.i - Manufacture of Solid Fuels				0	0	0	0
1.A.1.c.ii - Other Energy Industries	0	0	0	0	0	0	0
1.A.2 - Manufacturing Industries and Construction	12.88148	5E-04	1E-04	0	0	0	0
1.A.2.a - Iron and Steel				0	0	0	0
1.A.2.j - Wood and wood products				0	0	0	0
1.A.2.k - Construction				0	0	0	0
1.A.2.l - Textile and Leather				0	0	0	0
1.A.2.m - Non-specified Industry				0	0	0	0
1.A.3 - Transport	160.3433	0.021	0.008	0	0	0	0
1.A.3.a - Civil Aviation				0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers) (1)							
1.A.3.a.ii - Domestic Aviation				0	0	0	0
1.A.3.b - Road Transportation	160.3433	0.021	0.008	0	0	0	0
1.A.3.b.i - Cars				0	0	0	0
1.A.3.b.i.1 - Passenger cars with 3-way catalysts				0	0	0	0
1.A.3.b.i.2 - Passenger cars without 3-way catalysts				0	0	0	0
1.A.3.b.ii - Light-duty trucks				0	0	0	0
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts				0	0	0	0
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts				0	0	0	0
1.A.3.b.iii - Heavy-duty trucks and buses				0	0	0	0

	Emissions (Gg)						
Categories	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
1.A.3.b.iv - Motorcycles				0	0	0	0
1.A.3.b.v - Evaporative emissions from vehicles				0	0	0	0
1.A.3.b.vi - Urea-based catalysts (3)	0			0	0	0	0
1.A.3.c - Railways				0	0	0	0
1.A.3.d - Water-borne Navigation				0	0	0	0
1.A.3.d.i - International water-borne navigation (International bunkers) (1)							
1.A.3.d.ii - Domestic Water-borne Navigation				0	0	0	0
1.A.3.e - Other Transportation				0	0	0	0
1.A.3.e.i - Pipeline Transport				0	0	0	0
1.A.3.e.ii - Off-road				0	0	0	0
1.A.4 - Other Sectors	113.871	6.456	0.085	0	0	0	0
1.A.4.a - Commercial/Institutional	40.95335	0.243	0.003	0	0	0	0
1.A.4.b - Residential	36.62256	6.208	0.081	0	0	0	0
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	36.29509	0.005	3E-04	0	0	0	0
1.A.4.c.i - Stationary	36.29509	0.005	3E-04	0	0	0	0
1.A.4.c.ii - Off-road Vehicles and Other Machinery				0	0	0	0
1.A.4.c.iii - Fishing (mobile combustion)				0	0	0	0
Memo Items (3)							
International Bunkers	13.08393	9E-05	4E-04	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers) (1)	13.08393	9E-05	4E-04	0	0	0	0
1.A.3.d.i - International water-borne navigation (International bunkers) (1)	0	0	0	0	0	0	0
1.A.5.c - Multilateral Operations (1)(2)				0	0	0	0
Information Items							
CO2 from Biomass Combustion for Energy Production	2404.519						

ANNEX-E: GHG EMISSION FROM IPPU SECTOR

Categories	(Gg)			CO2 Equivalents(Gg)				(Gg)				
	CO2	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (1)	Other halogenated gases without CO2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO2
2 - Industrial Processes and Product Use	190.5583	0	0	21.2358227	0	0	0	0	0	0	0	0
2.A - Mineral Industry	190.5583	0	0	0	0	0	0	0	0	0	0	0
2.A.1 - Cement production	185.3173								0	0	0	0
2.A.2 - Lime production	5.241								0	0	0	0
2.A.3 - Glass Production	0								0	0	0	0
2.C - Metal Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	0	0							0	0	0	0
2.C.2 - Ferroalloys Production	0	0							0	0	0	0
2.C.3 - Aluminium production	0				0				0	0	0	0
2.C.4 - Magnesium production(5)	0					0			0	0	0	0
2.C.5 - Lead Production	0								0	0	0	0
2.C.6 - Zinc Production	0								0	0	0	0
2.C.7 - Other (please specify)(3)									0	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use(6)	0	0	0	0	0	0	0	0	0	0	0	0
2.D.1 - Lubricant Use	0								0	0	0	0
2.D.2 - Paraffin Wax Use	0								0	0	0	0
2.D.3 - Solvent Use(7)									0	0	0	0
2.D.4 - Other (please specify)(3), (8)									0	0	0	0
2.E - Electronics Industry	0	0	0	0	0	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor(9)				0	0	0		0	0	0	0	0
2.E.2 - TFT Flat Panel Display(9)					0	0		0	0	0	0	0
2.E.3 - Photovoltaic(9)					0				0	0	0	0
2.E.4 - Heat Transfer Fluid(10)					0				0	0	0	0
2.E.5 - Other (please specify)(3)									0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	21.2358227	0	0	0	0	0	0	0	0
2.F.1 - Refrigeration and Air Conditioning	0	0	0	21.2358227	0	0	0	0	0	0	0	0
2.F.1.a - Refrigeration and Stationary Air Conditioning				19.9829317					0	0	0	0

Categories	(Gg)			CO2 Equivalents(Gg)				(Gg)				
	CO2	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (1)	Other halogenated gases without CO2 equivalent conversion factors (2)	NOx	CO	NMVOCs	SO2
2.F.1.b - Mobile Air Conditioning				1.252891					0	0	0	0
2.F.2 - Foam Blowing Agents				0				0	0	0	0	0
2.F.3 - Fire Protection				0	0				0	0	0	0
2.F.4 - Aerosols				0				0	0	0	0	0
2.F.5 - Solvents				0	0			0	0	0	0	0
2.F.6 - Other Applications (please specify)(3)				0	0			0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry									0	0	0	0
2.H.2 - Food and Beverages Industry	0								0	0	0	0
2.H.3 - Other (please specify)(3)									0	0	0	0

ANNEX-F: GHG EMISSION FROM AFOLU SECTOR

Categories	(Gg)						
	Net CO2 emissions / removals	Emissions					
		CH4	N2O	NOx	CO	NMVOCs	
3 - Agriculture, Forestry, and Other Land Use	-205.0106901	146.3389142	0.377557065	0	0	0	
3.A - Livestock	0	146.3389142	0.377557065	0	0	0	
3.A.1 - Enteric Fermentation	0	140.362855	0	0	0	0	
3.A.1.a - Cattle	0	73.99371	0	0	0	0	
3.A.1.a.i - Dairy Cows		1.092684		0	0	0	
3.A.1.a.ii - Other Cattle		72.901026		0	0	0	
3.A.1.b - Buffalo		0.00154		0	0	0	
3.A.1.c - Sheep		13.118505		0	0	0	
3.A.1.d - Goats		28.7255		0	0	0	
3.A.1.e - Camels		18.078		0	0	0	
3.A.1.f - Horses		0.1134		0	0	0	

Categories	(Gg)					
	Net CO2 emissions / removals	Emissions				
		CH4	N2O	NOx	CO	NMVOCs
3.A.1.g - Mules and Asses		6.327		0	0	0
3.A.1.h - Swine		0.0052		0	0	0
3.A.1.j - Other (please specify)		0		0	0	0
3.A.2 - Manure Management(1)	0	5.9760592	0.377557065	0	0	0
3.A.2.a - Cattle	0	2.3754	0.00746289	0	0	0
3.A.2.a.i - Dairy cows		0.023754	0.000112403	0	0	0
3.A.2.a.ii - Other cattle		2.351646	0.007350487	0	0	0
3.A.2.b - Buffalo		0	0	0	0	0
3.A.2.c - Sheep		0.5247402	0.098599733	0	0	0
3.A.2.d - Goats		1.263922	0.270867513	0	0	0
3.A.2.e - Camels		1.00608	0	0	0	0
3.A.2.f - Horses		0.013797	0	0	0	0
3.A.2.g - Mules and Asses		0.75924	0	0	0	0
3.A.2.h - Swine		0.0052	4.10879E-05	0	0	0
3.A.2.i - Poultry		0.02768	0.000585841	0	0	0
3.A.2.j - Other (please specify)		0	0	0	0	0
3.B - Land	-205.0106901	0	0	0	0	0
3.B.1 - Forest land	-207.9816216	0	0	0	0	0
3.B.1.a - Forest land Remaining Forest land	-207.9816216			0	0	0
3.B.1.b - Land Converted to Forest land	0	0	0	0	0	0
3.B.1.b.i - Cropland converted to Forest Land	0			0	0	0
3.B.1.b.ii - Grassland converted to Forest Land	0			0	0	0
3.B.1.b.iii - Wetlands converted to Forest Land	0			0	0	0
3.B.1.b.iv - Settlements converted to Forest Land	0			0	0	0
3.B.1.b.v - Other Land converted to Forest Land	0			0	0	0
3.B.2 - Cropland	2.590331517	0	0	0	0	0
3.B.2.a - Cropland Remaining Cropland	0.0264			0	0	0
3.B.2.b - Land Converted to Cropland	2.563931517	0	0	0	0	0
3.B.2.b.i - Forest Land converted to Cropland	0			0	0	0
3.B.2.b.ii - Grassland converted to Cropland	0			0	0	0

Categories	(Gg)					
	Net CO2 emissions / removals	Emissions				
		CH4	N2O	NOx	CO	NMVOCs
3.B.2.b.iii - Wetlands converted to Cropland	0			0	0	0
3.B.2.b.iv - Settlements converted to Cropland	0			0	0	0
3.B.2.b.v - Other Land converted to Cropland	2.563931517			0	0	0
3.B.3 - Grassland	0	0	0	0	0	0
3.B.3.a - Grassland Remaining Grassland	0			0	0	0
3.B.3.b - Land Converted to Grassland	0	0	0	0	0	0
3.B.3.b.i - Forest Land converted to Grassland	0			0	0	0
3.B.3.b.ii - Cropland converted to Grassland	0			0	0	0
3.B.3.b.iii - Wetlands converted to Grassland	0			0	0	0
3.B.3.b.iv - Settlements converted to Grassland	0			0	0	0
3.B.3.b.v - Other Land converted to Grassland	0			0	0	0
3.B.4 - Wetlands	-0.017233333	0	0	0	0	0
3.B.4.a - Wetlands Remaining Wetlands	-0.017233333	0	0	0	0	0
3.B.4.a.i - Peat lands remaining peat lands	-0.017233333		0	0	0	0
3.B.4.a.ii - Flooded land remaining flooded land				0	0	0
3.B.4.b - Land Converted to Wetlands	0	0	0	0	0	0
3.B.4.b.i - Land converted for peat extraction			0	0	0	0
3.B.4.b.ii - Land converted to flooded land	0			0	0	0
3.B.4.b.iii - Land converted to other wetlands				0	0	0
3.B.5 - Settlements	0.397833333	0	0	0	0	0
3.B.5.a - Settlements Remaining Settlements	0			0	0	0
3.B.5.b - Land Converted to Settlements	0.397833333	0	0	0	0	0
3.B.5.b.i - Forest Land converted to Settlements	0			0	0	0
3.B.5.b.ii - Cropland converted to Settlements	0			0	0	0
3.B.5.b.iii - Grassland converted to Settlements	0			0	0	0
3.B.5.b.iv - Wetlands converted to Settlements	0			0	0	0
3.B.5.b.v - Other Land converted to Settlements	0.397833333			0	0	0
3.B.6 - Other Land	0	0	0	0	0	0
3.B.6.a - Other land Remaining Other land				0	0	0
3.B.6.b - Land Converted to Other land	0	0	0	0	0	0

Categories	(Gg)					
	Net CO2 emissions / removals	Emissions				
		CH4	N2O	NOx	CO	NMVOCs
3.B.6.b.i - Forest Land converted to Other Land	0			0	0	0
3.B.6.b.ii - Cropland converted to Other Land	0			0	0	0
3.B.6.b.iii - Grassland converted to Other Land	0			0	0	0
3.B.6.b.iv - Wetlands converted to Other Land	0			0	0	0
3.B.6.b.v - Settlements converted to Other Land	0			0	0	0
3.D - Other	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	0			0	0	0
3.D.2 - Other (please specify)				0	0	0

ANNEX-G: GHG EMISSION FROM WASTE SECTOR

Categories	Emissions [Gg]						
	CO2	CH4	N2O	NOx	CO	NMVOCs	SO2
4 - Waste	1.103512271	1.522020094	0	0	0	0	0
4.A - Solid Waste Disposal	0	1.522020094	0	0	0	0	0
4.A.1 - Managed Waste Disposal Sites				0	0	0	0
4.A.2 - Unmanaged Waste Disposal Sites				0	0	0	0
4.A.3 - Uncategorised Waste Disposal Sites				0	0	0	0
4.B - Biological Treatment of Solid Waste		0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	1.103512271	0	0	0	0	0	0
4.C.1 - Waste Incineration	0	0	0	0	0	0	0
4.C.2 - Open Burning of Waste	1.103512271	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	0	0	0	0	0	0
4.D.1 - Domestic Waste water Treatment and Discharge		0	0	0	0	0	0
4.D.2 - Industrial Wastewater Treatment and Discharge		0		0	0	0	0
4.E - Other (please specify)				0	0	0	0

ANNEX-H: LEVEL AND TREND UNCERTAINTY

A	B	C	D	E	F	G	H	I	J	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncer-tainty (%)	Emis-sion Factor Uncer-tainty (%)	Combined Uncertain-ty (%)	Contribution to Variance by Category in Year T	Type Sensi-tivity (%)	Type B Sensi-tivity (%)	Uncer-tainty in trend in national emis-sions intro-duced by emis-sion factor uncer-tainty (%)	Uncer-tainty in trend in national emis-sions intro-duced by activity data uncer-tainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A - Fuel Combustion Activities												
1.A.1.a.i - Electricity Generation - Liquid Fuels	CO2	158.2133	215.2460	5.0000	6.1362	7.9153	0.0702	0.0089	0.0334	0.0545	0.2365	0.0589
1.A.1.a.i - Electricity Generation - Liquid Fuels	CH4	0.1295	0.1759	5.0000	228.7879	228.8425	0.0000	0.0000	0.0000	0.0017	0.0002	0.0000
1.A.1.a.i - Electricity Generation - Liquid Fuels	N2O	0.3823	0.5195	5.0000	228.7879	228.8425	0.0003	0.0000	0.0001	0.0049	0.0006	0.0000
1.A.1.a.iii - Heat Plants - Solid Fuels	CO2	101.0769	114.9019	5.0000	12.4119	13.3811	0.0572	0.0022	0.0179	0.0268	0.1262	0.0167
1.A.1.a.iii - Heat Plants - Solid Fuels	CH4	0.0224	0.0255	5.0000	200.0000	200.0625	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
1.A.1.a.iii - Heat Plants - Solid Fuels	N2O	0.4968	0.5648	5.0000	222.2222	222.2785	0.0004	0.0000	0.0001	0.0024	0.0006	0.0000
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CO2	0.0000	12.8815	15.0000	5.0000	15.8114	0.0010	0.0020	0.0020	0.0100	0.0425	0.0019
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	CH4	0.0000	0.0108	15.0000	5.0000	15.8114	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.2 - Manufacturing Industries and Construction - Liquid Fuels	N2O	0.0000	0.0323	15.0000	5.0000	15.8114	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
1.A.2.m - Non-specified Industry - Liquid Fuels	CO2	21.5049	0.0000	5.0000	6.1362	7.9153	0.0000	0.0033	0.0000	0.0205	0.0000	0.0004
1.A.2.m - Non-specified Industry - Liquid Fuels	CH4	0.0177	0.0000	5.0000	228.7879	228.8425	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000
1.A.2.m - Non-specified Industry - Liquid Fuels	N2O	0.0521	0.0000	5.0000	228.7879	228.8425	0.0000	0.0000	0.0000	0.0019	0.0000	0.0000
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CO2	4.3577	13.0839	5.0000	4.1708	6.5112	0.0002	0.0014	0.0020	0.0057	0.0144	0.0002
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	CH4	0.0006	0.0019	5.0000	100.0000	100.1249	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.3.a.i - International Aviation (International Bunkers) - Liquid Fuels	N2O	0.0378	0.1135	5.0000	150.0000	150.0833	0.0000	0.0000	0.0000	0.0018	0.0001	0.0000

A	B	C	D	E	F	G	H	I	J	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncer-tainty (%)	Emis-sion Factor Uncer-tainty (%)	Combined Uncertain-ty (%)	Contribution to Variance by Category in Year T	Type Sensi-tivity (%)	Type B Sensi-tivity (%)	Uncer-tainty in trend in national emis-sions intro-duced by emis-sion factor uncer-tainty (%)	Uncer-tainty in trend in national emis-sions intro-duced by activity data uncer-tainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A.3.b - Road Transportation - Liquid Fuels	CO2	196.5285	160.3433	15.0000	3.0683	15.3106	0.1457	0.0056	0.0249	0.0172	0.5285	0.2796
1.A.3.b - Road Transportation - Liquid Fuels	CH4	0.4918	0.4449	15.0000	244.6928	245.1521	0.0003	0.0000	0.0001	0.0018	0.0015	0.0000
1.A.3.b - Road Transportation - Liquid Fuels	N2O	3.0842	2.4974	15.0000	209.9376	210.4728	0.0067	0.0001	0.0004	0.0191	0.0082	0.0004
1.A.4.a - Commercial/Institutional - Liquid Fuels	CO2	56.2100	40.9533	12.0000	6.1362	13.4778	0.0074	0.0024	0.0064	0.0145	0.1080	0.0119
1.A.4.a - Commercial/Institutional - Liquid Fuels	CH4	0.1550	0.0898	12.0000	200.0000	200.3597	0.0000	0.0000	0.0000	0.0020	0.0002	0.0000
1.A.4.a - Commercial/Institutional - Liquid Fuels	N2O	0.1358	0.0590	12.0000	228.7879	229.1024	0.0000	0.0000	0.0000	0.0027	0.0002	0.0000
1.A.4.a - Commercial/Institutional - Biomass	CO2	87.6900	92.3785	15.0000	18.6942	23.9681	0.1185	0.0007	0.0144	0.0138	0.3045	0.0929
1.A.4.a - Commercial/Institutional - Biomass	CH4	4.7267	5.0095	15.0000	227.2727	227.7672	0.0315	0.0000	0.0008	0.0101	0.0165	0.0004
1.A.4.a - Commercial/Institutional – Biomass	N2O	0.8778	0.9383	15.0000	297.7273	298.1049	0.0019	0.0000	0.0001	0.0028	0.0031	0.0000
1.A.4.b - Residential - Liquid Fuels	CO2	48.1601	36.6226	12.0000	6.1362	13.4778	0.0059	0.0018	0.0057	0.0110	0.0966	0.0094
1.A.4.b - Residential - Liquid Fuels	CH4	0.1236	0.0900	12.0000	200.0000	200.3597	0.0000	0.0000	0.0000	0.0010	0.0002	0.0000
1.A.4.b - Residential - Liquid Fuels	N2O	0.0962	0.0665	12.0000	236.3636	236.6681	0.0000	0.0000	0.0000	0.0011	0.0002	0.0000
1.A.4.b - Residential - Biomass	CO2	2465.9729	2312.1406	15.0000	18.6942	23.9681	74.2538	0.0235	0.3593	0.4398	7.6210	58.2726
1.A.4.b - Residential - Biomass	CH4	139.1268	130.2777	15.0000	227.2727	227.7672	21.2884	0.0014	0.0202	0.3088	0.4294	0.2797
1.A.4.b - Residential - Biomass	N2O	26.9311	25.1909	15.0000	297.7273	298.1049	1.3635	0.0003	0.0039	0.0796	0.0830	0.0132
1.A.4.c.i - Stationary - Liquid Fuels	CO2	25.4675	36.2951	15.0000	6.1362	16.2066	0.0084	0.0017	0.0056	0.0103	0.1196	0.0144
1.A.4.c.i - Stationary - Liquid Fuels	CH4	0.0725	0.1033	15.0000	200.0000	200.5617	0.0000	0.0000	0.0000	0.0010	0.0003	0.0000

A	B	C	D	E	F	G	H	I	J	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncer-tainty (%)	Emis-sion Factor Uncer-tainty (%)	Combined Uncertain-ty (%)	Contribution to Variance by Category in Year T	Type Sensi-tivity (%)	Type B Sensi-tivity (%)	Uncer-tainty in trend in national emis-sions intro-duced by emis-sion factor uncer-tainty (%)	Uncer-tainty in trend in national emis-sions intro-duced by activity data uncer-tainty (%)	Uncertainty introduced into the trend in total national emissions (%)
1.A.4.c.i - Stationary - Liquid Fuels	N2O	0.0642	0.0915	15.0000	236.3636	236.8391	0.0000	0.0000	0.0000	0.0010	0.0003	0.0000
2.A - Mineral Industry												
2.A.1 - Cement production	CO2	163.0200	185.3173	5.0000	6.1400	7.9183	0.0521	0.0035	0.0288	0.0214	0.2036	0.0419
2.A.2 - Lime production	CO2	6.5360	5.2410	15.0000	6.1400	16.2080	0.0002	0.0002	0.0008	0.0012	0.0173	0.0003
2.F - Product Uses as Substitutes for Ozone Depleting Substances												
2.F.1.a - Refrigeration and Stationary Air Conditioning	CH2FCF3	13.5281	19.9829	30.0000	6.1400	30.6219	0.0091	0.0010	0.0031	0.0062	0.1317	0.0174
2.F.1.b - Mobile Air Conditioning	CH2FCF3	0.7061	1.2529	15.0000	6.1400	16.2080	0.0000	0.0001	0.0002	0.0005	0.0041	0.0000
3.A - Livestock												
3.A.1.a.i - Dairy Cows	CH4	22.2711	22.9464	15.0000	6.1400	16.2080	0.0033	0.0001	0.0036	0.0007	0.0756	0.0057
3.A.1.a.ii - Other Cattle	CH4	1485.8717	1530.9215	15.0000	6.1400	16.2080	14.8863	0.0072	0.2379	0.0439	5.0460	25.4642
3.A.1.b - Buffalo	CH4	0.0323	0.0323	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.A.1.c - Sheep	CH4	267.3825	275.4886	15.0000	6.1400	16.2080	0.4820	0.0013	0.0428	0.0079	0.9080	0.8246
3.A.1.d - Goats	CH4	585.5010	603.2355	15.0000	6.1400	16.2080	2.3113	0.0028	0.0937	0.0173	1.9883	3.9536
3.A.1.e - Camels	CH4	368.5290	379.6380	15.0000	6.1400	16.2080	0.9154	0.0018	0.0590	0.0109	1.2513	1.5659
3.A.1.f - Horses	CH4	2.3058	2.3814	15.0000	6.1400	16.2080	0.0000	0.0000	0.0004	0.0001	0.0078	0.0001
3.A.1.g - Mules and Asses	CH4	128.9610	132.8670	15.0000	6.1400	16.2080	0.1121	0.0006	0.0206	0.0038	0.4379	0.1918
3.A.1.h - Swine	CH4	0.1071	0.1092	10.0000	6.1400	11.7345	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000
3.A.2.a.i - Dairy cows	CH4	0.4842	0.4988	15.0000	6.1400	16.2080	0.0000	0.0000	0.0001	0.0000	0.0016	0.0000
3.A.2.a.i - Dairy cows	N2O	0.0338	0.0348	15.0000	0.0000	15.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
3.A.2.a.ii - Other cattle	CH4	47.9313	49.3846	15.0000	6.1400	16.2080	0.0155	0.0002	0.0077	0.0014	0.1628	0.0265
3.A.2.a.ii - Other cattle	N2O	0.0000	2.2787	15.0000	0.0000	15.0000	0.0000	0.0004	0.0004	0.0000	0.0075	0.0001
3.A.2.c - Sheep	CH4	10.6953	11.0195	15.0000	6.1400	16.2080	0.0008	0.0001	0.0017	0.0003	0.0363	0.0013
3.A.2.c - Sheep	N2O	29.6665	30.5659	15.0000	0.0000	15.0000	0.0051	0.0001	0.0047	0.0000	0.1007	0.0102
3.A.2.d - Goats	CH4	25.7620	26.5424	15.0000	6.1400	16.2080	0.0045	0.0001	0.0041	0.0008	0.0875	0.0077

A	B	C	D	E	F	G	H	I	J	K	L	M
2006 IPCC Categories	Gas	Base Year emissions or removals (Gg CO2 equivalent)	Year T emissions or removals (Gg CO2 equivalent)	Activity Data Uncer-tainty (%)	Emis-sion Factor Uncer-tainty (%)	Combined Uncertain-ty (%)	Contribution to Variance by Category in Year T	Type Sensi-tivity (%)	Type B Sensi-tivity (%)	Uncer-tainty in trend in national emis-sions intro-duced by emis-sion factor uncer-tainty (%)	Uncer-tainty in trend in national emis-sions intro-duced by activity data uncer-tainty (%)	Uncertainty introduced into the trend in total national emissions (%)
3.A.2.d - Goats	N2O	81.5003	83.9689	15.0000	0.0000	15.0000	0.0384	0.0004	0.0130	0.0000	0.2768	0.0766
3.A.2.e - Camels	CH4	20.5094	21.1277	15.0000	6.1400	16.2080	0.0028	0.0001	0.0033	0.0006	0.0696	0.0048
3.A.2.f - Horses	CH4	0.2805	0.2897	15.0000	6.1400	16.2080	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000
3.A.2.g - Mules and Asses	CH4	15.4753	15.9440	15.0000	6.1400	16.2080	0.0016	0.0001	0.0025	0.0005	0.0526	0.0028
3.A.2.h - Swine	CH4	0.1071	0.1092	10.0000	6.1400	11.7345	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000
3.A.2.h - Swine	N2O	0.0042	0.0127	10.0000	0.0000	10.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.A.2.i - Poultry	CH4	0.5698	0.5813	15.0000	6.1400	16.2080	0.0000	0.0000	0.0001	0.0000	0.0019	0.0000
3.A.2.i - Poultry	N2O	0.0000	0.1816	15.0000	0.0000	15.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000
3.B – Land												
3.B.1.a - Forest land Remaining Forest land	CO2	-212.1389	-207.9816	20.0000	6.1400	20.9213	0.4578	0.0006	0.0323	0.0038	0.9140	0.8355
3.B.2.a - Cropland Remaining Cropland	CO2	0.0264	0.0264	20.0000	6.1400	20.9213	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
3.B.2.b.v - Other Land converted to Cropland	CO2	2.5493	2.5639	30.0000	6.1400	30.6219	0.0001	0.0000	0.0004	0.0000	0.0169	0.0003
3.B.4.a.i - Peat lands remaining peat lands	CO2	-0.0172	-0.0172	10.0000	6.1400	11.7345	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.B.5.b.v - Other Land converted to Settlements	CO2	0.3978	0.3978	20.0000	0.0000	20.0000	0.0000	0.0000	0.0001	0.0000	0.0017	0.0000
4.A - Solid Waste Disposal												
4.A - Solid Waste Disposal	CH4	27.2468	31.9624	15.0000	6.1400	16.2080	0.0065	0.0007	0.0050	0.0045	0.1054	0.0111
4.C - Incineration and Open Burning of Waste												
4.C.2 - Open Burning of Waste	CO2	1.0128	1.1035	15.0000	6.1400	16.2080	0.0000	0.0000	0.0002	0.0001	0.0036	0.0000
Total												
		Sum(C): 6435.920	**Sum(D): 6431.159**				**Sum(H): 116.666**					**Sum(M): 92.095**
						Uncertainty in total inventory: 10.801						**Trend uncertainty: 9.597**