Republic of Mauritius

NATIONAL GREENHOUSE GAS INVENTORY REPORT

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Ministry of Social Security, National Solidarity, and
Environment and Sustainable Development
(Environment and Sustainable Development Division)

August 2017

REPUBLIC OF MAURITIUS

Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division)

National Greenhouse Gases Inventory Report (NIR)

Sources and Sinks of Greenhouse Gases in the Republic of Mauritius

Report to the United Nations Framework Convention on Climate Change

2000-2013

August 2017

Preface

The National Inventory Report (NIR) was compiled by the Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division) as part as the Third National Communication for the Republic of Mauritius.

The NIR has been prepared in accordance with the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories and the reporting guidelines of national communication for Parties not included in Annex 1 of the United Nations Framework Convention on Climate Change (UNFCCC).

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Acknowledgements

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Rodrigues

Commission for Environment, Forestry, Tourism, Marine Parks and Fisheries
Commission for Public Infrastructure and Water Resources
Commission for Agriculture
Commission for Health
Commission for Land
Mauritius Port Authority
Rodrigues Council of Social Service
Mauritian Wildlife Foundation
Rodrigues Environment Friendly Group
Airport of Rodrigues Limited
Anse Raffin/Tamarin Socio-Environment Group

Private sectors

Air Mauritius Ltd
Alteo Limited
Association of Hoteliers and Restaurants in Mauritius
Mauritius Chamber of Agriculture
Mauritius Chamber of Commerce and Industry
Mauritius Chemical and Fertilizer Industry (MCFI) Limited
Mauritius Export Association
Mauritius Meat Association
Mauritius Shipping Corporation Ltd
Medine Sugar Milling Company Ltd
Omnicane Ltd
Samlo Ltd
Terragen Ltd

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University of Mauritius

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List of Acronyms, Abbreviation and Units

A2	Scenario assuming a very heterogeneous world with high population growth, slow economic development and slow technological change.
AD	Activity Data
AFOLU	Agriculture, Forestry, and Other Land Use
B2	Scenario assuming a world with intermediate population and economic growth, emphasising local solutions to economic, social, and environmental
BOD	Biological Oxygen Demand
BUR	Biennial Update Report
CaO	Calcium Oxide
CC	Climate Change
CCB	Climate Change Bill
CCC	Climate Change Committee
CEB	Central Electricity Board
CH_4	Methane
CLRS	Curepipe Livestock Research Station
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
COP	Conference of Parties
CS	Country Specific Emissions
D	Default Emissions
DCC	Department of Climate Change
DM	Dry mass
DOWA	Deep Ocean Water Application
EEZ	Exclusive Economic Zone
EF	Emission Factors
EIA	Environmental Impact Assessment
EPA	Environment Protection Act
ESDD	Environment and Sustainable Development Division
EST	Environmentally Sound Technologies
FAO	Food and Agriculture Organisation of the United Nations
FAREI	Food and Agricultural Research and Extension Institute
FL	Forestland
FOD	First Order Decay
FOLU	Forestry and Other Land Use
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Gigagram
GHG	Greenhouse gas
GIS	Geographical Information System
GNI	Gross National Income
GSP	Global Support Programme
GWh	Giga Watt hour
ha	hectare
HFC	Hydro Fluoro Carbon

HFC-143a	1, 1, 1-Trifluoroethane
HFO	Heavy Fuel Oil
IE	Included Elsewhere
IIASA	International Institute for Applied Systems Analysis
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
ITCZ	Inter-tropical Convergence Zone
KCA	Key Category Analysis
kg	kilogram
km^2	kilometre square
KP	Kyoto Protocol
ktoe	kiloton of oil equivalent
kW	kilo Watt
kWh	kilo Watt hour
l	litre
LFG	Landfill Gas
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land use change and Forestry
M	Million
m^3	Cubic Metre
mm	Millimetre
MCF	Methane Correction Factor
MCFI	Mauritius Chemical and Fertiliser Industry
MCIA	Mauritius Cane Industry Authority
MSW	Municipal Solid Waste
NCV	Net Calorific Value
MoAIFS	Ministry of Agro-Industry and Food Security
MoSSNSESD	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division)
MoEPU	Ministry of Energy and Public Utilities
MSIRI	Mauritius Sugar Industry Research Institute
MW	Mega Watt
N	Nitrogen
N_2O	Nitrous oxide
NA	Not available or Not Applicable
NAPRO	National Agricultural Products Regulatory Office
NC	National Communication
NDU	National Development Unit
NE	Not Estimated
NGO	Non-Governmental Organisation
NIR	National Greenhouse Gases Inventory Report
NMVOC	Non-methane volatile organic compound
NO	Not Occurring
NOx	Oxides of nitrogen
NTA	National Transport Authority
O_2	Oxygen
^oC	Degree Celsius
ODS	Ozone Depleting Substance

PDF	Probability Density Function
PFC	Perfluoro Carbon
PIV	Protein Intake Value
QA	Quality assurance
QC	Quality Control
RCCC	Rodrigues Climate Change Committee
RoM	Republic of Mauritius
SEFA	Sustainable Energy Fund for Africa
SIPP	Small Independent Power Producer
SNC	Second National Communication
STC	State Trading Corporation
T1	Tier 1
T2	Tier 2
TL	Team Leader
t	tonne
TNC	Third National Communication
TWG	Technical Working Group
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UoM	University of Mauritius
W	Watt
WMA	Waste Water Management Authority
WMO	World Meteorological Organisation
WWTP	Wastewater Treatment Plant

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Global Warming Potential (GWP)

The Global Warming Potential (GWP) was adopted from the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR – 100 years' time horizon) as in the table below.

Greenhouse Gases (GHG)		GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbons	HFC-23	11700
	HFC-32	650
	HFC-125	2800
	HFC-134a	1300
	HFC-143a	3800
	HFC-152a	NO
	HFC-227ea	2900
	HFC-236fa	NO

Note: NO: Not Occurring

EXECUTIVE SUMMARY

ES1. Introduction

The National Inventory Report (NIR) for the Republic of Mauritius (RoM) has been prepared in line with Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and the Guidelines for National Communications of non-Annex I Parties to the UNFCCC, adopted in decision 17/ CP. 8. These guidelines and decisions state that non-Annex I Parties shall include information on a national inventory of anthropogenic emissions by source and absorption by sinks of all Greenhouse Gases (GHG) not controlled by the Protocol of Montreal[1] within the limits of their possibilities.

This NIR presents the GHG inventory for RoM for the period 2000 to 2013. The GHG inventory was clustered around four main sectors, namely, the energy sector which includes energy industries (power generation), transport, manufacturing industries and construction; the waste sector (solid and liquid waste); the Agriculture, Forestry and Other Land Use (commonly referred as AFOLU) sector, and the Industrial Processes and Product Use (IPPU) sector. The emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) as well as other minor gases, namely, hydrofluorocarbons (HFC), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), were considered. The methodology adopted was based on the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories and the GHG emissions and removals (through carbon sink) were computed through the 2006 IPCC Inventory Software.

RoM recognises the need to respond to enhanced reporting requirements and to provide regular submissions in a timely manner. This NIR has been prepared through a collaborative and participative approach involving concerned stakeholders from the public and private sectors, research organisations, academic institutions as well as non-governmental organisations. This was made possible by the establishment of institutional arrangements during the preparation of the Third National Communication (TNC).

Country profile

The Republic of Mauritius is a small island developing state of about 2,040 km² in area, comprising the mainland Mauritius, the autonomous island Rodrigues, Agalega, Tromelin, Cargados Carajos and the Chagos Archipelago. On the other hand, its Exclusive Economic Zone (EEZ) is nearly 2.3 million km² as well as an Extended Continental Shelf of 396,000 km² managed jointly by RoM and Seychelles, outside the border of their respective EEZ. The

[1] Greenhouse Gas (GHG) not controlled by the Protocol of Montreal are carbon dioxide (CO_2), methane (CH_4) , nitrous oxide (N_2O) , hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), sulphur oxides (SO_x), amongst others

mainland Mauritius occupies about 1,865 km² and Rodrigues about 108 km² making up over 96% of the land area of RoM, and its population is nearly 1.3 million.

Mauritius has recorded sustained economic growth over the period 2012-2014, followed by a growth rate of 3.0% of GDP for 2015, 3.5% for 2016 and a forecasted 3.8% for 2017. The main sectors driving growth in 2015 were tourism, financial services, retail trade, and the Information and Communication Technology (ICT)/BPO. Sustained growth of the economy has been possible due to several factors such as political stability; stable institutions; an outward market-driven strategy; prudent fiscal, exchange rate, trade, investment and monetary policies; and the careful overall planning, and policy choices. According to the World Bank's classification, Mauritius has graduated to an upper middle-income country (MIC) status with a per capita GNI (Gross National Income) of US$ 9,610 in 2015. The Rodriguan economy is based on a subsistence type of agriculture, livestock rearing and fishing.

GHG emitting sectors

The energy sector is the largest source of GHG emissions with the majority of emissions arising from energy industries (electricity generation) and road transportation. Generally, during the past ten years, the Total Primary Energy Supply (TPES) emanated mostly from imported fossil fuel, which included coal, gasoline, diesel, kerosene, Liquefied Petroleum Gas (LPG) and heavy fuel oil, representing almost 80% of the TPES. Indigenous renewable sources (fuel wood, hydro, wind, solar and bagasse) contribute around 20% to the TPES. The Government's declared policy (Elahee, 2011) is to increase this renewable contribution to 28% by the year 2020 and 35% by 2025.

Solid wastes disposal is an important source of GHG emissions in terms of methane. The average amount of solid wastes generated per capita daily has increased steadily from 0.6 kg in 2000 to about 0.94 kg in 2014 generating around 420,000 tons of solid wastes annually (Statistic Mauritius, 2016). The single landfill, operational since 1997 at Mare Chicose, currently contains about 93% of solid waste generated. The Mare Chicose landfill is a fully managed site generating 22 GWh of electricity annually from captured landfill gas (Solid Waste Management Division) and hence representing an offsetting of GHG emissions. The remaining wastes are mainly composted. Before advent of the landfill, wastes were disposed in open dumps.

With regard to wastewater, about 25 % of private households are currently connected to the sewage system with more than 80% in Port Louis, the Capital, and more than 50% in the main towns (Wastewater Management Authority). Most industries are also connected to the sewerage system. On the other hand, the sugar industry, the most important industrial sector, discharges treated wastewater into the environment while the tourist hotels operate onsite wastewater treatment plants. In general, it is observed that industrial process does not contribute significantly to GHG emissions as RoM does not have heavy industries such as metal or cement production.

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories are designed to assist in estimating and reporting national inventories of anthropogenic greenhouse gas emissions and removals for the Agriculture, Forestry and Other Land Use (AFOLU) sector. The agricultural sector is a source of GHG emissions mostly from fertiliser use in crop cultivation in terms of N_2O and livestock rearing in terms of CH_4 and N_2O. The Forestry and Other Land Use (FOLU) is the only sector that accounts for CO_2 removals. RoM has a forest area of 50,508[2] ha representing 25% of land cover. The forest cover for the island of Mauritius is 47, 108 ha.

Summary of Chapters

Chapter 1: Introduction
Chapter 1 introduces the national circumstances of the RoM, that is, its economy, environment and the institutional arrangements set up for this GHG inventory exercise. The chapter also describes the commitment of RoM under the UNFCCC for GHG reporting and an overview of the GHG inventory process for all the sectors identified.

Chapter 2: Trends of Greenhouse Gas Emissions
Chapter 2 discusses the trends of GHG emissions across all the sectors identified for the period of the year 2000 to the year 2013.

Chapter 3: Energy Sector
Chapter 3 details the GHG emission for the Energy sector for the year 2000 to the year 2013. The chapter includes the methodology used for the inventory process for this particular sector and the planned improvements for this sector.

Chapter 4: Industrial Processes and Product Use
Chapter 4 details the GHG emission for the Industrial Processes and Product Use sector for the year 2000 to the year 2013. The chapter includes the methodology used for the inventory process for this particular sector and the planned improvements for this sector.

Chapter 5: Agriculture, Forestry and Other Land Use (AFOLU)
Chapter 5 details the GHG emission for the AFOLU sector for the year 2000 to the year 2013. The chapter includes the methodology used for the inventory process for this particular sector and the planned improvements for this sector.

Chapter 6: Waste
Chapter 6 details the GHG emission for the Waste sector for the year 2000 to the year 2013. The chapter includes the methodology used for the inventory process for this particular sector and the planned improvements for this sector.

[2] According to A. Sookun et al. (nd), - work in progress, this figure is different with one provided in ***Table 49*** for forest and other woodland because, according to IPCC guidelines, the forests include other wooded lands which are not captured in forest statistics i.e.: Croplands, Settlements and Other lands including trees outside of forests and other green belts and areas, e.g., abandoned lands.

Chapter 7: Planned Improvement on the Methodology
Chapter 7 details the planned improvements for the methodology and the identified sectors.

ES2. The Inventory Process

The Environment and Sustainable Development Division (ESDD) of the Ministry of Social Security, National Solidarity, and Environment and Sustainable Development is the National Focal Point to the UNFCCC. ESDD is responsible for coordinating climate change activities as well as any related legal instruments that the Conference of the Parties (COP) may adopt and RoM ratifies. It also has the mandate to fulfil all reporting requirements of RoM to the UNFCCC, its Kyoto Protocol (KP) and the Paris Agreement.

In Rodrigues, the Office of the Commissioner for Environment of the Rodrigues Regional Assembly is responsible for the planning, coordination and monitoring of climate change measures.

The institutional arrangement for the TNC/NIR comprises the Steering Committee, Project Technical Committee and Technical Working Groups (TWGs), including the national GHG inventory TWG. The Steering Committee is structured to ensure stakeholders' acceptance of TNC/NIR outcomes, and to secure high-level political support to further mainstream climate change considerations in national sustainable development planning. The Project Technical Committee deals principally with all the technical aspects of the TNC and NIR and supports the works of all TWGs.

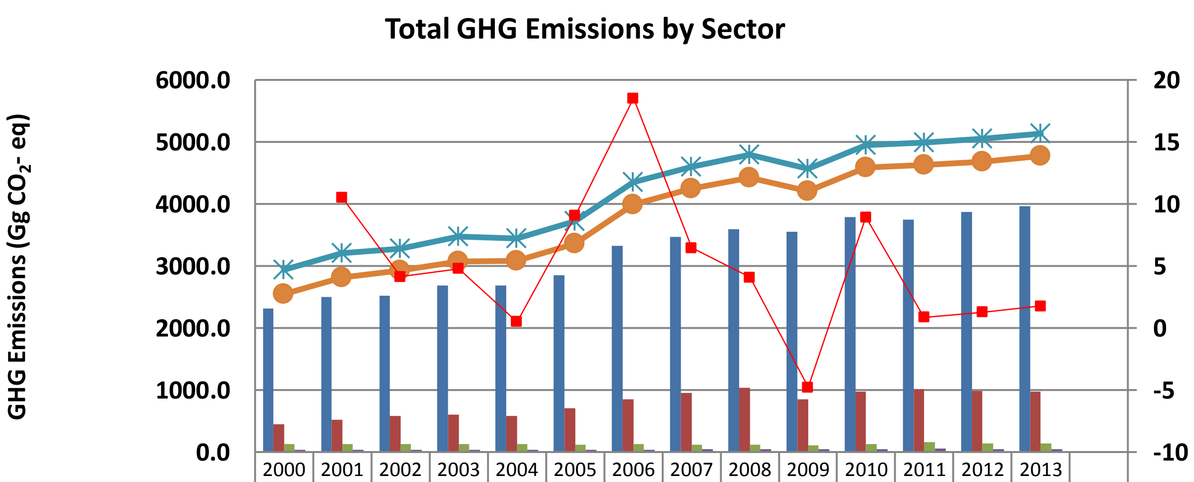
Specifically for the GHG inventory, six sectoral teams have been constituted with members nominated from Ministries, departments and private sectors that are involved in the GHG sectors. Team leaders coordinated the activities for each sector in terms of collection and entry of data into the 2006 IPCC Inventory Software, including quality control. The institutions involved in data collection, verification and data entry are shown in ***Table 1***.

ES3. Summary of GHG Emissions Trends per Sector

In 2013, the net GHG emissions for the Republic of Mauritius, including the Forest and Other Land Use (FOLU) sector, was estimated to be 4,769.2 Gg[3] of carbon dioxide equivalent (CO_2-eq), representing an increase of 2,223.8 Gg CO_2-eq compared to the figure for the year 2000 (***Figure 1a***). While excluding FOLU, which is estimated to be net carbon sink, the total GHG emissions was 5136.7 Gg CO_2-eq in 2013, demonstrating a growth of 2,195.2 Gg of CO_2-eq compared to 2000 (***Figure 1a***).

The energy sector was the main source of GHG emissions, amounting to 77% of overall GHG emissions (excluding FOLU) in 2013, followed by waste sector 19%. Agriculture (livestock and use of fertilisers) contributed 2.8% of total emissions in 2013. The aggregated emissions from Industrial Processes and Product Use (IPPU) are considered not significant (at about 1%) as shown in ***Figure 1b***. CO_2 removal by forestry (a sink of carbon) was around 15.5% of total emission (including FOLU) in 2000 but dropped to about 7.7% in 2013 due to increased emissions driven by increased energy consumption. Rodrigues contributes annually to an average of about 32 Gg of CO_2 in these removals.

From 2000 to 2013, the general trends in emissions have been driven by energy consumptions which followed a similar growth pattern, as illustrated in ***Figure 1c***. Additionally, the total aggregated CO_2 emissions correlate with rise in the GDP (***Figure 1d***).



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy	2315.2	2504.5	2521	2692.4	2692.7	2855.2	3327.8	3477.1	3595.3	3553.5	3789.0	3752.7	3875.8	3964.9
Waste	447.3	527.3	583.8	606.4	583.8	707.7	854.3	955.2	1034.6	857.2	980.6	1022.3	990.5	979.3
AFOLU - Agriculture	134.9	134.7	132.9	130.8	127.5	122.1	127.1	124.6	118.2	115.2	129.1	163.4	141.2	141.4
IPPU	44.1	44.1	43.9	43.8	43.5	43.6	42.9	44.6	46.6	48.5	48.2	55.5	51.2	54.0
Total -exc. FOLU	2941.5	3210.6	3282.0	3473.5	3447.4	3728.6	4352.1	4601.5	4794.7	4574.3	4946.8	4993.9	5058.8	5139.7
Total - inc.FOLU	2545.4	2813.1	2930.2	3070.5	3086.5	3366.6	3990.7	4249.4	4423.2	4212.1	4588.6	4629.3	4688.7	4772.1
Annual change(%)		11	4	5	1	9	19	6	4	-5	9	1	1	2

Figure 1a: Total GHG Emissions by Sector, 2013

[3] 1 Gg is equivalent to 1000 tonnes

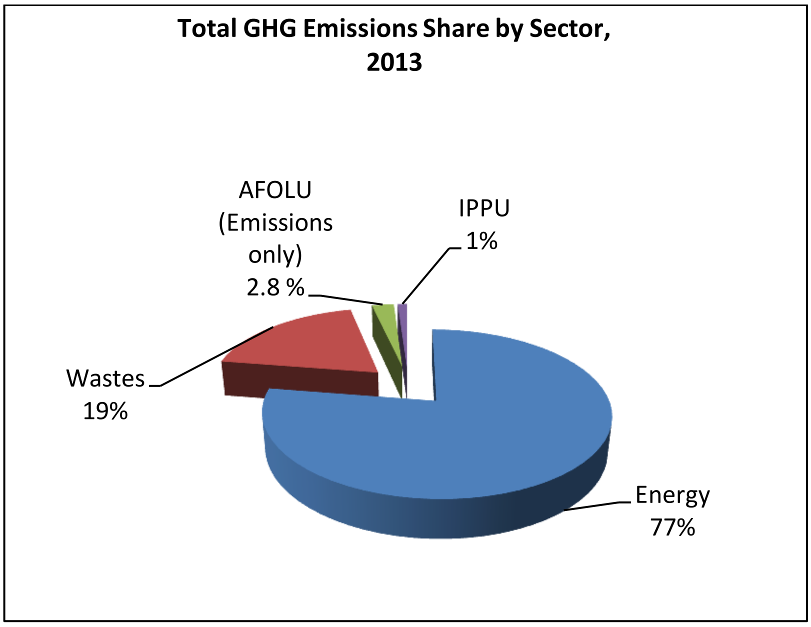


Figure 1b: Share of GHG Emissions by Sector, 2013

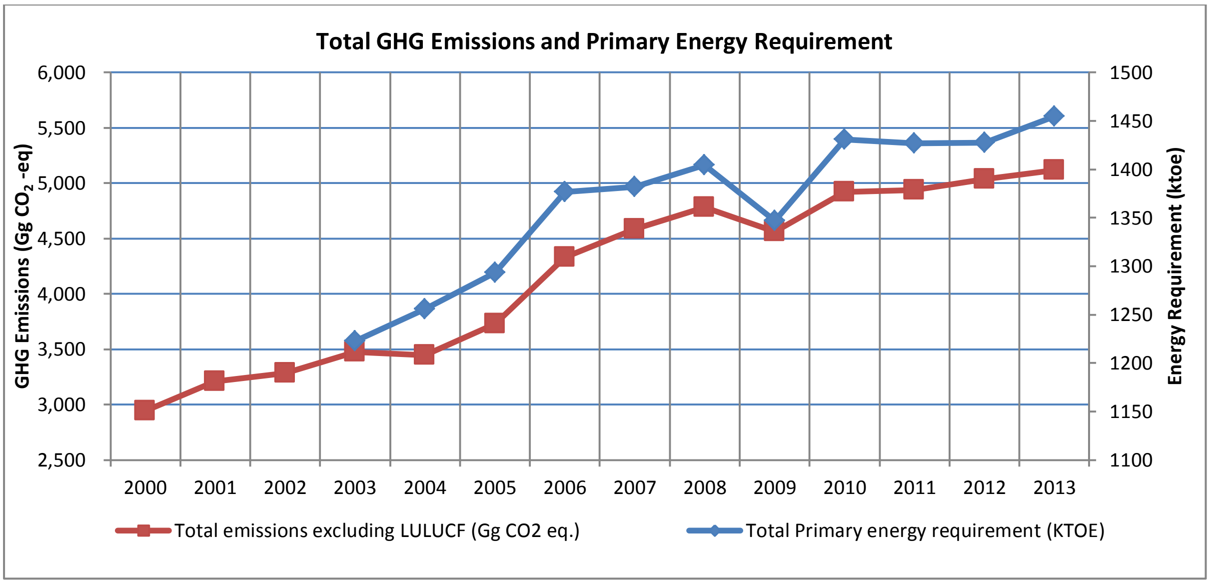


Figure 1c: Total GHG Emissions and Primary Energy Requirement

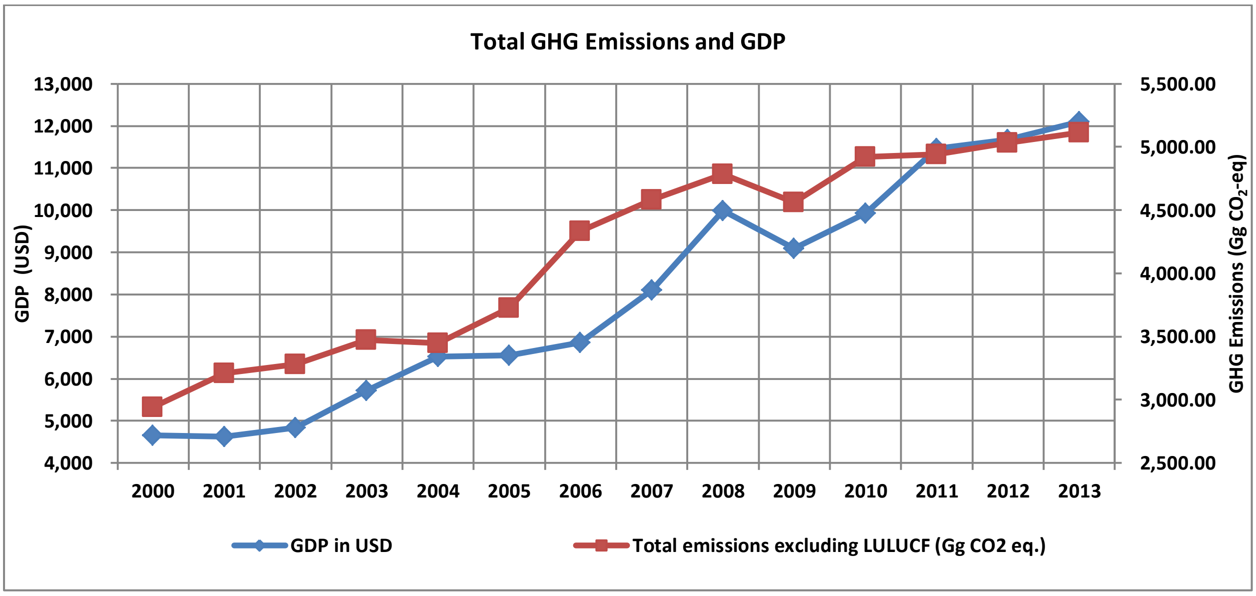
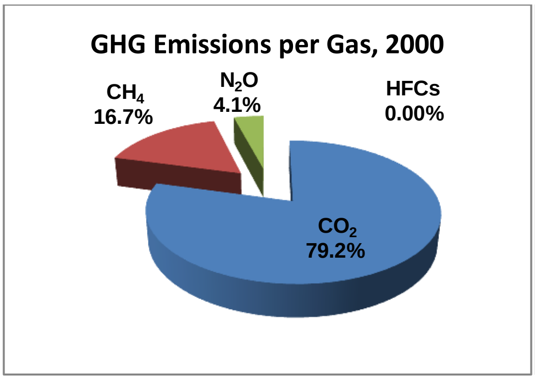


Figure 1d: Total GHG Emissions and GDP

ES4. Summary of GHG Emissions Trends per Gas

The dominant GHG was CO_2, contributing 79% of total emissions in 2000 and 77% in 2013 (***Figures 2a and 2b***). The second most important GHG was CH_4. Due to increasing quantity of solid waste that follows the GDP growth and improvement of lifestyle, CH_4 increased from 16.7% in 2000 to 19.7% in 2013 (***Figures 2a and 2b***). The share of N_2O varied from 4% to 3% over the time period due to the ceasing of nitric acid production, which was used to produce fertilizers. The contribution of hydro fluorocarbons (HFC) in 2013 was relatively minor. HFC contributed to 0.12% of GHG emissions in 2013, due to the Consumer Protection Regulations, which have been amended to ban the import of appliances containing hydro chlorofluorocarbons (HCFC) as from 01 January 2013. The replacement of HCFC with HFC-143a in 2013 resulted in a rise in the importation of HFC-143a and consequently related estimated emissions increase in the same year.



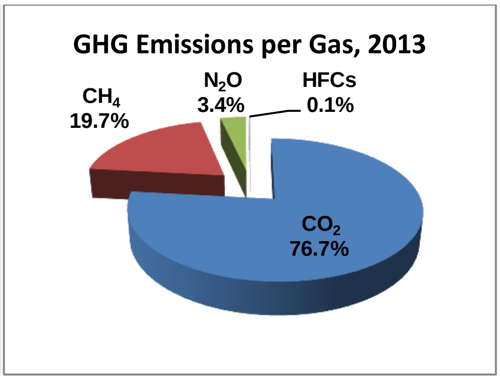
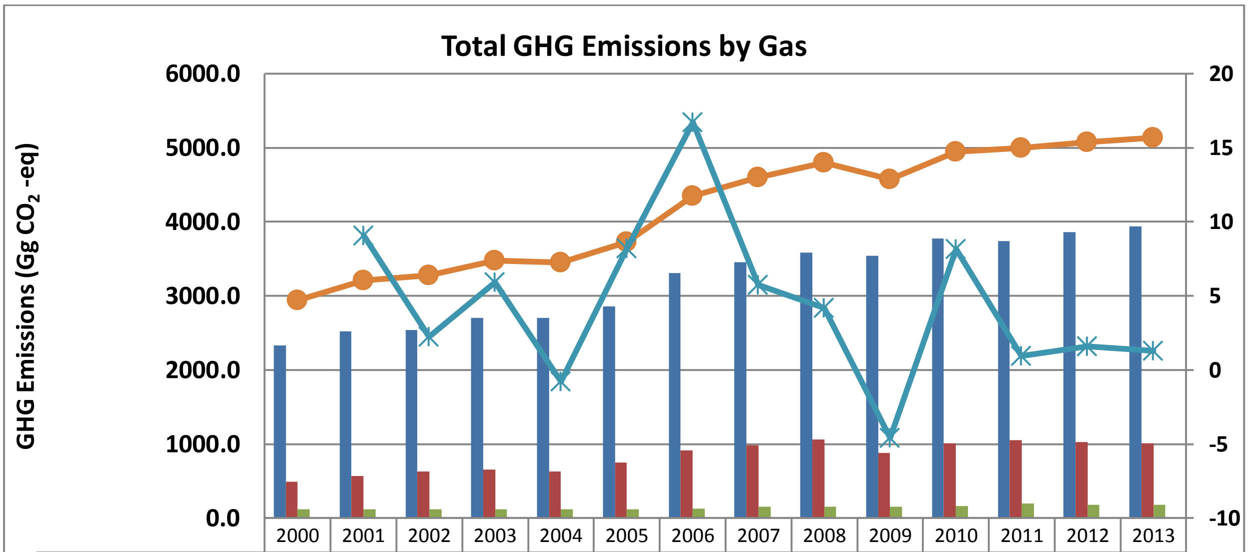


Figure 2a: Share GHG Emissions by Gas, (2000 & 2013)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CO2	2330.8	2518.0	2535.6	2702.5	2700.7	2861.5	3309.5	3458.1	3580.6	3540.2	3773.1	3741.4	3860.2	3941.2
CH4	491.0	571.7	628.1	650.6	626.3	752.3	911.0	983.2	1058.7	878.9	1006.7	1050.0	1025.0	1012.8
N2O	120	119	116	121	119	115	131	157.4	150.8	150.0	162.0	195.8	181.4	176.6
HFCs							0.9	2.8	3.8	4.6	4.6	5.7	6.0	6.2
TOTAL GHG	2941.5	3208.5	3279.9	3473.7	3446.0	3728.4	4352.2	4601.5	4793.8	4573.6	4946.4	4992.8	5072.5	5136.7
Annual change(%)		9	2	6	-1	8	17	6	4	-5	8	1	2	1

Figure 2b: Total GHG Emissions by Gas

ES5. Other Information

Uncertainty analysis

Uncertainty[4] estimates are an essential element of a complete inventory of GHG emissions and removals. They should be derived for both the national level and the trend estimate, as well as for the component parts such as emission factors, activity data and other estimation parameters for each category (IPCC Guidelines, 2006)

Uncertainties were estimated to be generally below 10% for most sectors/sub sectors. However, for the FOLU sector and N_2O emission from agricultural sector, there were still some cases of data gaps that demanded estimation from relevant experts and which have resulted in varying degree of uncertainties of the data used. Therefore, the uncertainty of related categories was estimated to be around +/- 15%.

[4] Uncertainty represents the lack of knowledge of the true value of a variable by defining the possible range within a confidence level the value could be. Uncertainties are used to highlight where the real emissions/removals have the potential to be significantly different to estimate (Volume I of 2006 IPCC Guidelines).

Measures were taken to reduce uncertainty during the preparation of the Inventory, in terms of, *inter alia*:

- Use of precise measurement methods such as laboratories testing of fuel characteristics;
- Use of country specific data, in particular, activity data;
- Increased in sample size and reducing data gaps, as far as possible; and
- Involvement of more stakeholders/experts and provision of trainings by the local consultant and international consultant.

Completeness of national inventory

A complete inventory refers to an inventory which includes estimates for all relevant anthropogenic sources and sinks and gases, and that covers all the applicable geographic area of the country concerned.

As far as possible, the national inventory strives to include the most complete picture of GHG emissions and removals from all known sources and sinks within the whole territory. Assessments of completeness for each sector have been provided under the sector-specific description section.

However, the incompleteness was noted in the IPPU and waste sectors:

- For IPPU, this concerned the halocarbons, per fluorocarbons, and sulphur hexafluoride due to lacks of data on consumption.
- For Waste, it was about the biological treatment of solid waste where only CH_4 was estimated while N_2O was not estimated as per 2006 IPCC methodology. As a remedial plan, this will be considered in future improvement during the development of 4th National Communication.

Methodological change, recalculation and improvement

The GHG inventory included the trend of emissions extended from 2000 to 2013. The 2006 IPCC methodology was applied for all sectors for the period 2006 to 2013. Compared to the Second National Communication (SNC), the emissions/removals of FOLU, soils and livestock for the period 2000 to 2006 have been recalculated to take into account new activity data and revised 1996 IPCC methods. Emissions from the remaining sectors and sub-sectors, including Energy, Agriculture and Waste and for the period 2000 to 2005, were adopted from the SNC, which used the 1996 IPCC Guidelines. For these sectors and sub-sectors, the total emissions for 2006 (using the 1996 IPCC guideline) were compared with total estimates calculated using the 2006 IPCC Guidelines. It was found that the difference between the results were less than 6% and therefore the results of SNC for the period 2000 to 2005 were adopted and no recalculation was required. For future improvement, a complete recalculation starting from 2000 using the 2006 IPCC Guidelines is proposed.

ES6. Conclusion

The 2000 to 2013 GHG emissions results revealed an increase in emissions from the energy, waste and IPPU sectors, and a decline in emissions from the AFOLU sector. In 2013, the net GHG emissions for the Republic of Mauritius, including the Forest and Other Land Use (FOLU) sector, was estimated to be 4,769.2 Gg CO_2-eq, representing an increase of 2,223.8 Gg CO_2-eq compared to the year 2000. The energy sector was the main source of GHG emissions, amounting to 77% of overall GHG emissions (excluding FOLU) in 2013 followed by waste sector 19%. Agriculture (livestock and use of fertilisers) contributed 2.8% of total GHG emissions in 2013.

CHAPTER 1 INTRODUCTION

1.1 National Circumstances

The Republic of Mauritius (RoM) is located in the South West Indian Ocean, comprises the main island Mauritius, Rodrigues and several Outer Islands namely Agalega, Cargados Carajos Archipelago (known as St Brandon), Tromelin and the Chagos Archipelago which includes the Diego Garcia atoll. Its total area is about 2,040 km² with the mainland Mauritius occupying about 1,865 km², and Rodrigues about 108 km². Its ocean territory is about 2.3 million km^2 including 396, 000 km^2 of Extended Continental shelf under joint management with the Republic of Seychelles (Republic of Mauritius, 2016).

RoM enjoys a mild tropical maritime climate throughout the year. It is influenced by sub-tropical anticyclones and situated in the tropical cyclone belt of the South West Indian Ocean. The climate of RoM is also influenced by the Inter-tropical Convergence Zone (ITCZ). The main island of Mauritius and Agalega have the mean annual rainfall of 2010 mm and 1710 mm respectively. However, St. Brandon and Rodrigues receive mean annual rainfall of 974 mm and 1,116 mm per year, respectively.

The annual mean temperature varies from 24.7^{o}C to 27.4^{o}C with respectively low and high values in main island of Mauritius and in St. Brandon. Coastal average air temperature varies from 25^o C to 30^o C. Temperature more than 33^o C during the summer months is occurring more frequently. The sea-surface temperature varies from 22^{o}C to 28^o C and occasionally can reach 31^o C.

The general economy of RoM is dominated by manufacturing industries, financial services, agriculture and tourism. These sectors contribute altogether to 50.6% with 21.6% for manufacturing industries, 15% for financial services, 8% for agriculture and 6% for tourism industry. The Republic of Mauritius is now an upper middle-income country. The Gross Domestic Product (GDP) for the year 2013 was US$ 10.492 billion. However, the economy of Rodrigues Island is based on a subsistence type of agriculture, stock rearing, tourism and fishing.

The energy production sector is the largest source of GHG emissions. The Total Primary Energy Supply, is obtained from imports (fossil fuel) representing almost 80% of energy production and the rest from indigenous production (fuel wood, hydro, wind, solar and bagasse). RoM does not have any fossil fuel source of energy and all fossil fuels are imported. There are five Independent Power Producers (IPPs), using either only bagasse or a mix of bagasse during the cane harvest season and coal off season, which supplied 63.2% of the total electricity generated, and the Central Electricity Board (CEB) using fossil fuel, supplied 36.8% of the total electricity generated.

Besides bagasse, which contributes about 18% of energy production, renewable sources of energy are gradually being exploited. Some energy are also produced from the burning of methane at Mare Chicose landfill, which has a potential to produce clean energy from waste landfill gas. Large-scale solar photovoltaic plants have also been installed and are now producing 25.9 GWh of electricity in 2015 compared to 2.7 GWh in 2013. Incentives are being provided to Small Independent Power Producers (SIPPs) with capacity below 50 kW to generate electricity for their own purpose and feed any surplus into the national grid. The first large scale 17.85 MW wind energy farm was installed in the north Mauritius Island (Plaine des Roches). The project construction began in May 2014, and the wind power plant started commercial operation on 15 March 2016.

The Deep Ocean Water Application (DOWA) project is the first of its kind in Africa to use cold deep water to supply air condition to, initially, 50 large buildings in the heart of Port Louis, the Capital. This will contribute to an annual reduction of 40,000 tonnes of CO_2 emissions and will be financed by Sustainable Energy Fund for Africa (SEFA).

Natural forest covered almost the whole of RoM before it became inhabited. In 2013 the total forest area of the Island of Mauritius was 47,108 ha representing, approximately 25% of the land cover. Among these approximately 14,686 ha were exotic plantation forests. The area of good quality forest, i.e. having more than 50% native plant cover is estimated to be around 3,730 ha.

There are two types of forest ownership in Mauritius, namely, public and private. In the year 2013, the privately owned forestlands were estimated to be approximately 25,000 ha representing 53% of the total forest area. **This excludes the number of trees along roads, river reserves and in household premises, which are currently not well documented**.

The area of mangrove forest in Mauritius was only 45 ha in 1980. A mangrove rehabilitation and propagation programme was initiated in 1995 by the Ministry of Fisheries and Rodrigues and is still ongoing with the active involvement of NGOs. The mangrove area has increased quite significantly. In 2013, the mangrove forest area was estimated to be 178 [5] ha. In Rodrigues, the mangrove area is about 24 ha. A small mangrove plantation also exists in Agalega. Many potential sites in both Mauritius and Rodrigues to extend the mangrove propagation programme have been identified.

In the past, agriculture, in particular sugar, has been a major development pillar in the economy of the country. Fishery resources, which have been traditionally exploited, are found in the lagoon and offshore areas around Mauritius, Rodrigues, St. Brandon, Chagos Archipelago and other outer islands. The fishery sector of the Republic of Mauritius constitutes of four main types of fisheries namely; coastal/artisanal, aquaculture, offshore demersal and tuna.

[5] The mangrove forest area for 2014 was 181 ha.

The average amount of solid wastes generated per capita has increased steadily from 1 kg in 2000 to about 1.5 kg in 2014. A single landfill was established in 2002 at Mare Chicose and currently contains all the solid waste generated from that year onwards. Previously this waste was disposed in open dumps, after their compaction at the 5 transfer stations around the country[6]. The Mare Chicose site is now fully managed, generating 22 GWh of electricity annually from the captured Landfill gas (LFG), and hence representing an offsetting of GHG emissions.

With regard to wastewater, about 25 % of private households are currently connected to the sewage system, with more than 80% in Port Louis, the Capital, and more than 50% in the main towns. Most industries are also connected to the sewerage system. With the sugar industry, the most important industrial sector, which also discharges, treated wastewater into the environment. The main tourist hotels operate onsite wastewater treatment plants.

1.2 Commitment under UNFCCC for GHG Reporting

RoM submitted its first inventory of GHG as part of its Initial National Communication in April 1999. The improved national GHG inventory was developed by RoM as National Inventory Report (NIR) during the preparation of the Second National Communication in November 2010.

RoM has an obligation to submit its Biennial Update Report (BUR) as well as NC on a regular basis. It is vital that the process be strengthened and a system is developed and maintained in a robust manner to ensure that it functions on a continuous basis to meet RoM reporting requirement. There is a need to strengthen the existing institutional arrangements or establish new ones to ensure that national capacity is available to yield more technically robust reports and meet the frequency of submissions. This is required to meet an increased frequency of submissions. An attempt has been made to establish a sustainable team of experts and data flows in the context of the preparation of the TNC.

1.3 Involvement and Participation of Stakeholders

The Environment and Sustainable Development Division (ESDD) of the Ministry of Social Security, National Solidarity, and Environment and Sustainable Development is the UNFCCC Focal Point and responsible for all climate change activities. In addition, it is mandated to fulfil the reporting requirement for RoM to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (KP) and now the Paris Climate Change Agreement, as well as any related legal instruments that the Conference of the Parties (COP) may adopt and RoM ratifies thereafter. It also coordinated the TNC preparation in

[6] http://environment.govmu.org/English/Pages/swmd/SWMD-Waste-Disposal-Sites.aspx

collaboration with other Ministries and Government Institutions, Private Sectors and Non-Governmental Organisations (NGOs). A Climate Change Bill has been proposed in the government programme 2015-2019, in view to establish the legal framework and mechanism, for making RoM climate change-resilient and developing and strengthening a low-carbon economy and it is expected to be finalised in 2018.

Many other Ministries and Government Institutions, private sectors and NGOs are involved at various levels and collaborating within their capabilities in various climate change activities.

1.3.1 Climate Change Committee

As measure of supporting sustainability in the future, a Climate Change Committee (CCC) has been proposed in the Climate Change Bill (CCB) which would coordinate the preparation of National Communications and such other reports and other climate-related activities as may be required under the UNFCCC. The Climate Change Bill also makes provision for the establishment of a Rodrigues Climate Change Committee (RCCC).

1.3.2 Institutional Arrangements for GHG Inventory

The institutional arrangement used for the NIR is shown in ***Figure 3*** below. Six Sub Technical Working Groups (Sub-TWGs) contain assigned experts and have been established to oversee the technical implementation of data collection, quality control and Greenhouse gases inventory. These Sub-TWGs are namely: Energy Industries, Transport (Road, Aviation, and Navigation), and Energy-Other Sectors (Residential, Commercial, Manufacturing), Agriculture & Forestry and Other Land Use (FOLU); and Waste (Solid and Liquid waste).

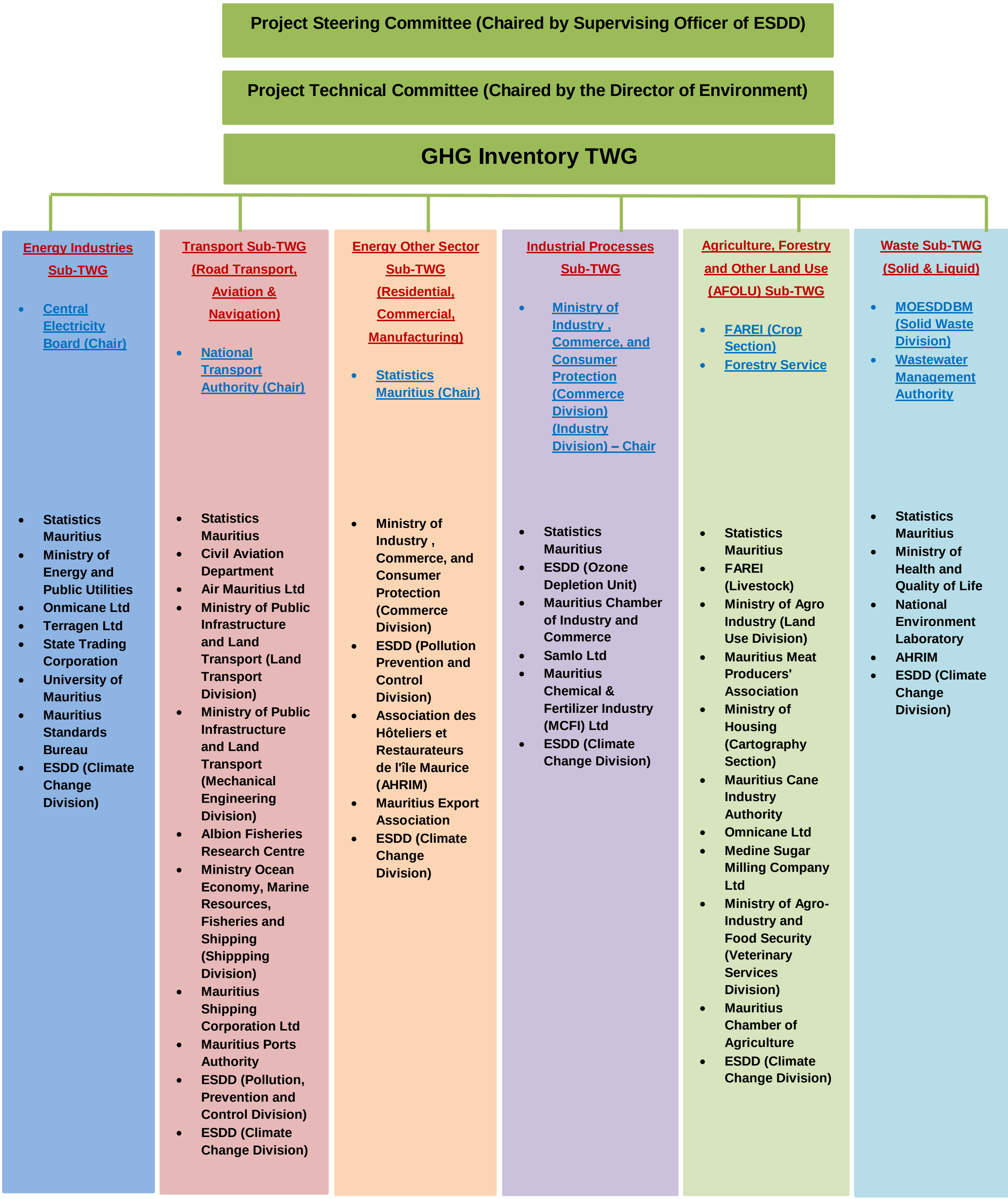


Figure 3: Stakeholders of Technical Working Groups (TWG) and sub - Technical Working Groups

1.4 Inventory Preparation

1.4.1 Data Collection

The Climate Change Division of the ESDD, was assigned the responsibility for coordinating the activities related to data collections, identification of relevant stakeholders and organising capacity building exercises. The data collection process was led by the Team Leaders (TLs) for each sectoral working groups, under the guidance of the consultants. In the event where data was not available, the data were estimated using expert knowledge.

The institutions involved in data collection, verification and data entry in IPCC software are presented in ***Table 1***. The wide range of relevant stakeholders from both the public and private sectors, who contributed to the preparation of the GHG inventory, ensured access to information.

Initial technical and quality evaluation of the data was done by a dedicated team (refer to ***Table 1*** below) for data collection, software entry and report writing. The database created within the IPCC software was shared by the national and international consultants to prepare the national inventory report. Team members were given access to the sectoral database within the software. Activity data, emission and conversion factors were recorded directly into the sectoral and sub-sectoral worksheets of the 2006 IPCC Inventory Software.

Table 1: Institutions contributing to the GHG Inventory

Institutions	Responsibilities
Forestry Service	Data on forestry for land-use and estimation of GHG emissions/sequestration in forestry and other land use.
Food Agricultural Research and Extension Institute(FAREI)	Data for livestock population, crop production data including fruits, flowers, fodder and tea, national consumption of fertilisers and soil fertility data. Estimation of GHG emissions in agriculture.
Mauritius Cane Industry Authority (MCIA)	Data on sugar cane (plantation, processing and energy production related to sugar cane, consumption of fertilisers and cane burning).
Statistics Mauritius (SM)	Responsible for data and information and facilitate access to timely and high quality statistical data. Some energy statistics were also provided.
Fisheries Division	Data on marine transport and estimation of GHG emissions from water borne navigation.
Ministry of Housing and Lands (MoHL)	Provision of additional data on land use data.
National Transport Authority (NTA)	Data on road transport and estimation of GHG emissions from road transport.
Civil Aviation Department	Data on domestic flights.
CEB of the Ministry of Energy and Public Utilities (MoEPU) and Private sector (e.g. IPPs)	• Data on energy (General) • Data on electricity generation and distribution and other energy data. • Estimation of GHG emissions from energy sector.

Institutions	Responsibilities
Wastewater Management Authority of the Ministry of Energy and Public Utilities (MoEPU)	Data on Wastewater Management and estimation of GHG emissions from wastewater.
Solid Waste Management Division (MoSSNSESD)	Data on solid waste and estimation of GHG emissions from solid waste.
Ministry of Industry, Commerce and Consumer Protection (Industry Division).	Data on the IPPU sector and estimation of GHG emissions from industrial process.
National Ozone Unit (ESDD)	Data on ozone depleting substances substitutes and estimation of GHG emissions from products use as ozone depleting substances.

1.4.2 Brief Description of Methodology and Data Source

The methodologies identified for each of the sectors are outlined below. The three general levels of complexity and detail of methods is defined in 2006 IPCC General Guidance section.

- Tier 1 is the simplest approach and uses IPCC defaults. Tier 1 methods are designed to be used where limited activity data is available.
- Tier 2 methods involve simple methods but include the use of country specific emission factors.
- Tier 3 methods are the most complex and cover the use of models or plant specific data to generate accurate GHG estimates.

The methodology included the capacity building of key stakeholders, data collection and data entry in the software. The methodology of GHG estimation, information of collected data and applied emission factors are described in each sectoral chapter (Chapter 3 to Chapter 6).

a. Energy

The energy sector contains a number of key categories including carbon dioxide (CO_2) emissions from Energy Industries, CO_2 emissions from Manufacturing Industries and Construction, CO_2 emissions from Civil Aviation, CO_2 emissions from Road Transportation, CO_2 emissions from Water-borne Navigation.

The adopted approach is the simplest Tier 1 (as defined in 2006 IPCC) but with country specific net calorific values (NCVs) which have been derived from Energy Statistics from Statistics Mauritius. Reference is also made to imported data on fuel specifications provided by the State Trading Corporation (STC) applied to the mass or volume of fuel consumed. The consumption has been obtained from different sources, namely, Independent Power Producers (IPPs), Central Electricity Board and Statistics Mauritius. The application of default energy unit based emission factors (EFs) from 2006 IPCC Guidelines (for 2006 – 2013). This method is quite the same for 2000-2006 except that the Revised 1996 IPCC Guidelines were used instead of the 2006 IPCC Guidelines.

There is a number of fuel types used to produce electricity in RoM. Around 80% of these fuels are of fossil origin and the remaining is a renewable resource, of which bagasse is the main one and others include hydro, wind and solar which constitute minute amounts in the energy mix. As required by the 2006 IPCC Guidelines, only the non-CO_2 emissions from the bagasse (biomass) were accounted for in the national totals while the CO_2 emissions were taken as a memo item[7].

After entry of each of the activity data (AD), NCV and EF, the emissions were calculated in the 2006 IPCC Inventory Software. The results for each fuel were then aggregated to obtain the emissions.

b. Industrial Processes and Product Use (IPPU)

This sector is the least important one in terms of the magnitude of emissions and has only one key category of CO_2 emissions from Iron and Steel Production. Therefore, Tier 1 method was applied for emission estimation and default emission factor was applied.

- For lime production, the activity data were collected from the Statistics Unit of the ESDD and from lime manufacturers;
- For iron and steel production, CO_2 emissions are mainly associated with the consumption of the carbon electrodes. Activity data were obtained from Statistics Mauritius.
- For Product Use as substitute of Ozone Depleting Substance, the Activity data were obtained from the National Ozone Unit of the ESDD.

c. Agriculture, Forestry and Land Use (AFOLU)

The AFOLU sector has one key category for CO_2 removal by Forestland and Remaining Forest land.
A combination Tier 1 (T1) and Tier 2 (T2) have been used to calculate the emissions/removals in the AFOLU sector. While most of the AD has been obtained locally, the EFs have mainly been drawn from the 2006 IPCC guidelines and hence are default values with country specific adjustment for:

- enteric fermentation and manure management, the combined Tier 1 and Tier 2 were applied for emissions estimation. The data were collected from FAREI;
- aggregate sources and non-CO_2 emissions sources on land, the combined Tier 1 and Tier 2 were applied for emissions estimation. The data were collected from FAREI and MSIRI;
- forestland, mostly Tier 1 was applied for emissions estimation. The data were collected from Forestry Service;

[7] According to the 2006 IPCC Guidelines, CO_2 Emissions from the use of biofuels should be reported as a memo item for QA/QC purposes. Memo items are multilateral operations, which should not accounted for in the inventory process for a country.

- cropland, the Tier 1 was applied for emissions estimation. The data were collected from FAREI; and
- grasslands, wetlands, settlements and other lands, the Tier 1 was applied for emissions estimation. The data were collected from Ministry of Housing and Lands and the ESDD.

d. Waste

GHG emissions from the Waste sector include CH_4 emissions from the anaerobic decomposition of organic waste disposed in the sanitary landfill, biological treatment of solid waste and CH_4 emissions from handling of domestic and industrial wastewater under anaerobic conditions. Waste emissions also include N_2O emissions from human sewage.

The Waste sector is the second largest emitter in RoM. It contains two key categories including CH_4 emissions from solid waste disposal and CH_4 emissions from Biological Treatment of Solid Waste.

A combination of Tier 1 (T1) and Tier 2 (T2) has been used to calculate the emissions in the Waste sector. While AD has been obtained locally, the EFs have mainly been drawn from the 2006 IPCC Guidelines and hence are default values with country specific adjustment:

- For solid waste and wastewater treatment and discharge, the combined Tier 1 and Tier 2 were applied for emissions estimation. The data were collected from Waste Water Management Authority of MoEPU and from Solid Waste Management Division of ESDD;
- Emission from Biological Treatment of Solid Waste and Incineration and Open Burning of Waste are not significant in RoM. The methodologies were drawn from Tier 1 and emissions factors were purely default values. Data were collected from Solid Waste Management Division of ESDD.

1.4.3 Methodology for Key Category Analysis and Trend Assessment

Qualitative Key Category Analysis (KCA) has been used to prioritise categories that contribute to over 95% of the cumulative emissions (Level Assessment) or contribute to significantly increasing or decreasing trends (Trend Assessment).

The quantitative assessment of key category analysis was calculated using the equation 4.1 from the chapter 4, Volume 1 of 2006 IPCC Guidelines as follow:

$$\boldsymbol{Level} = \frac{|\boldsymbol{Category\ estimate}|}{\boldsymbol{Total\ contribution}}$$

Or mathematically

$$L_{x,t} = |E_{x,t}| / \sum_{y} |E_{y,t}|$$

Where:

Lx,t : the level assessment for source or sink x in latest inventory year (year t)

|Ex,t| : the absolute value of emission or removal estimate of source or sink category x in year t

$$\sum_{y} |E_{y,t}|$$

The total contribution, which is the sum of the absolute values of emissions and removals in year t, calculated using the aggregation level chosen by the country for key category analysis. Because both emissions and removals are entered with positive sign, the total contribution/level can be larger than a country's total emissions less removal.

The key category analysis was conducted using 2006 IPCC Software. The results from the software were interpreted as follow:

- The categories totalising the emission contribution thresholds of 95 are compared with the most recent key category analysis with the assessments for three or more previous years; and
- If a category has been key for all or most previous years according to the either level or trend assessments or both (the two assessments should be considered separately), they should be identified as key in the latest year estimate except in cases where a clear explanation can be provided why a category may no longer be key in any future years;

The trend was assessed to identify categories that, although not large enough to be identified by the level assessment, their trend may be significantly increasing or decreasing to require particular attention, checking and possible improvement of methods. The Trend Assessment was calculated according to Equation 4.2 from the chapter, Volume 1 of 2006 IPCC Guidelines as follows:

$$T_{x,t} = \frac{|E_{x,0}|}{\sum_{y} |E_{y,0}|} \bullet \left| \left[\frac{(E_{x,t} - E_{x,0})}{|E_{x,0}|} \right] - \frac{\left(\sum_{y} E_{y,t} - \sum_{y} E_{y,0} \right)}{\left| \sum_{y} E_{y,0} \right|} \right|$$

Where:

Tx,t: trend assessment of source or sink category x in year t as compared to the base year (year 0)

$|E_{x,0}|$: absolute value of emission or removal estimate of source or sink category x in year 0

$E_{x,t}$ **and** $E_{x,0}$ = real values of estimates of source or sink category x in years t and 0, respectively

$\sum_y E_{y,t}$ **and** $\sum_y E_{y,0}$: total inventory estimates in years t and 0, respectively

1.4.4 Quality Assurance and Quality Control (QA/QC)

The 2006 IPCC Guidelines recommend that quality control be exercised by comparing emission results using alternative approaches, comparing results and investigating anomalies. They also recommend that control include review of emission factors, verification of activity data to ascertain source of data, reliability, and distinction in use where applicable, and to ensure avoidance of double counting.

All the data used were reviewed during peer review meetings with stakeholders. QC procedures were implemented by the inventory team through routine and consistent checks to identify errors and omissions. All calculations made during the exercise used approved standardised procedures for emissions calculations, measurements and documentations as per 2006 IPCC Guidelines. The inventory process was carried out under close supervision of the local and international consultants to ensure compliance with 2006 IPCC Guidelines.

Regarding the quality assurance (QA), it is normally conducted by external reviewers that offer the opportunity to uncover technical issues related to the application of methodologies, selection of activity data, development and selection of emission factors. By request of RoM, Mr. Stanford Mwakasonda from UNEP/UNDP Global Support Programme (GSP) reviewed the draft of NIR and his comments were taken into consideration for final draft. The final quality assurance was conducted by Mr. Justin Goodwin, the reviewer and editing expert hired by RoM in collaboration with UNEP.

For future improvement of QA/QC, specific templates were developed basing on the 2006 IPCC Guidelines and on US-EPA templates. These templates are located in chapter seven on overall plan of improvement and will help to record checked information, who checked that information, when checked and corrective measure taken. These templates will be used in future GHG inventory.

1.4.5 Uncertainty Assessment

As defined in Volume I of 2006 IPCC Guidelines, the uncertainty represents the lack of knowledge of the true value of a variable by defining the possible range within a confidence level the value could be. Uncertainties are used to highlight where the real emissions/removals have the potential to be significantly different to estimate.

The uncertainty should be based on evidence (measurement) of the range a value could be. However, due to the lack of measurements or statistics to statistically determine a range an uncertainty ranges are often based on “Expert Judgement”. This is based on the analyst’s (an expert) state of knowledge, of the quality and quantity of applicable data as well as knowledge of underlying processes and inference methods.

The most used method to calculate uncertainties are: (i) Error Propagation (2006 IPCC Guidelines Approach 1) and (ii) Monte Carlo Simulation (2006 IPCC Guidelines Approach 2).

Error Propagation

- Standard spreadsheet can be used (Simple)
- Difficult to deal with correlations
- Strictly (standard deviation/mean) < 0.3
- Guidelines give explanation and equations

Monte Carlo Simulation

- Specialised software is used
- Needs shape of Probability Density Function (PDF)
- Suitable where uncertainties large

RoM is committed to continuous improvement of its GHG estimates. During the development of the TNC report, the following activities were applied to reduce uncertainties:

- Using more precise measurement methods: Measurement error was reduced by using more precise measurement methods (i.e. laboratories tests of fuel characteristics in Independent Power Producers - IPPs), avoiding simplifying assumptions.
- Collecting more measured data: Compared to the second national communication, the sample size was increased and data gaps were reduced as much as possible.(i.e. forestry data)
- The state of knowledge was improved by involving more stakeholders/experts in the process of data collection and compilation. In addition, several training activities were conducted by the local consultant and international consultant. This improved understanding of the categories and the processes leading to emissions and removals and has improved the completeness and accuracy of the estimates.
- Improving representativeness and improving on emission factors: The Mauritius Cane Industry Authority (MCIA) carry out air quality monitoring at power stations and other industrial sites. An attempt was made to develop emission factors using air quality

monitoring data but given the remaining short period remaining to deliver the report for TNC, it was recommended that this should be addressed during the upcoming GHG inventory exercise;

- Improvements to the methodologies used for the measurements and how measurement data can be made appropriate for GHG inventories are needed. Particularly, for deriving plant specific emission factor from coal and other fossil fuels and in development of national emissions factors and use of data from the Continuous Emissions Monitoring Systems.

1.4.6 Completeness Assessment

Referring to the Chapter 8, Volume 1 of the 2006 IPCC Guidelines (reporting table), data for the GHG inventory were corrected and analysed by IPCC categories and periods. The completeness table are presented for all categories in their respective chapters. The combined completeness table is at ***Appendix 1***.

CHAPTER 2 TRENDS OF GREENHOUSE GAS EMISSIONS

This Chapter summarises the emission trends from 2000 to 2013 combining the results of the current inventory (2006-2013) and the inventory results from the Second National Communication (2000- 2006) published in November 2010 whereby the first NIR was developed. The inventory for the SNC was developed following the Revised 1996 IPCC Guidelines, 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF) and the current inventory is based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The emissions trends from both inventory periods were combined after checking the comparability of both. In fact, for the year 2006, the total aggregated GHG emissions were 4,508 Gg CO_2-eq and 4,352 Gg CO_2-eq respectively for the NIR under SNC and the current NIR. This indicates a slight emission decrease of 156 Gg (due to the data correction of ODS) representing less than 4%. Therefore, the results for the NIR under SNC are considered valid for trend analysis together with results for the current NIR.

The general trends are described as follow:

- As indicated in ***Table 2 and Figure 4***, GHG trends, including and excluding FOLU, increased between 2000 and 2013 by 5%. The steady upward trend faltered in 2009 as a result of economic downturns. These trends did follow general trends in GDP/Energy consumption illustrating a strong link between decoupling from economic activity and growth/population. In fact, the GDP trends for RoM fluctuated from a growth of +5.6% in 2007 down to +4.5% in 2010 and +3.4% in 2013

Table 2: Total GHG Emissions Trends

Year	Total – excluding LULUCF (Gg CO_2 eq)	Total – including LULUCF (Gg CO_2 eq)
2000	2941.5	2545.4
2001	3210.6	2813.1
2002	3282.0	2930.2
2003	3473.5	3070.5
2004	3447.4	3086.5
2005	3728.6	3366.6
2006	4352.1	3990.7
2007	4601.5	4249.5
2008	4793.8	4422.3
2009	4573.6	4211.4
2010	4947.0	4588.9
2011	4991.6	4626.9
2012	5072.5	4702.4
2013	5136.7	4769.2

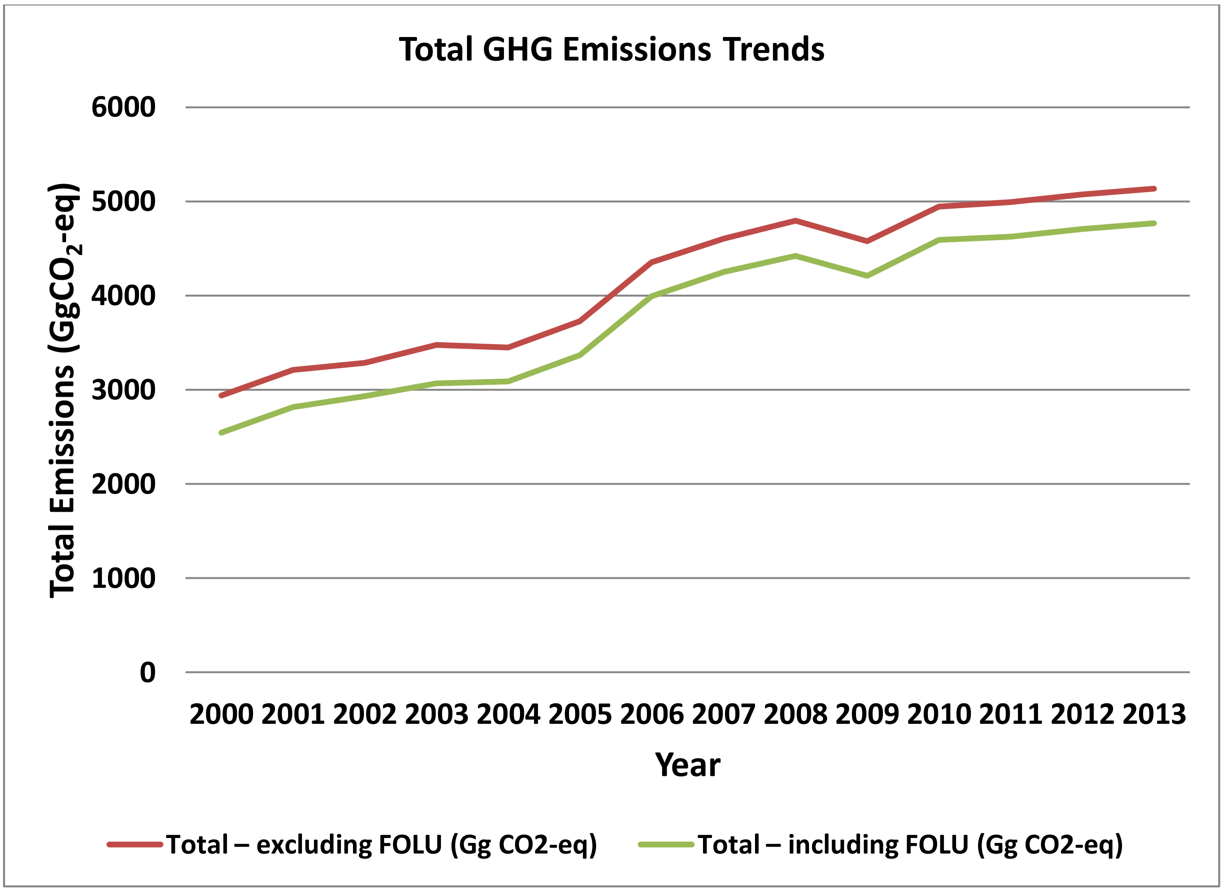


Figure 4: Trends of Total Aggregated GHG Emissions

2.1 Emission Trends by Sector

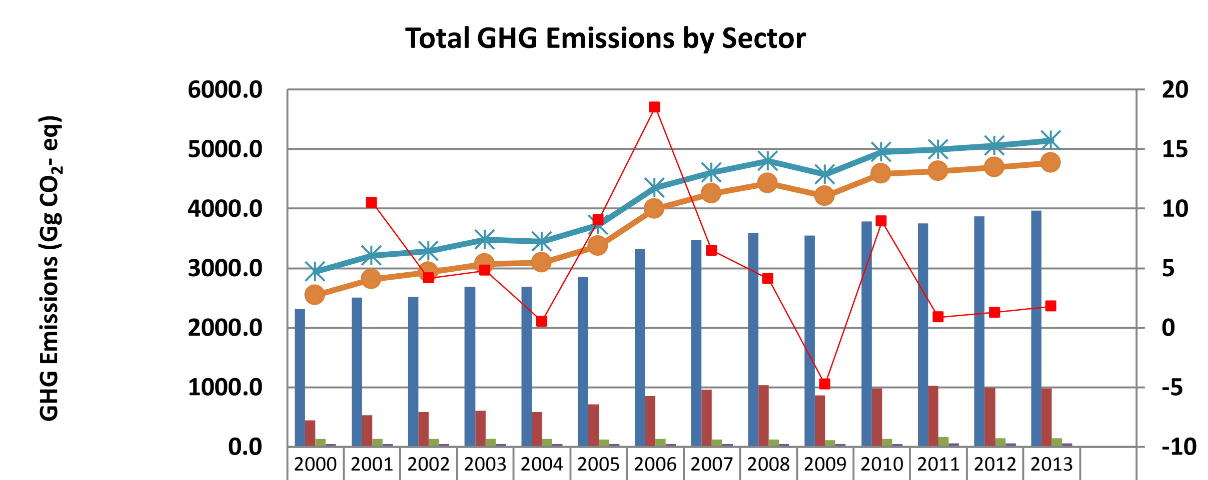
The trends by sector for the GHG estimate 2000 – 2013 are tabulated in ***Table 3*** and ***Figure 5*** presents the emission share for each sector. Energy and waste are the dominant sectors influencing the trend and emissions from IPPU are not significant.

The general trend characteristics were driven mainly by the energy consumptions, which followed a similar growth pattern. The total aggregated GHG emissions depends also on GDP growth. In fact, the GDP growth of RoM fluctuated from a growth of +5.6% in 2007 down to 4.5% in 2010 and +3.4% in 2013[8].

[8] Statistics Mauritius: National accounts historical series (http://statsmauritius.govmu.org/English/StatsbySubj/Pages/National-Accounts.aspx)

Table 3: GHG Emissions by Sector (Gg CO_2-eq)

Year	Energy	IPPU	AFOLU - Agriculture	AFOLU - LULUCF	Waste	Total GHG (excluding FOLU)	Total GHG (including FOLU)	Annual Change (%)
2000	2315.3	44.1	134.9	-396.1	447.3	2941.5	2545.4	
2001	2504.4	44.1	134.7	-397.5	527.3	3210.6	2813.1	11
2002	2521.6	43.9	132.9	-351.9	583.8	3282.0	2930.2	4
2003	2692.3	43.8	130.8	-403.0	606.4	3473.5	3070.5	5
2004	2692.8	43.5	127.5	-360.9	583.8	3447.4	3086.5	1
2005	2855.3	43.6	122.1	-362.0	707.7	3728.6	3366.6	9
2006	3327.8	42.9	127.1	-361.4	854.3	4352.1	3990.7	19
2007	3477.0	44.8	123.1	-352.1	956.6	4601.5	4249.5	6
2008	3595.3	47.1	116.7	-371.5	1034.6	4793.8	4422.3	4
2009	3553.4	49.3	113.8	-362.2	857.0	4573.6	4211.4	-5
2010	3788.9	49.9	127.6	-358.1	980.6	4947.0	4588.9	9
2011	3752.7	54.4	161.6	-364.7	1022.8	4991.6	4626.9	1
2012	3875.8	51.0	141.1	-370.1	1004.7	5072.5	4702.4	2
2013	3964.8	43.7	141.6	-367.5	986.6	5136.7	4769.2	2



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy	2315.	2504.	2521	2692.	2692.	2855.	3327.	3477.	3595.	3553.	3789.	3752.	3875.	3964.
Waste	447.3	527.3	583.8	606.4	583.8	707.7	854.3	955.2	1034.	857.2	980.6	1022.	990.5	979.3
AFOLU - Agriculture	134.9	134.7	132.9	130.8	127.5	122.1	127.1	124.6	118.2	115.2	129.1	163.4	141.2	141.4
IPPU	44.1	44.1	43.9	43.8	43.5	43.6	42.9	44.6	46.6	48.5	48.2	55.5	51.2	54.0
Total -exc. FOLU	2941.	3210.	3282.	3473.	3447.	3728.	4352.	4601.	4794.	4574.	4946.	4993.	5058.	5139.
Total - inc.FOLU	2545.	2813.	2930.	3070.	3086.	3366.	3990.	4249.	4423.	4212.	4588.	4629.	4688.	4772.
Annual change(%)		11	4	5	1	9	19	6	4	-5	9	1	1	2

Figure 5: Total GHG Emissions by Sector

2.1.1 Energy Sector

The biggest emitter within the energy sector is the Energy Industries, which in RoM, is the electricity production. The average annual growth in GHG emissions from 2000 to 2013 has been 4.3%, with a few occasional slight drops and rises due to economic sluggishness and growth. However, from 2005 to 2006 a high annual rise change in emissions was observed (from 9% in 2005 to 19% in 2006) due to the use of different IPCC guidelines and increase of energy requirement[9]. The general rising trend can be explained by the change in lifestyle and increased demand for electricity in households and industries (***Figure 6***). The per capita consumption of electricity sold increased from 1158 kWh in year 2000 to 1894 kWh in 2013, which translates to a 63% rise in consumption. The second largest emitter in energy is the transport. The emissions of transport increased are less compared to Energy Industries but the transport (road transportation) is still a key and growing category for RoM as per ***Figure 7***.

[9] From 2000 to 2013, the highest emissions change from 2005 to 2006 is explained as follow:
(i) The use of 2006 IPCC guidelines has contributed alone to emissions rise by 6% in 2006 (Ref.: Appendix 5); and
(ii) In 2006, it was observed one of highest change in energy requirement (6%). In fact the change of energy requirement/energy consumption is one of main drivers of GHG emissions in Mauritius and the availability of energy is the engine of other economic activities which are also linked with GHG emission rise (Ref. Energy Requirement, Tables 2.1 in Digest of Energy and Water Statistics, 2011-2015)

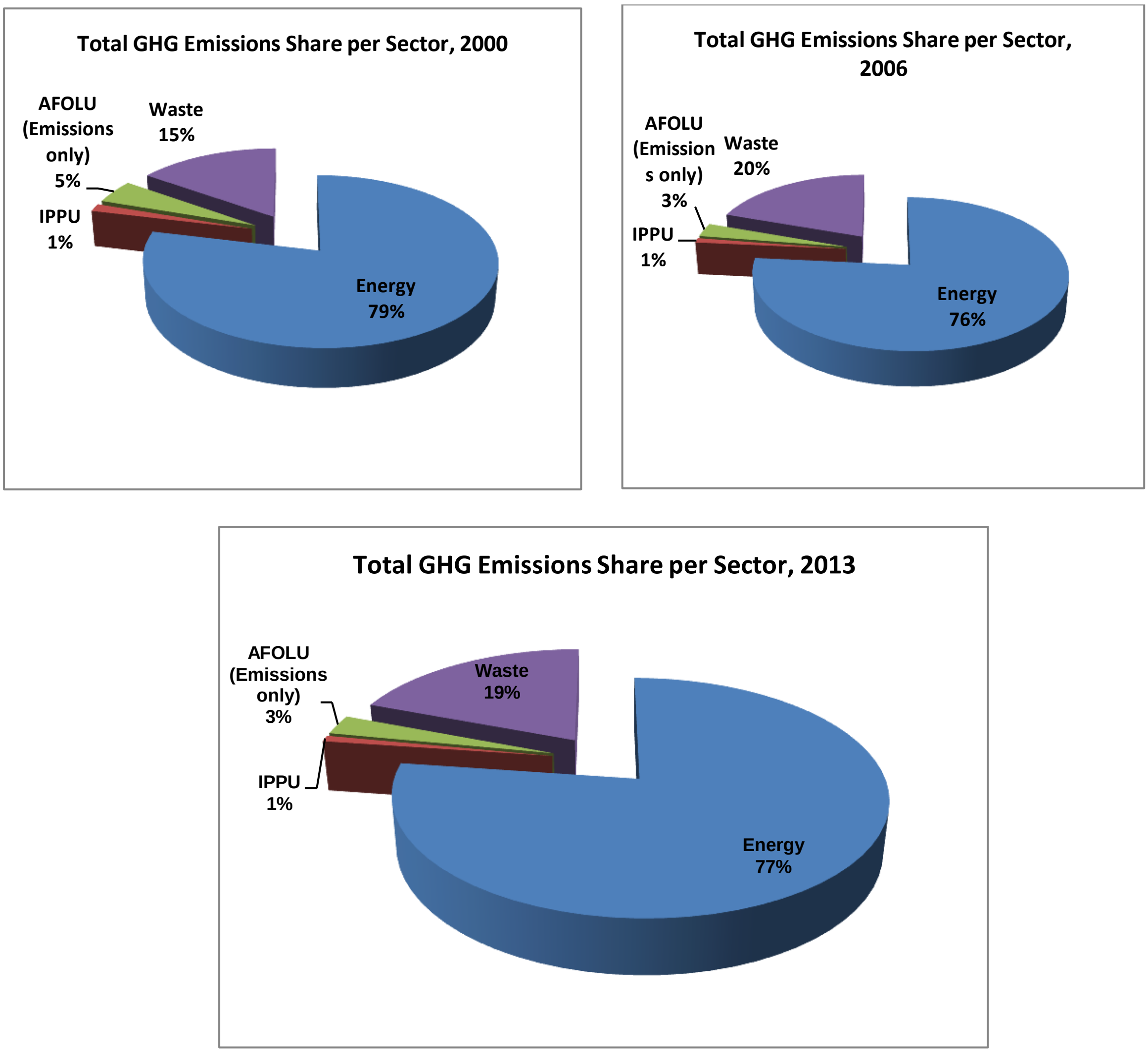
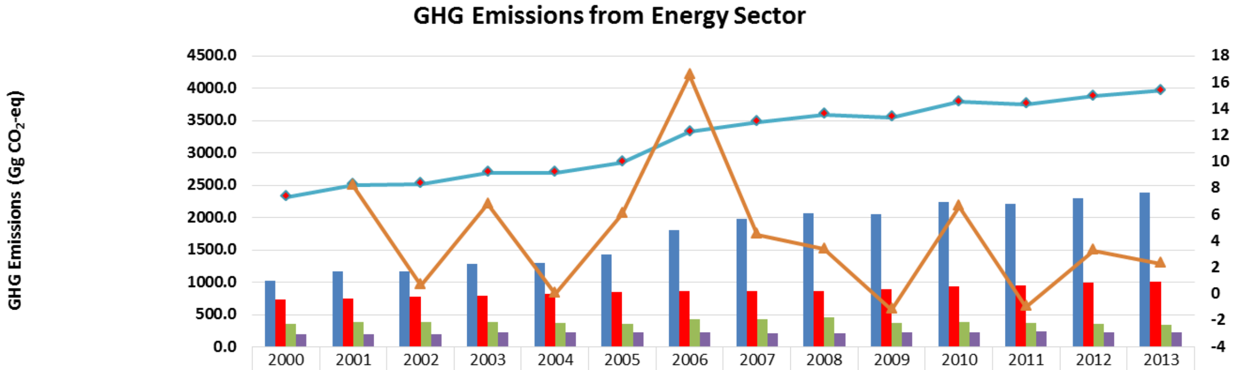
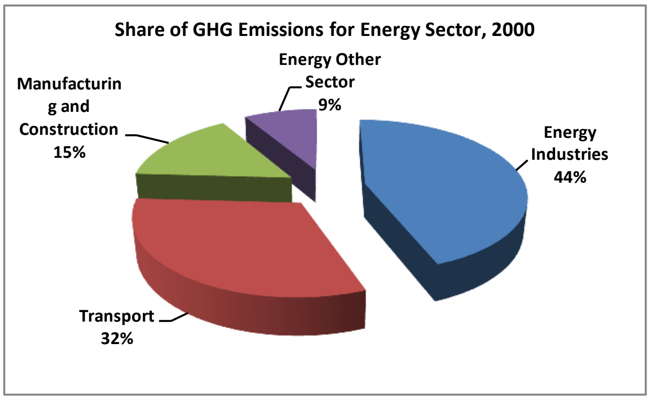


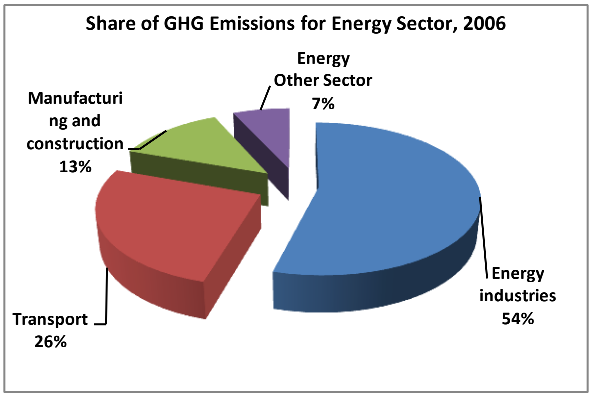
Figure 6: Share of GHG Emissions by Sector (2000, 2006 & 2013)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy industries	1024.0	1167.9	1164.2	1290.7	1293.7	1429.9	1806.0	1979.1	2059.8	2055.7	2246.0	2207.1	2302.9	2386.0
Transport	732.7	748.7	769.8	796.6	814.0	844.6	869.3	866.0	867.2	895.8	936.4	948.2	987.1	1007.4
Mng ind. and construction	358.4	385.3	385.2	385.5	362.8	352.5	426.6	423.8	450.8	374.7	380.4	362.7	356.5	342.3
Others	200.0	202.5	202.2	219.6	222.1	228.2	226.0	208.2	217.5	227.2	226.2	234.6	229.3	229.1
Total energy	2315.2	2504.5	2521.4	2692.4	2692.7	2855.2	3327.8	3477.1	3595.3	3553.5	3789.0	3752.7	3875.8	3964.9
Annual change(%)		8	1	7	0	6	17	4	3	-1	7	-1	3	2

Figure 7: Total GHG Emissions for Energy Sector





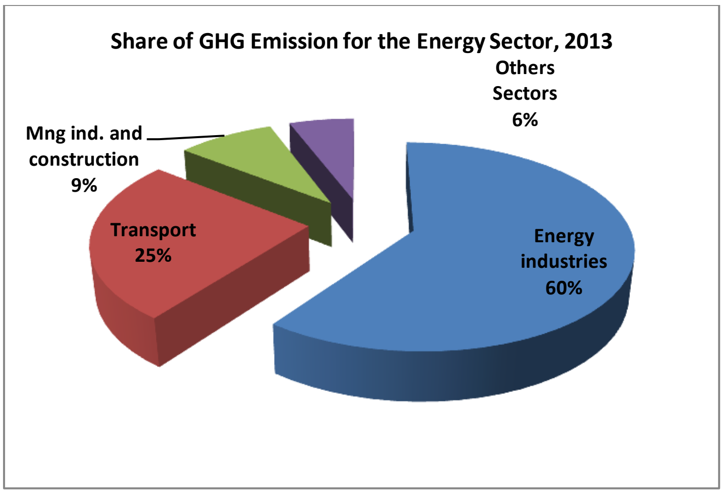


Figure 8: Share of GHG Emissions for Energy Sector (2000, 2006 & 2013)

2.1.1.1 Energy Industries

The biggest emitter within the energy sector is the energy industries, which in RoM is electricity production. The total GHG emissions growth from 2000 to 2013 was 133%. This general rising trend can be explained by the change in lifestyle and increased demand for electricity in households and industries with the Energy sector. For CH_4 and N_2O, there is a big difference between the emission for the period covered by the SNC (2000-2005) and those covered by the TNC (2006-2013). This is due to the use of different methodologies for both assessments. Since both gases are not key categories within the Energy Industries, it was proposed to keep both results by keeping in mind that: (i) CH_4 and N_2O are recommended for recalculation in future inventories; (ii) CH_4 and N_2O results from 2006 to 2013 are only ones used for total percentage change.

Table 4: Total Emissions for Energy Industries (Gg CO_2-eq)

Year	CO_2	CH_4	N_2O	Total
2000	1021.00	0.55	2.48	**1024.0**
2001	1163.00	0.59	4.34	**1167.9**
2002	1159.00	0.57	4.65	**1164.2**
2003	1285.00	0.71	4.96	**1290.7**
2004	1288.00	0.76	4.96	**1293.7**
2005	1424.00	0.67	5.27	**1429.9**
2006	1775.54	8.39	22.10	**1806.0**
2007	1947.70	8.40	23.01	**1979.1**
2008	2028.06	8.34	23.43	**2059.8**
2009	2024.15	8.39	23.21	**2055.7**
2010	2213.48	8.44	24.08	**2246.0**
2011	2174.84	8.45	23.83	**2207.1**
2012	2270.19	8.48	24.25	**2302.9**
2013	2352.83	8.52	24.69	**2386.0**

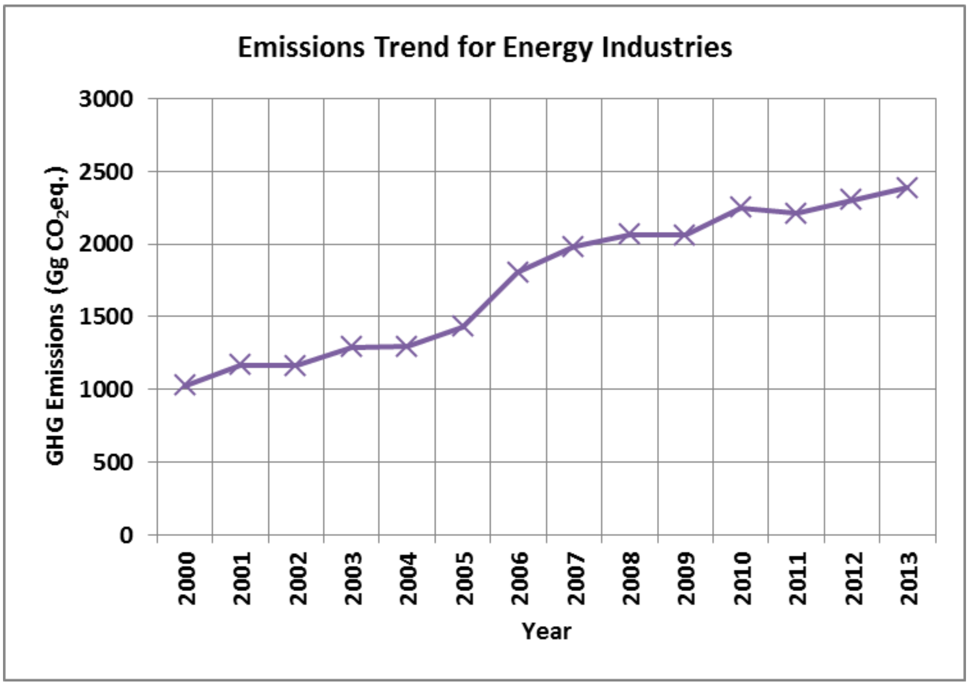


Figure 9: Emissions Trend for the Energy Industries

2.1.1.2 Manufacturing Industries and Construction

In the energy sector, the sub-sector of Manufacturing Industries and Construction is the third emitter following the sub-sectors of Energy Industries and Transport. From 2000 to 2013, the total emissions growth from this sub-sector was -4.5% (i.e., almost no significant change in 14 years).

Table 5: Total Emissions for Manufacturing Industries and Construction (Gg CO_2-eq)

Year	CO_2	CH_4	N_2O	Total GHG
2000	349.3	2.9	6.2	**358.4**
2001	376.2	2.9	6.2	**385.3**
2002	376.5	2.5	6.2	**385.2**
2003	376.6	2.7	6.2	**385.5**
2004	353.9	2.7	6.2	**362.8**
2005	343.8	2.5	6.2	**352.5**
2006	414.9	3.8	7.8	**426.6**
2007	413.6	3.3	6.9	**423.8**
2008	443.7	2.3	4.8	**450.8**
2009	368.4	2.0	4.3	**374.7**
2010	373.2	2.3	4.9	**380.4**
2011	356.0	2.2	4.5	**362.7**
2012	350.5	1.9	4.1	**356.5**
2013	336.6	1.9	3.9	**342.3**

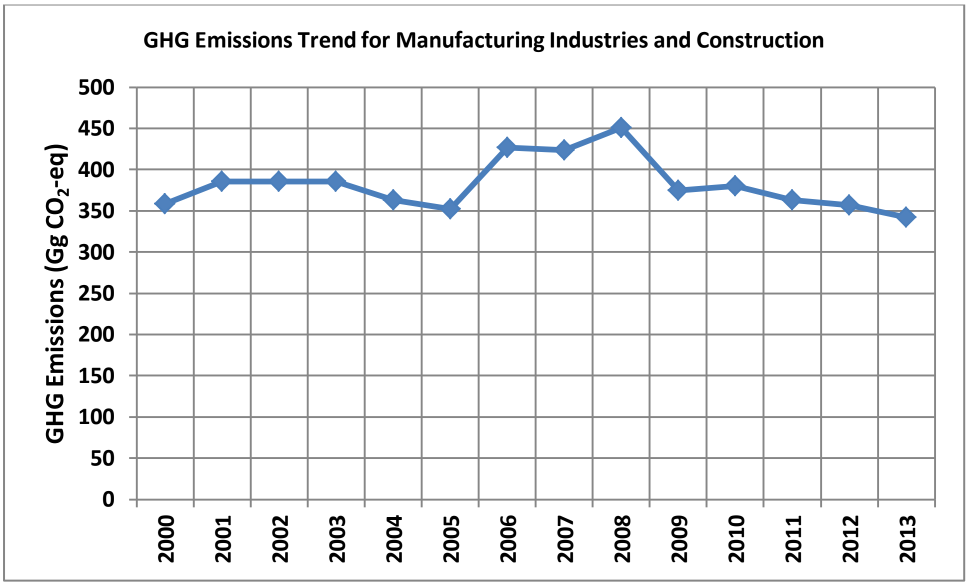


Figure 10: Emissions Trend for Manufacturing Industries and Construction

The following is emissions share for Manufacturing Industries and Construction in 2013. The textiles sub categories contributed most to the emissions (55% in 2013) as this is an important sector of the economy. Its emissions declined in 2013 to reach 189 Gg CO_2-eq in 2013 from 230 Gg CO_2-eq. in 2006. The other non-specified industries such as wood, animal feeds and medical facilities also contributed to GHG emissions.

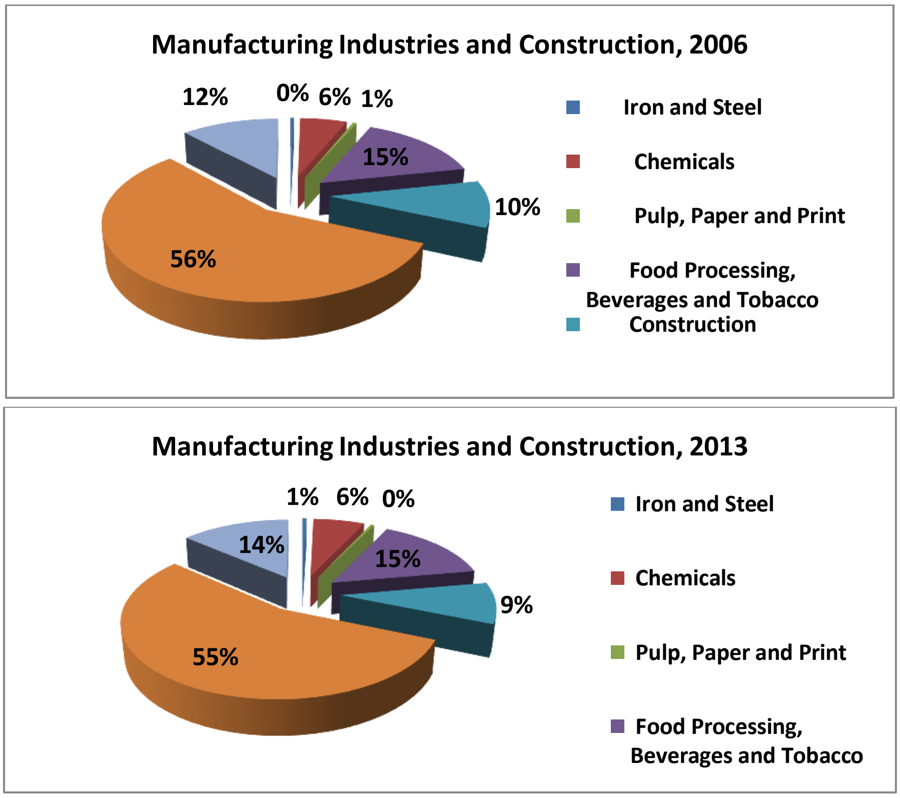


Figure 11: Share of GHG Emissions for Manufacturing Industries and Construction (2006 & 2013)

2.1.1.3 Transport

Between 2000 and 2013, GHG emissions from the transport sector increased by 37.5% rising from 732.7 Gg CO_2-eq to 1007.4 Gg CO_2-eq respectively. Road Transportation contributed the most among all sub-categories with 95% of the total GHG emissions.

The summary of GHG emissions trend for the inventory period for the whole sector was as follows:-

Table 6: Total Emissions for Transport Sector (Gg CO_2-eq)

Year	CO_2	CH_4	N_2O	Total GHG
2000	720.8	4.3	7.8	732.8
2001	736.6	4.3	7.8	748.6
2002	757.8	3.8	8.4	770.0
2003	781.6	3.7	11.2	796.4
2004	797.7	3.4	13.0	814.1
2005	826.1	3.7	14.9	844.6
2006	853.8	2.3	13.3	869.3
2007	849.4	4.0	12.6	866.0
2008	850.6	4.0	12.7	867.2
2009	878.5	4.2	13.1	895.8
2010	918.2	4.5	13.7	936.4
2011	929.8	4.6	13.9	948.2
2012	967.9	4.8	14.4	987.1
2013	987.75	4.95	14.73	1007.4

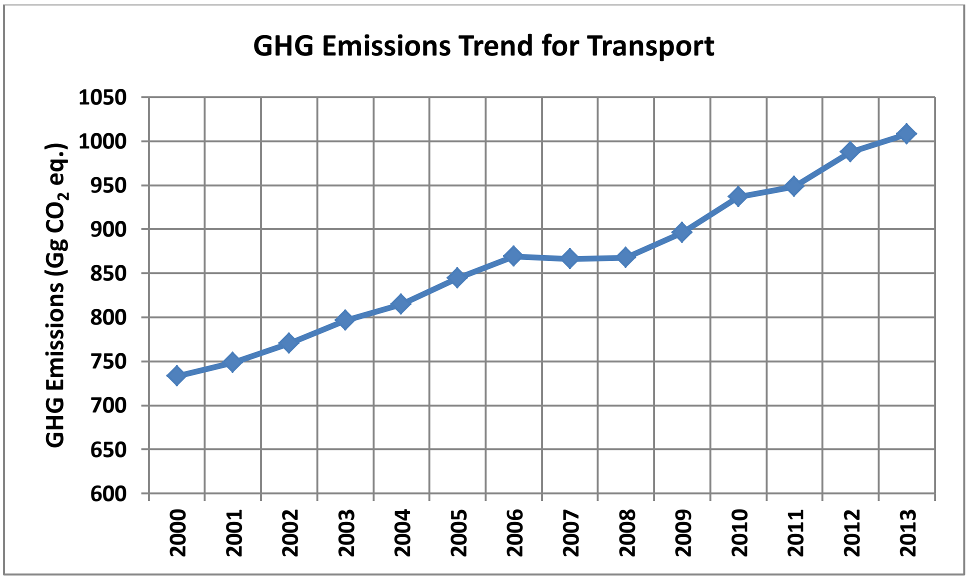
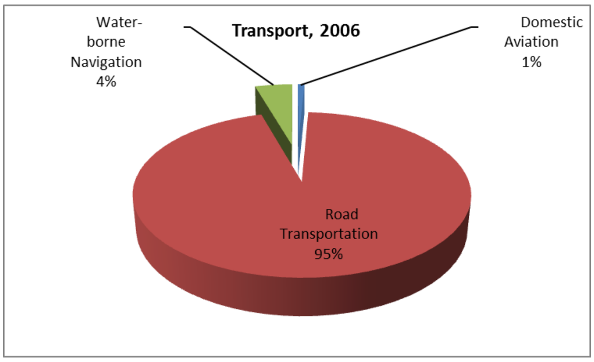


Figure 12: GHG Emissions Trend for Transport Sector



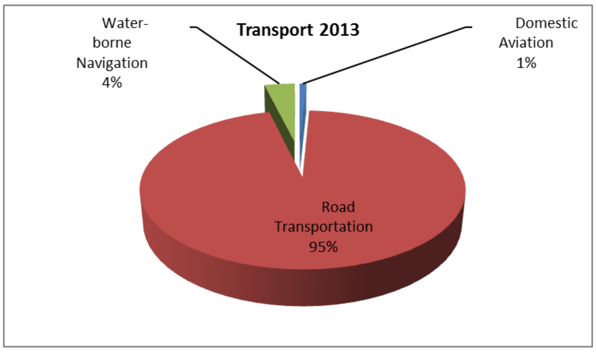


Figure 13: GHG Emissions Share for Transport Sector (2006 & 2013)

2.1.1.4 Energy Other Sectors

Between 2000 and 2013, GHG emissions from Energy Other Sectors increased by 14.6 % rising from 200.0 Gg CO_2-eq to 229.1 Gg CO_2-eq respectively. Residential contributed the most among all sub-categories, with 62% of the total GHG emissions as shown in ***Figure 15*** below.

Table 7: Total Emissions for Energy Other Sectors (Gg CO_2-eq)

Year	CO_2	CH_4	N_2O	Total GHG
2000	196.1	2.1	1.8	200.0
2001	198.4	2.1	2.0	202.5
2002	198.1	2.2	2.0	202.2
2003	215.4	2.2	2.1	219.6
2004	217.7	2.3	2.2	222.1
2005	223.7	2.3	2.1	228.2
2006	223.2	2.2	0.6	226.0
2007	205.5	2.2	0.6	208.2
2008	214.8	2.1	0.6	217.5
2009	224.5	2.1	0.6	227.2

Year	CO_2	CH_4	N_2O	Total GHG
2010	223.5	2.1	0.6	226.2
2011	231.9	2.1	0.6	234.6
2012	226.7	2.1	0.5	229.3
2013	226.5	2.0	0.5	229.1

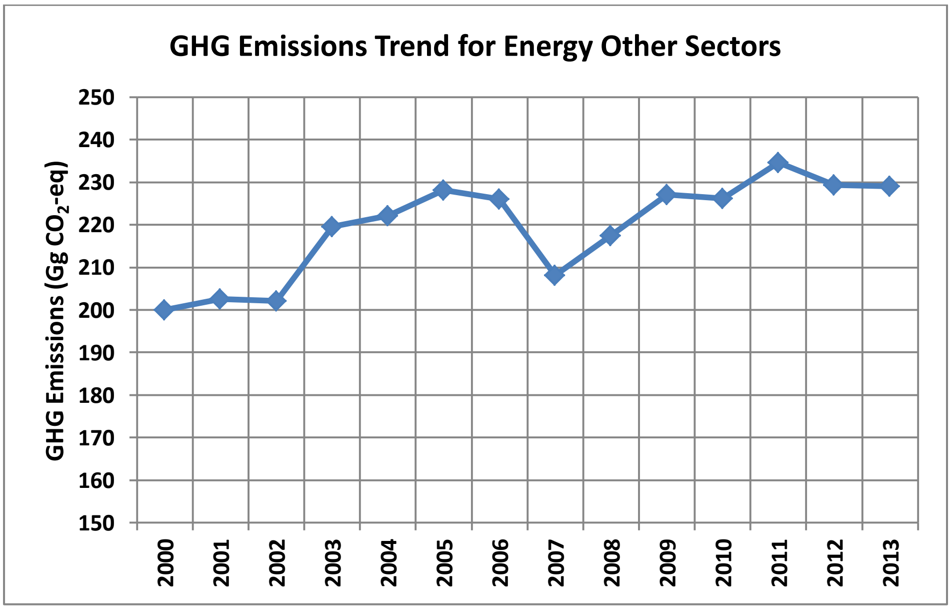


Figure 14: GHG Emissions Trend for Energy Other Sectors

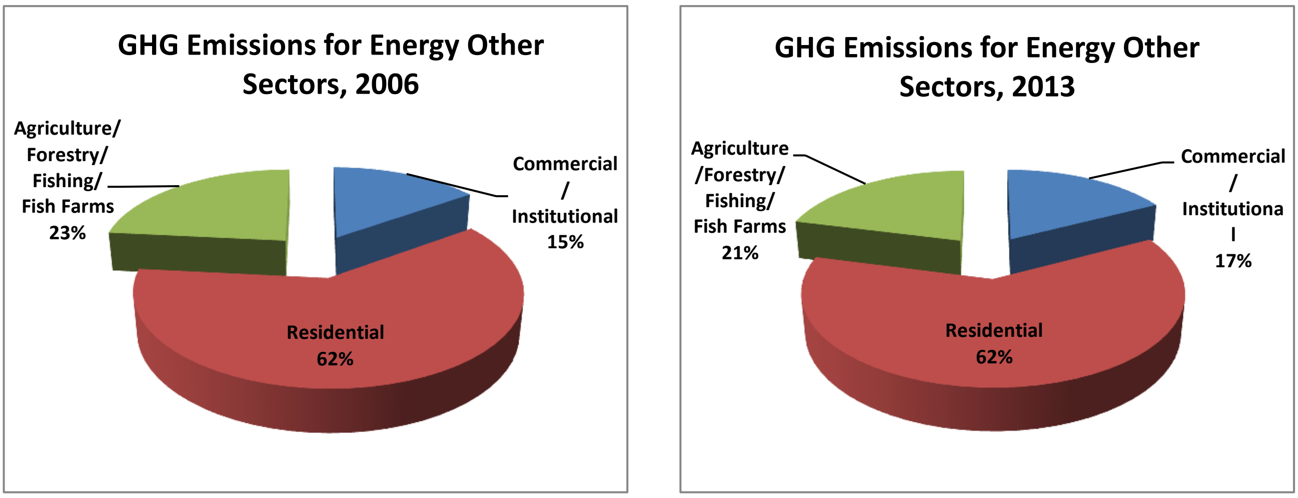


Figure 15: GHG Emissions Share for Energy Other Sector (2006 & 2013)

2.1.2 Industrial Processes and Product Use (IPPU) Sector

This sector is the least important one in terms of the magnitude of emissions in RoM. Very few sub-categories in this sector emit GHGs (refer to ***Figure 5***).

Referring to ***Figures 16 and 17***, GHG emissions from the IPPU sector in RoM increased annually by an average of 1.9% between 2006 and 2013 due to an increase in demand of products. From 2011 to 2012, total GHG emissions in the IPPU sector decreased from 54.4 Gg CO_2-eq to 51.0 Gg CO_2-eq respectively mainly to a lower production of iron bars that met national standards.

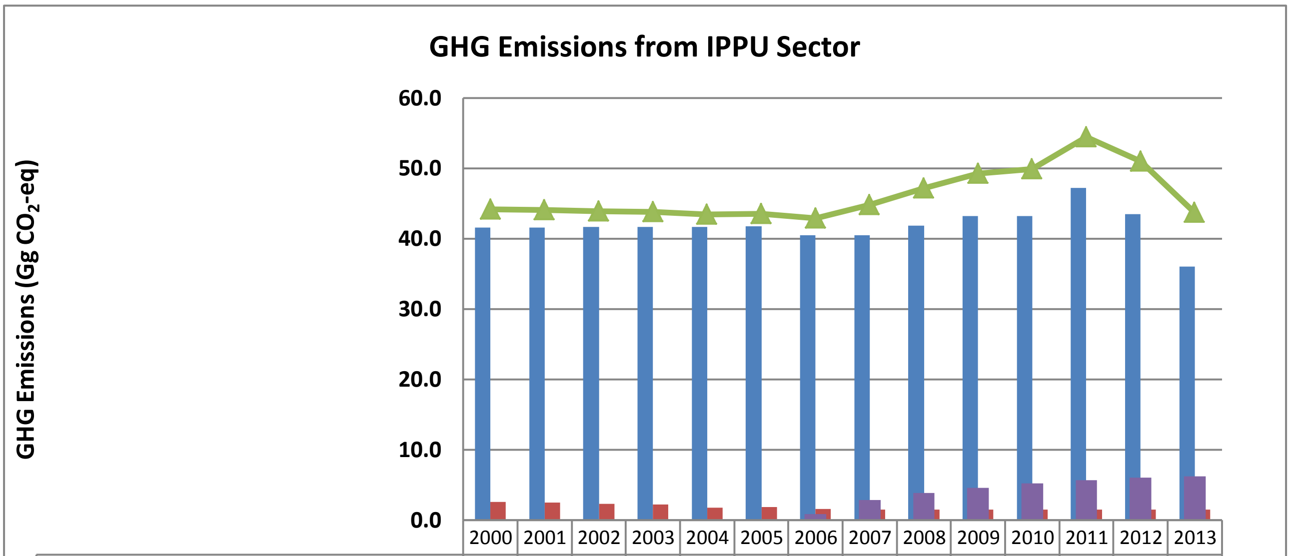
The most significant source of emissions in the IPPU sector was from the production of iron and steel bars in the metal industries. This source alone emitted between 94.4% and 82.5% of GHG of the total IPPU emissions over the period 2006 to 2013. GHG emissions from the mineral industry, more specifically from the production of lime, contributed to 3.5% and 3.4% in 2006 and 2013 respectively. Product uses as substitutes to Ozone Depleting Substances (ODS) substitute, on the other hand, contributed 2.1% in 2006 and 14.1% in 2013 to the total GHG emissions in the IPPU sector.

The secondary metal industry (construction iron and steel bars from scrap metals) has the highest level of emissions out of the total for this sector, but with a slight drop as from 2011, due to a decrease in production in 2011. Emissions from mineral industry reduced significantly, as there was a lower demand for locally produced hydrated lime by the sugar factories.

For lime production, the total GHG emissions amounted to 2.6 Gg CO_2-eq in 2000 and decreased significantly to 1.5 Gg CO_2-eq in 2006. This was mainly due to a significant decrease in the production of hydrated lime. Most of the sugar industries in RoM import lime from other countries to refine their sugar produced. This measure led to a decrease in the demand for the locally produced hydrated lime. From 2006 to 2013, GHG emissions remained constant at 1.5 Gg CO_2-eq, mainly due to a constant production of 2,530 tonne of lime per year.

Iron and steel production is responsible for the emissions of 94% of GHG in 2006 in the IPPU sector in RoM. In 2006, GHG emissions resulting from this industrial activity amounted to 40.5 Gg of CO_2eq. The emissions continued to increase from 2007 to 2010, with an increase in the amount of iron and steel produced. In 2011, CO_2 emissions amounted to as high 48.7 Gg due to a higher production of 35,000 tons of iron and steel. In 2013, the manufacturer produced a lower amount of iron and steel bars that could meet the national measurements standard. This lower production, from 32,200 tons in 2012 to 26,700 tons in 2013, led to a lower amount of CO_2 being emitted to the atmosphere.

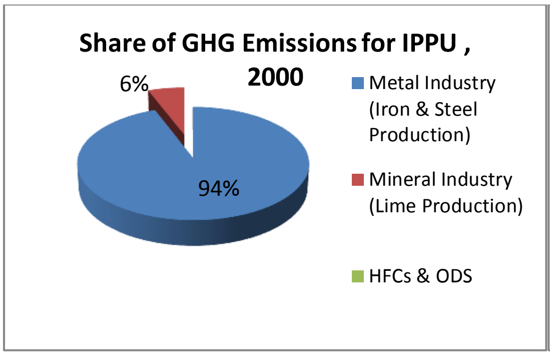
For Hydrofluorocarbons (HFCs), the SNC data was not used for year 2000 to 2005 as they were still to be improved by the national ozone unit of the ESDD. Total HFCs emissions increased significantly from 0.9 Gg CO_2-eq in 2006 to 6.2 Gg CO_2-eq in 2013 due to increased use of the gases in air conditioning and refrigeration. HFC-143a is the largest contributor, with an average contribution of 35.1%. From 2012 to 2013, there was one refrigerant that was banned and it was preferably substituted by HFC-143a, which witnessed a sharp rise in importations.

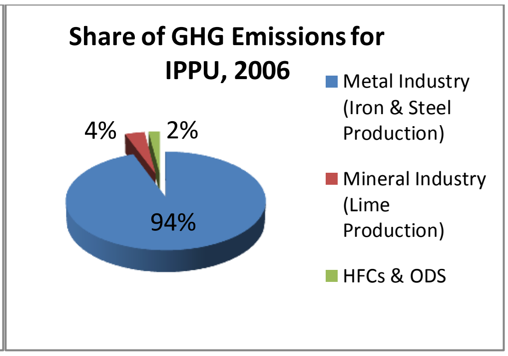


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CO2 Emissions from Metal Industry (Iron & Steel Production)	41.6	41.6	41.6	41.7	41.7	41.7	40.5	40.5	41.9	43.2	43.2	47.3	43.5	36.0
CO2 Emissions from Mineral Industry (Lime Production)	2.6	2.5	2.3	2.2	1.8	1.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
HFCs Emissions from Product Uses as Substitutes to ODS							0.9	2.8	3.8	4.6	5.2	5.7	6.0	6.2
Total GHG Emissions from IPPU	44.1	44.1	43.9	43.8	43.5	43.6	42.9	44.8	47.1	49.3	49.9	54.4	51.0	43.7

Figure 16: Total GHG Emissions for IPPU Sector[10]

[10] For HFCs the SNC data was not used for year 2000 to 2006 as they were still to be improved by the national ozone unit of the MSSNSESDD





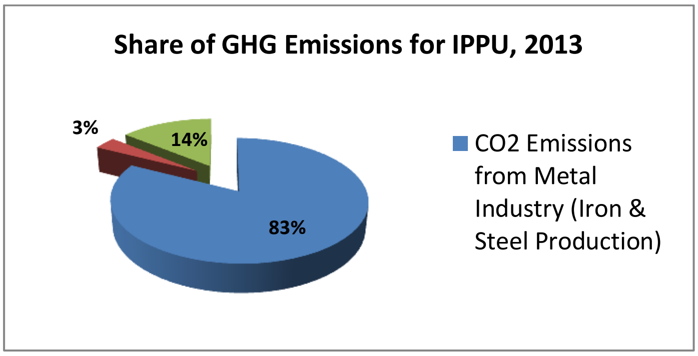
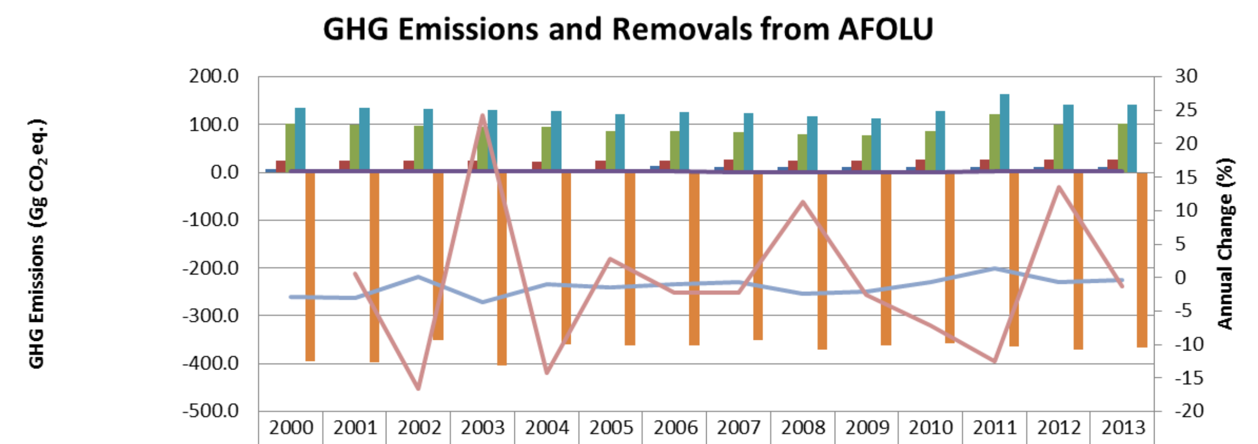


Figure 17: Share of Emissions for the IPPU Sector (2000, 2006 & 2013)

2.1.3 Agriculture, Forestry and Other Land Use (AFOLU) Sector

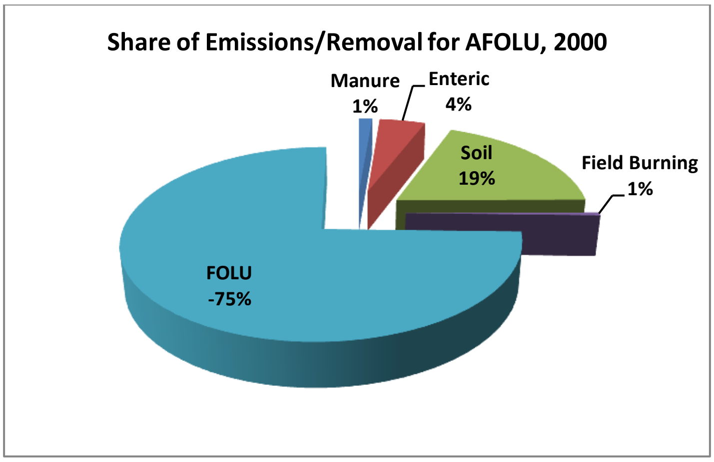
The Forestry and Other Land Use (FOLU) part of the AFOLU sector (***Figures 18, 19 and 20***) is particularly an important carbon sink. The forests and a few other lands sequester carbon with an average of about 370 Gg yearly in total, with a contribution of 32 Gg from Rodrigues. The emissions occur most importantly from the soils (as N_2O) in the Agriculture sector as use of fertilisers are very common, especially in the sugarcane cultivations, from where on average 83 Gg CO_2-eq were emitted yearly. Livestock, with enteric fermentation and manure management contributed in the emissions of CH_4. Rodrigues, which has important livestock populations accounts for almost half of the total emissions.

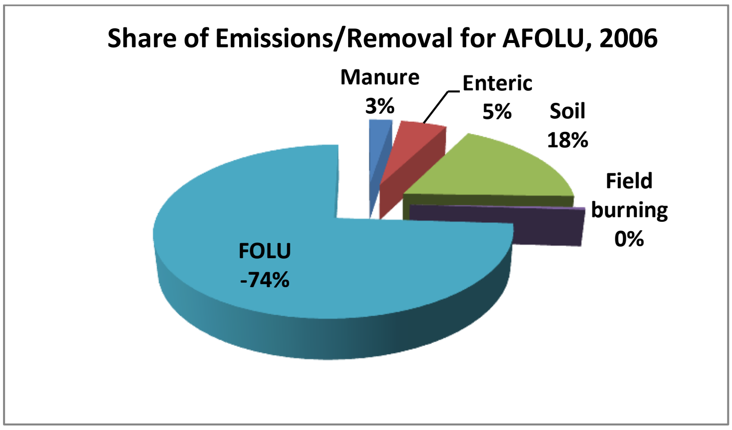


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Manure	7.0	6.8	7.3	7.2	7.2	7.8	12.4	10.9	10.8	11.0	12.3	12.3	12.0	11.6
Enteric	24.0	24.5	24.9	24.7	23.2	24.6	24.9	26.5	24.7	23.6	26.9	27.4	27.6	27.2
Soil	101.0	100.2	97.7	95.8	94.2	86.7	87.1	84.6	80.2	78.2	87.4	121.3	99.8	101.1
Total Agriculture	134.9	134.7	132.9	130.8	127.5	122.1	127.1	123.1	116.7	113.8	127.6	162.8	141.1	141.6
FOLU	-396.1	-397.5	-351.9	-403.0	-360.9	-362.0	-361.4	-352.1	-371.5	-362.2	-358.1	-364.6	-370.1	-367.5
Field burning	2.84	3.16	3.08	3.05	2.83	2.94	2.61	1.04	0.99	1.00	0.97	1.82	1.69	1.66
Total AFOLU	-261.2	-262.8	-219.0	-272.2	-233.5	-239.9	-234.4	-229.0	-254.8	-248.4	-230.6	-201.8	-229.0	-226.0
Annual Change (%)		1	-17	24	-14	3	-2	-2	11	-3	-7	-12	13	-1

Figure 18: Trend of GHG Emissions and Removals for AFOLU Sector

Note: Data for Rodrigues are included for FOLU. Interpolations have been used for 2000 to 2005, as no data were available.





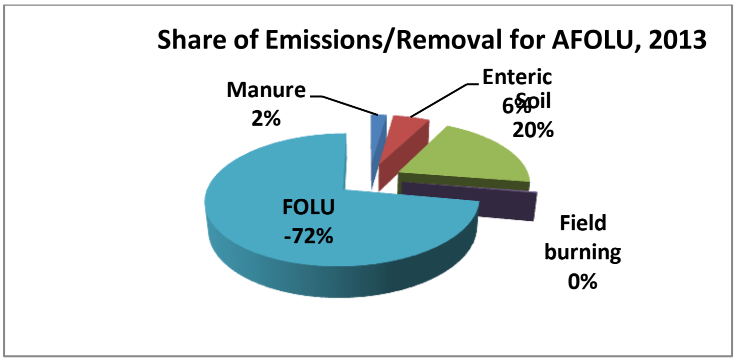


Figure 19: Share of GHG Emissions/Removals for AFOLU Sector (2000, 2006 & 2013)

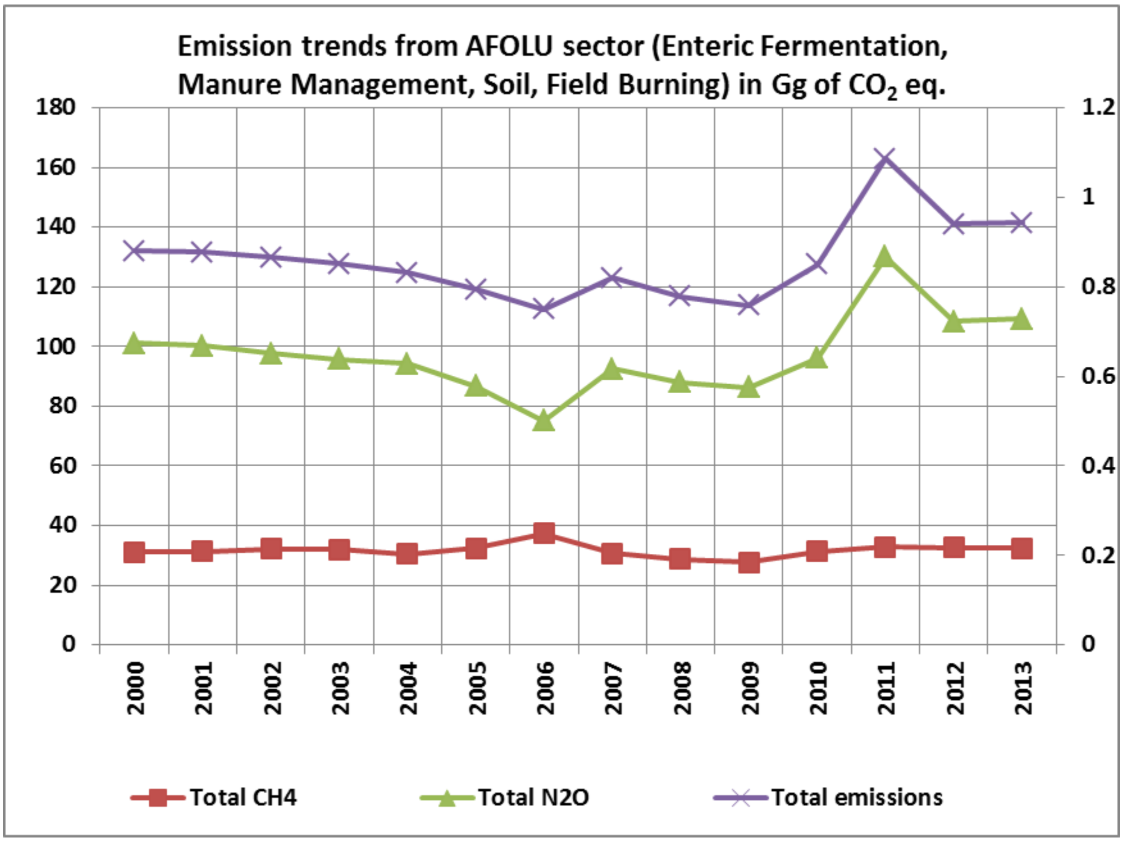


Figure 20: Combined GHG Emissions Trend from AFOLU Sector (Enteric Fermentation, Manure Management, Agricultural Soil and Field Burning)

2.1.3.1 Livestock

The animal population as well as their housing system and waste management determine the amount of emissions. The GHG inventory in the livestock subsector considers only two of the six direct greenhouse gases, namely, methane and nitrous oxide emanating from Enteric Fermentation and Manure Management source categories (***Table 8***).

Table 8: Combined Emissions Trend from AFOLU Sector (Enteric Fermentation, Manure Management, Agriculture Soils and Field Burning) [Gg CO_2-eq]

Year	Emissions from Field Burning	Emissions from Enteric Fermentation & Manure Management	Emissions from Agricultural Soils	Total GHG Emissions
2000	2.84	31.03	101.02	**134.89**
2001	3.16	31.33	100.23	**134.72**
2002	3.08	32.15	97.65	**132.88**
2003	3.05	31.94	95.8	**130.79**
2004	2.83	30.39	94.24	**127.46**
2005	2.94	32.39	86.73	**122.06**

Year	Emissions from Field Burning	Emissions from Enteric Fermentation & Manure Management	Emissions from Agricultural Soils	Total GHG Emissions
2006	2.61	37.34	75.05	**115.00**
2007	1.04	37.41	84.61	**123.06**
2008	0.99	35.48	80.24	**116.71**
2009	1.00	34.63	78.21	**113.84**
2010	0.97	39.22	87.37	**127.56**
2011	1.82	39.69	121.32	**162.83**
2012	1.69	39.55	99.84	**141.08**
2013	1.66	38.81	101.08	**141.55**

The total emissions trend for enteric fermentation varied from 24.93 Gg CO_2-eq in 2006 to 27.23 Gg CO_2-eq in 2013. The maximum emission was 27.55 Gg CO_2-eq in 2012. The total emissions trend for manure management varied from 12.41 Gg CO_2-eq in 2006 to 11.58 Gg CO_2-eq in 2013. The minimum value is 10.75 Gg CO_2-eq, observed in 2008 while the maximum value of 12.41 Gg CO_2-eq was observed in year 2006. ***Table 9*** shows the trend of the GHG Emissions for livestock.

Table 9: Trend of GHG Emissions for Livestock (Gg CO_2-eq)

	2006	2007	2008	2009	2010	2011	2012	2013
	Island of Mauritius							
Manure Management	11.7	10.64	10.14	10.46	11.68	11.62	11.36	10.99
Enteric Fermentation	14.98	16.39	16.74	16.84	17.42	16.73	17.37	17.13
Total	26.68	27.03	26.87	27.31	29.11	28.35	28.73	28.12
	Island of Rodrigues							
Manure Management	0.71	0.27	0.61	0.54	0.61	0.66	0.64	0.59
Enteric Fermentation	9.95	10.11	7.99	6.79	9.51	10.69	10.18	10.09
Total	10.66	10.38	8.60	7.33	10.12	11.35	10.82	10.68
	Republic of Mauritius							
Manure Management	12.41	10.91	10.75	11.00	12.29	12.28	12.00	11.58
Enteric Fermentation	24.93	26.5	24.73	23.63	26.93	27.42	27.55	27.22
Total	**37.34**	**37.41**	**35.48**	**34.63**	**39.22**	**39.69**	**39.55**	**38.81**

2.1.3.2 Lands

The Net CO_2 emissions resulting from: (i) the land remaining the same and (ii) the land converted to other land use was estimated for the period 2006 to 2013. The land use sector represented a net removal of CO_2 for the period 2006 to 2010. Forestland remaining forestland represented a net carbon sink form living biomass during the period 2006-2013. Very little variation in the total CO_2 removal was observed for this land category with the average being -369.39 Gg CO_2-eq.

Under the category forestland, CO_2 removal is limited to the subcategory category forestland remaining forestland (***Table 10 and Figure 21***). Over the period 2000 to 2013, CO_2 removal from forestland remaining forestland tended to fluctuate very slightly. The total variation observed during 14 years was -5%.

These changes were attributed primarily to changes in the growing stock. The evolution of emissions/removals by the forest sector reported for the time period from 2000 through 2013 was influenced by the low rate of deforestation (average rate of 0.02%) and application of the principles of the National Forest Policy (2006). The Policy prescribes the management of Mauritian Forests for environmental and ecological functions rather than for the production of timber. Timber exploitation is gradually being phased out on State Lands and exotic species are gradually being replaced by native species. As a result, the harvested timber and firewood has decreased from 8474 m^3/year and 6058 m^3/year respectively in the inventory year 2006 to 1244 m^3/year and 2012 m^3/year respectively in the inventory year 2013. The forest areas affected by disturbances (fire, pests and diseases) for the period 2006-2013 were negligible.

Table 10: GHG Trend of GHG Removals from Forest Land (Gg CO_2-eq)

Years	Forestry and Other Land Use (FOLU)
2000	-396.13
2001	-397.47
2002	-351.86
2003	-402.95
2004	-360.94
2005	-361.96
2006	-361.42
2007	-354.59
2008	-371.51
2009	-362.23
2010	-358.12
2011	-354.64
2012	-370.13
2013	-367.53
Total change (%)	-5

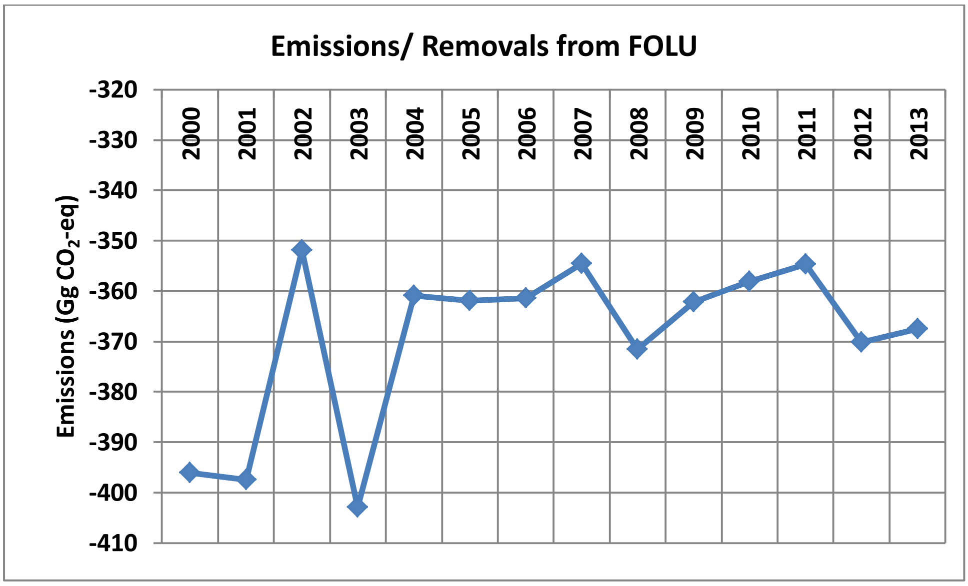


Figure 21: Emissions Trend for Forest Land Remaining Forest Land

2.1.3.3 Trend of Emissions from Sugarcane Burning over period 2006 to 2013

Emissions from sugar cane burning showed a net reduction of 36% from 2.61 Gg CO_2-eq in 2006 to 1.66 Gg CO_2-eq in 2013, mainly attributed to the decrease in area under sugar cane cultivation and thus a lower acreage is devoted to burning prior to harvest (refer to ***Figure 22***). With the willingness to go for green cane harvesting using maximum benefit derived from mechanisation, the emission from sugar cane burning will be further declined in the future years.

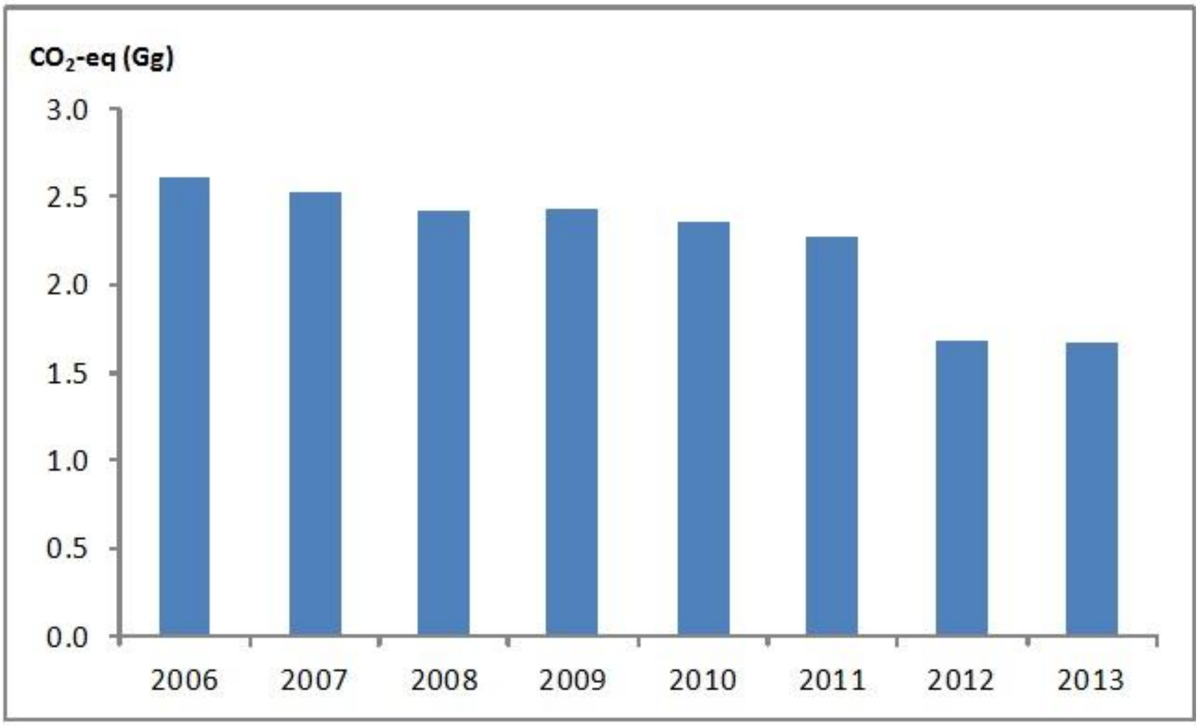


Figure 22: GHG Emissions from Biomass Burning

2.1.3.4 Agriculture Soils

Direct and indirect N_2O emissions on land produced a total of 101.08 Gg CO_2-eq in 2013. Direct N_2O emission from managed soil produces the highest amount of emissions of 80.39 Gg CO_2-eq for this sector (79.5 %). There has been a slight decrease in emission for this sector between 2006 and 2009. (***Figure 23 and Table 11***). Overall, there has not been any significant variation in GHG emissions over the inventory years, attributed mainly to stable acreage of land under cultivation and amount of fertiliser use.

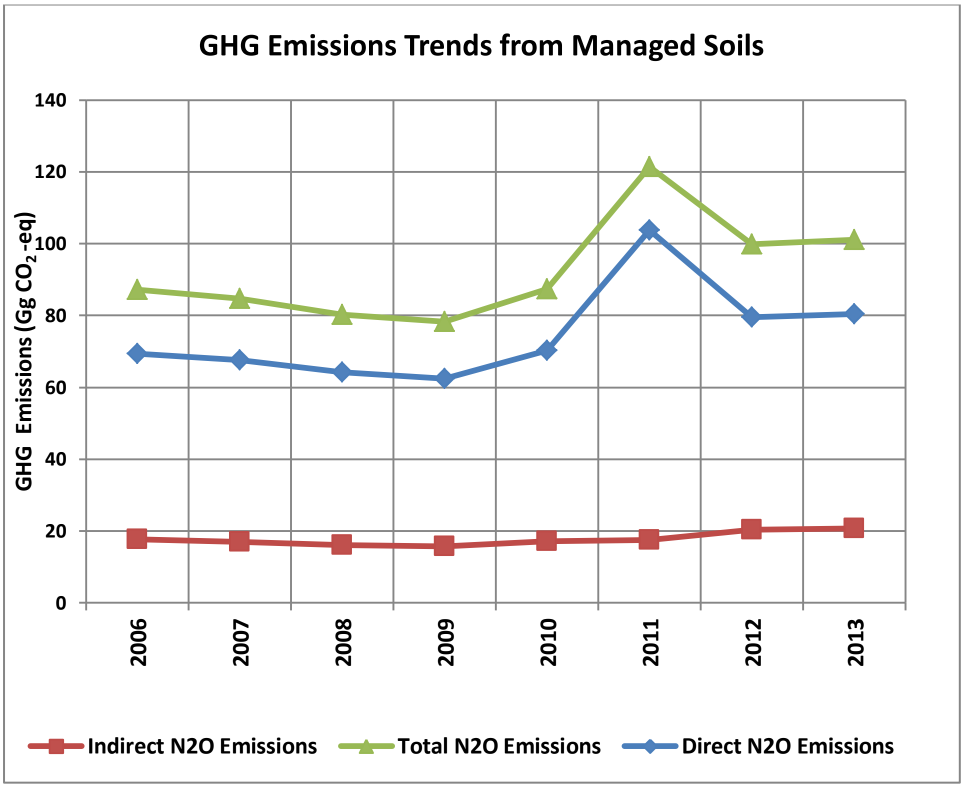


Figure 23: GHG Emissions from Managed Soil (2006 to 2013)

Table 11: Direct and Indirect N_2O Emissions from Managed Soils, 2006 – 2013 (Gg CO_2-eq)

Sources of Emissions	2006	2007	2008	2009	2010	2011	2012	2013
Direct N_2O Emission from Managed Soils	69.44	67.60	64.11	62.44	70.25	103.74	79.53	80.39
Indirect N_2O Emission from Managed Soils	17.67	17.02	16.13	15.77	17.12	17.58	20.31	20.69
Total N_2O Emissions from Managed Soils	87.11	84.62	80.24	78.21	87.37	121.32	99.84	101.08

2.1.4 Waste Sector

The waste sector comprises emissions from both solid waste disposal on land and wastewater treatment and discharge (***Table 12 and Figure 24***). The main GHG is methane. The emissions from solid wastes disposal on the land are the dominant source and continue to increase due to the increased amount of wastes landfilled. The emissions from solid wastes dropped in 2009 due to decreased economic activities, productions and consumptions. Emissions from wastewater treatment and discharge are estimated only from 2006 to 2013 because the activity data of this sub-sector from 2000 to 2005 needs some refinements (***Figure 25***).

Table 12: GHG Emissions from Waste Sector, 2006 – 2013 (Gg CO_2-eq)

Year	Emissions from Solid Waste Disposal (Gg CO_2-eq)	Emissions from Liquid Waste (Gg CO2-eq)	Total GHG Emissions (Gg CO2-eq)
2000	447.3		**447.3**
2001	527.3		**527.3**
2002	583.8		**583.8**
2003	606.4		**606.4**
2004	583.8		**583.8**
2005	707.7		**707.7**
2006	797.5	56.83	**854.3**
2007	899.40	57.16	**956.56**
2008	976.92	57.70	**1034.62**
2009	795.06	61.69	**857.02**
2010	922.85	57.71	**980.56**
2011	961.81	61.03	**1022.84**
2012	943.31	61.35	**1004.66**
2013	925.60	60.99	**986.59**

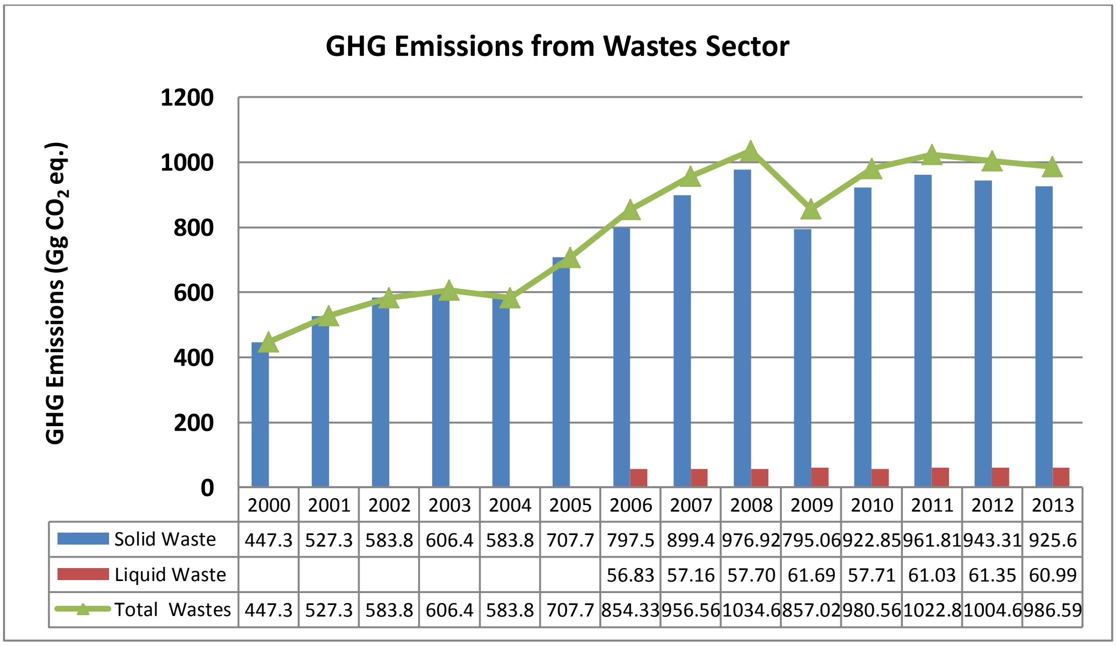
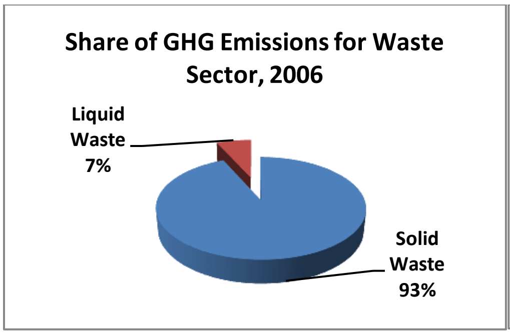


Figure 24: GHG Emissions Trend for Waste Sector[11]

[11] For the liquid wastes, the data for years 2000 to 2005 needs some refinements and not included here.



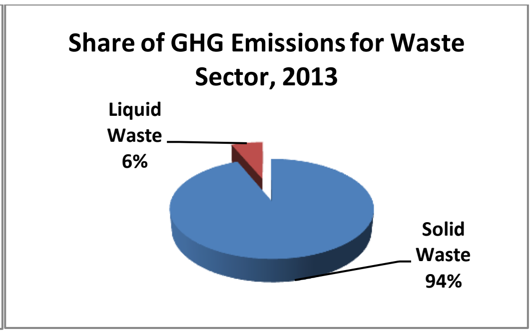


Figure 25: Share of GHG emissions from Waste Sector

2.1.4.1 Solid Waste Disposal

From the year 2000 to 2006, the emissions grew at an average rate of 10.4% per year, while the amount of waste landfilled grew at 7.6% per year. From 2009, RoM installed a power plant at Mare Chicose to capture methane and generate electricity. From that year to 2013, the amount of CH_4 emitted from waste reduced at the rate of 0.58% per year. The quantity of waste landfilled continued to grow at the rate of 1.7% per year and the quantity of methane captured grew at the rate of 9.0% per year. Therefore, there is a direct relationship between solid waste quantity, CH_4 emissions and amount of gas being captured (Refer to ***Table 13*** and ***Figure 26***).

Table 13: Emissions for Solid Waste compared with solid waste disposal and amount of CH_4 captured

Year	Methane Generated (Gg CO_2-eq)	Percentage Annual Change for Methane Generated (%)	Solid Waste Disposed (Thousand tonnes)	Percentage Annual Change for Solid Waste Disposed (%)	Amount of gas captured (Thousand tonnes)	Percentage Annual Change for Gas Captured (%)
2000	447.3		265.8			
2001	527.3	17.89	306.7	15.39		
2002	583.8	10.71	363.9	18.65		
2003	606.4	3.87	372.4	2.34		
2004	583.8	-3.73	365.4	-1.88		
2005	707.7	21.22	382.3	4.63		
2006	797.5	12.69	407	6.46		
2007	899.4	12.78	394.1	-3.17		
2008	976.9	8.62	399.5	1.37		
2009	795	-18.62	415.9	4.11	11.9	
2010	922.8	16.08	427.8	2.86	9	-24.37
2011	960.7	4.11	414.5	-3.11	10.2	13.33
2012	929.5	-3.25	387.9	-6.42	13.8	35.29
2013	918.3	-1.20	429.9	10.83	15.4	11.59

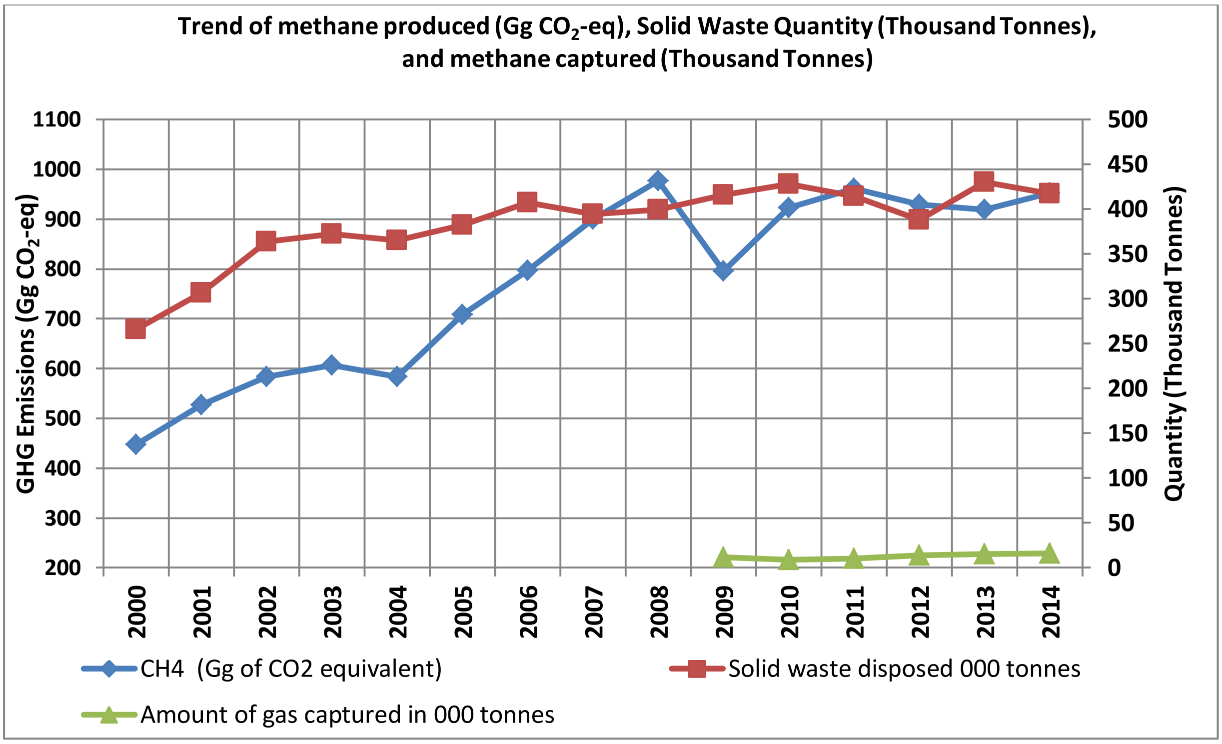


Figure 26: Trend of Solid Waste Quantity, methane produced and methane captured

2.1.4.2 Wastewater Treatment and Discharge

The total emissions trend for wastewater varies from 56.83 Gg CO_2-eq to 60.99 Gg CO_2-eq for period 2006 to 2013. The maximum emissions are observed in 2009**.** The emissions for CH_4 varied from 34.97 Gg CO_2-eq to 37.54 Gg CO_2-eq, while the remaining emissions of N_2O varied from 21.86 Gg CO_2-eq to 23.45 Gg CO_2-eq for period 2006 to 2013. Emissions from wastewater treatment and discharge are estimated only from 2006 to 2013 because the activity data of this sub-sector from 2000 to 2005 needs some refinements (Refer to ***Table 14*** and ***Figure 27***).

Table 14: Total GHG Emissions Trend for Wastewater Treatment and Discharge

Year	CH_4 Emissions (Gg CO_2-eq)	N_2O Emissions (Gg CO_2-eq)	Total GHG Emissions (Gg CO_2-eq)
2006	34.97	21.86	56.83
2007	35.21	21.96	57.16
2008	36.35	21.35	57.70
2009	39.36	22.60	61.69
2010	35.06	22.65	57.71
2011	38.13	22.90	61.03
2012	38.18	23.17	61.35
2013	37.54	23.45	60.99

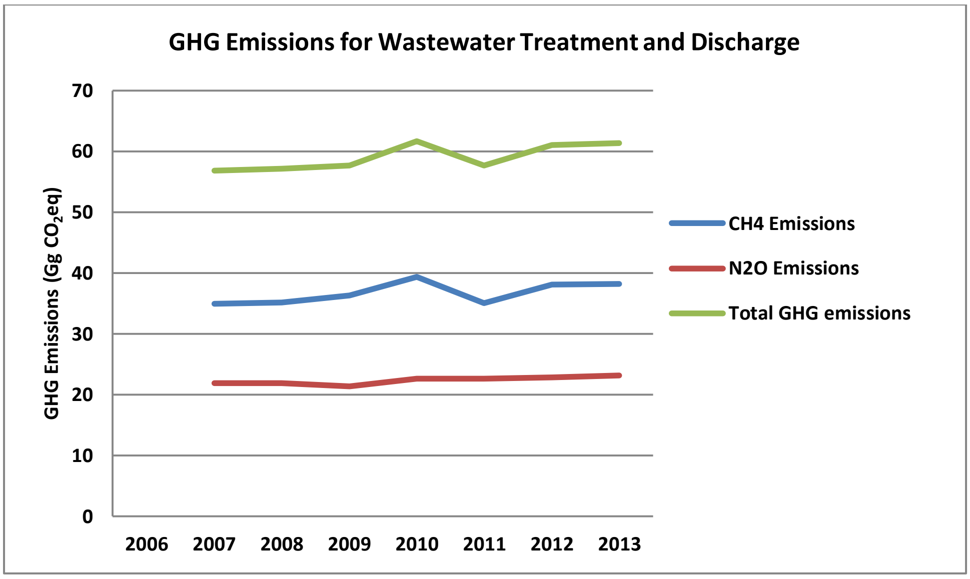
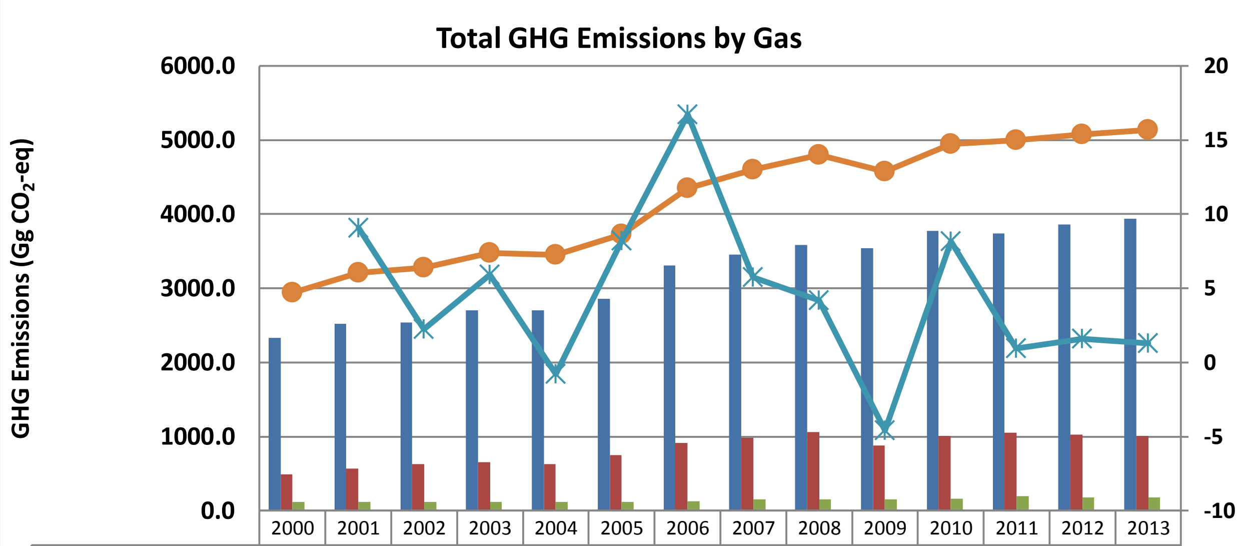


Figure 27: Trend of GHG Emissions from Wastewater Treatment and Discharge, 2006 – 2013

2.2 Summary of GHG Emissions Trends per Gas

From 2000 to 2013, the dominant GHG was CO_2, contributing 79% of total emissions in 2000 and 77% in 2013 (***Figures 28 and 29***). The second most important GHG was CH_4. Due to increasing quantity of solid waste that follows the increasing GDP and improvement of lifestyle, CH_4 increased its share from 17% in 2000 to 20% in 2013. The share of N_2O varied only from 4 to 3 % over the time period due to the ceasing of nitric acid production, which was used to produce fertilisers. The contribution of HFCs is still (in 2013) relatively minor. However, emissions have increased from 2.84 Gg CO_2-eq in 2007 to 6.17 Gg CO_2-eq in 2013. This big increase was due to the Consumer Protection Regulations, which have been amended to ban the import of appliances containing HCFCs as from 1st January 2013. The replacement of HCFCs with HFC-143a in 2013 resulted in rise of importation of HFC-143a and consequently related estimated emissions increase in the same year.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CO2	2330.8	2518.0	2535.6	2702.5	2700.7	2861.5	3309.5	3458.1	3580.6	3540.2	3773.1	3741.4	3860.2	3941.2
CH4	491.0	571.7	628.1	650.6	626.3	752.3	911.0	983.2	1058.7	878.9	1006.7	1050.0	1025.0	1012.8
N2O	120	119	116	121	119	115	131	157.4	150.8	150.0	162.0	195.8	181.4	176.6
HFCs							0.9	2.8	3.8	4.6	4.6	5.7	6.0	6.2
TOTAL GHG	2941.5	3208.5	3279.9	3473.7	3446.0	3728.4	4352.2	4601.5	4793.8	4573.6	4946.4	4992.8	5072.5	5136.7
Annual change(%)		9	2	6	-1	8	17	6	4	-5	8	1	2	1

Figure 28: Total GHG Emissions by Gas

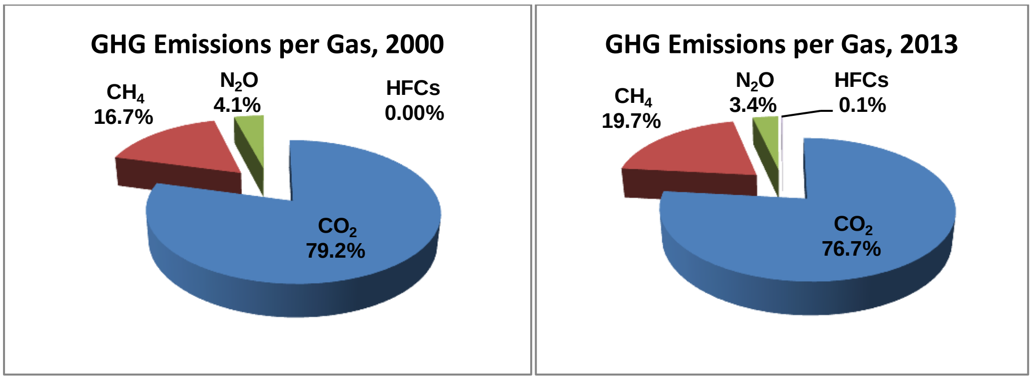


Figure 29: Share of GHG Emissions by Gas

2.2.1 Carbon Dioxide

From 2000 to 2013, the emissions trend for CO_2 (***Figure 28***) is similar to the trend of aggregated emission (***Figure 4***). This is explained by the share of CO_2, which is over 75% from 2000 to 2013. From 2000 to 2013, an average increase of CO_2 emissions by 4.2% per year was noted. This was due to the energy consumption pattern and GDP trends, which followed a similar trend. In fact, the GDP trends for RoM fluctuated from a growth of +5.6% in 2007 down to +4.5% in 2010 and +3.4% in 2013[12].

2.2.2 Methane

As indicated in section 2.1.4 above, CH_4 emissions increased significantly from 2004 to 2008 due to the increased amount of wastes landfilled. CH_4 dropped in 2009 due to decreased waste quantity following the economic downfall in 2009.

2.2.3 Nitrous Oxide

From 2006 to 2009, the emissions of N_2O dropped due to the ceasing of nitric acid production, which was used to produce fertilisers. The trend from 2010 to 2012 again increased due to rise in use of chemical fertilisers in agriculture in the same period.

2.2.4 Hydrofluorocarbons (HFCs)

The HFCs showed an increasing trend, especially in the recent years due to the demand for alternatives of Ozone Depleting Substances (ODS) substitute. The SNC data was not used for year 2000 to 2006, as they need to be improved by the National Ozone Unit of the ESDD. HFCs showed rising emissions due to increased use of the gases in air conditioning and refrigeration.

2.3 Key Category Analysis

A Key Category Analysis (KCA)[13] (refer to ***Table 15***) was carried out to determine the categories, fuels and GHGs that are important (cumulatively make up more than 95% of the absolute emissions or have significant upward or downward trends) in the inventory and that needs more focus for accurate calculations.

[12] Statistics Mauritius: National accounts historical series (http://statsmauritius.govmu.org/English/StatsbySubj/Pages/National-Accounts.aspx)

[13] A *key category* is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or he uncertainty in emissions and removals. Whenever the term *key category* is used, it includes both source and sink categories (IPCC 2006 – V1 sect 4.1.1)

The trend assessment for the period 2006-2013 resulted in the following gases and sectors as key sources/sinks of GHGs:

- CO_2 emissions from Energy Industries - Solid Fuels
- CO_2 emissions from Manufacturing Industries and Construction - Liquid Fuels
- CO_2 emissions from Energy Industries - Liquid Fuels
- CO_2 removals from Forest land Remaining Forest land
- CO_2 emissions from Other Sectors - Liquid Fuels
- CH_4 emissions from Solid Waste Disposal
- CO_2 emissions from Road Transportation
- CO_2 emissions from Iron and Steel Production
- CO_2 emissions from Water-borne Navigation - Liquid Fuels
- CH_4 emissions from Biological Treatment of Solid Waste

Table 15: Key Category Analysis from 2006 IPCC Software

A	B	C	D	E	F	G	H
IPCC Category code	**IPCC Category**	**Greenhouse Gas**	**2006 Year Estimate Ex0 (Gg CO_2-eq)**	**2013 Year Estimate Ext (Gg CO2-eq)**	**Trend Assessment (Txt)**	**% Contribution to Trend**	**Cumulative Total of Column G**
1.A.1	Energy Industries - Solid Fuels	CO_2	1095.13	1674.23	0.079	0.406	0.406
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	360.23	267.54	0.035	0.179	0.585
1.A.1	Energy Industries - Liquid Fuels	CO_2	680.41	678.59	0.028	0.146	0.731
3.B.1.a	Forest land Remaining Forest land	CO_2	-317.01	-332.00	0.016	0.084	0.815
1.A.4	Other Sectors - Liquid Fuels	CO_2	223.20	226.53	0.008	0.044	0.859
4.A	Solid Waste Disposal	CH_4	797.51	918.33	0.007	0.036	0.895
1.A.3.b	Road Transportation	CO_2	808.86	941.88	0.005	0.025	0.920
2.C.1	Iron and Steel Production	CO_2	40.50	36.05	0.003	0.014	0.933
1.A.3.d	Water-borne Navigation - Liquid Fuels	CO_2	38.11	37.62	0.002	0.009	0.942
4.B	Biological Treatment of Solid Waste	CH_4	0.00	7.28	0.002	0.008	0.950

CHAPTER 3 ENERGY SECTOR

3.1 Overview

The energy sector in RoM is dominated by fuel combustion activities. RoM has no natural resources and therefore depends heavily on imported petroleum products to meet most of its energy requirements, including electricity generation and road transportation (which is the only mode of land transport in RoM). Local and renewable energy sources are biomass, hydro, solar and wind energy[14]. Biomass energy consists mainly of bagasse, a by-product of the sugar industry, and contributes to about 22% of the primary energy supply. Fuel wood and charcoal are minimally used. Hydropower plants, with a combined installed capacity of 59 MW, are virtually the entire hydro potential.

The high dependence on the supply of fossil fuels has been a major concern for the Republic of Mauritius due to the uncertainty in the price and supply of fossil fuels in the world market. In this regard, the Government of RoM had come up with an Outline Energy Policy in 2007 to pave the road map for meeting the future energy demands of the country. The Outline Energy Policy focused on achieving sustainability in the energy sector and focused on the main drivers of the energy sector like Electricity Generation and Transport. Much focus was laid on capturing the potential of renewable energy sources.

The Long Term Energy Strategy and Action Plan[15] was prepared as a blue print for the development of the energy sector covering the years 2009 to 2025. It lays emphasis on the development of renewable energy, the reduction of RoM dependence on imported fossil fuel and the promotion of energy efficiency, in line, with the Government's objective to promote sustainable development.

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[14] From 2006 to 2013, the installed capacity increased from 710.7 MW to 778.2 MW. Therefore, the total electricity generated increased from 2,350.23 GWh to 2,885.29 GWh and the total consumption increased from 2,108.15 GWh to 2,658.3 GWh. In 2013, the total electricity generated was 2,885.3 GWh on which, Primary energy (Hydro, Landfill, Photovoltaic) was 121.2 GWh while the secondary energy (Gas turbine/kerosene, diesel &Fuel oil, bagasse and Coal) was 2,764.1 GWh. This represented 4.2% and 95.8% respectively for primary and secondary energy (Source: Statistic Mauritius, Digest of Energy and Water, 2015)

[15] http://publicutilities.govmu.org/English/publications/Pages/default.aspx

3.1.1 General Methodology

The methodologies used in the energy sector are highlighted in ***Table 16***.

Table 16: Summary of Methodologies used for the Energy Sector in RoM

Energy	CO_2			CH_4		N_2O	
	Method	NCV[16]	EF	Method	EF	Method	EF
1.A - Fuel Combustion Activities							
1.A.1 - Energy Industries	T1	CS	D	T1	D	T1	D
1.A.2 - Manufacturing Industries and Construction	T1	CS	D	T1	D	T1	D
1.A.3 - Transport	T1	CS	D	T1	D	T1	D
1.A.4 - Other Sectors	T1	CS	D	T1	D	T1	D
1.B- Fugitive Emissions from Fuels[17]	NE	NE	NE	NE	NE	NE	NE

T1: Tier 1; D: Default Values; CS: Country Specific (for some fuels), NE: Not Estimated

3.1.2 Total Primary Energy Requirements

In 2013, total primary energy requirements were 1,454.8 ktoe. Around 85% (1,235.4 ktoe) of the total primary energy requirement was met from imported fossil fuels (petroleum products, 55% and coal, 30%). The share of the different fossil fuels within the total primary energy requirement in 2013 was as follows: coal (30.3%), fuel oil (17.1%), diesel oil (14.2%), gasoline (9.8%), kerosene (8.4%) and Liquefied Petroleum Gas (LPG): 5.1%. Others such as hydro (0.6%), wind (<1%) and photovoltaic (<1%) were contributing to a much lesser extent (***Table 17 and Figure 30***).

Table 17: Primary Energy Requirements, 2006 - 2013

	2006	2007	2008	2009	2010	2011	2012	2013
Energy Sources	**Energy Unit (ktoe)**							
Imported (Fossil fuels)	**1,122.1**	**1,136.0**	**1,140.9**	**1,110.6**	**1,189.0**	**1,195.7**	**1,205.3**	**1,235.4**
Coal	300.4	355.0	403.9	369.3	414.1	397.7	418.4	440.6
Petroleum products	**821.8**	**781.0**	**737.0**	**741.2**	**775.0**	**798.0**	**786.9**	**794.7**
Gasoline	96.2	106.9	109.5	120.6	127.7	130.0	136.6	142.7
Diesel Oil	230.6	207.4	205.4	206.7	213.6	210.1	213.4	207.0
Dual Purpose Kerosene	152.7	146.0	140.9	117.2	131.3	138.7	118.8	121.6
Kerosene	*6.0*	*2.4*	*4.0*	*6.7*	*8.0*	*4.3*	*3.8*	*0.9*
Aviation Fuel	*146.7*	*143.6*	*136.9*	*110.5*	*123.3*	*134.3*	*115.0*	*120.7*
Fuel Oil	273.3	251.9	213.3	227.9	232.2	248.1	245.4	248.5

[16] NCV is assumed same as the same imported fuels are used across sectors. Data were provided by Central Electricity Board and Independent Power Producers (IPPs)
[17] Further assessment required for future inventories

	2006	2007	2008	2009	2010	2011	2012	2013
LPG	69.0	68.9	67.9	68.9	70.2	71.1	72.7	74.9
Local (Renewables)	**254.6**	**245.8**	**263.5**	**236.3**	**241.6**	**231.1**	**222.3**	**219.4**
Hydro	6.6	7.2	9.3	10.5	8.7	4.9	6.4	8.2
Wind	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3
Landfill Gas	-	-	-	-	-	0.3	1.5	1.7
Photovoltaic	-	-	-	-	-	-	0.1	0.2
Bagasse	240.0	230.5	246.4	218.0	225.0	218.1	206.5	201.7
Fuelwood	8.0	8.0	7.7	7.7	7.7	7.6	7.5	7.3
Total Energy unit (ktoe)	**1,376.8**	**1,381.8**	**1,404.4**	**1,346.9**	**1,430.7**	**1,426.8**	**1,427.6**	**1,454.8**
Energy Sources	**Percentage (%)**							
Imported (Fossil fuels)	**81.5**	**82.2**	**81.2**	**82.5**	**83.1**	**83.8**	**84.4**	**84.9**
Coal	21.8	25.7	28.8	27.4	28.9	27.9	29.3	30.3
Petroleum products	**59.7**	**56.5**	**52.5**	**55.0**	**54.2**	**55.9**	**55.1**	**54.6**
Gasoline	7.0	7.7	7.8	9.0	8.9	9.1	9.6	9.8
Diesel Oil	16.7	15.0	14.6	15.3	14.9	14.7	14.9	14.2
Dual Purpose Kerosene	11.1	10.6	10.0	8.7	9.2	9.7	8.3	8.4
Kerosene	*0.4*	*0.2*	*0.3*	*0.5*	*0.6*	*0.3*	*0.3*	*0.1*
Aviation Fuel	*10.7*	*10.4*	*9.7*	*8.2*	*8.6*	*9.4*	*8.1*	*8.3*
Fuel Oil	19.8	18.2	15.2	16.9	16.2	17.4	17.2	17.1
LPG	5.0	5.0	4.8	5.1	4.9	5.0	5.1	5.1
Local (Renewables)	**18.5**	**17.8**	**18.8**	**17.5**	**16.9**	**16.2**	**15.6**	**15.1**
Hydro	0.5	0.5	0.7	0.8	0.6	0.3	0.4	0.6
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Landfill Gas	-	-	-	-	-	0.0	0.1	0.1
Photovoltaic	-	-	-	-	-	-	0.0	0.0
Bagasse	17.4	16.7	17.5	16.2	15.7	15.3	14.5	13.9
Fuelwood	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.5
Total Percentage	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Digest of Energy and Water Statistics, Statistics Mauritius, 2015

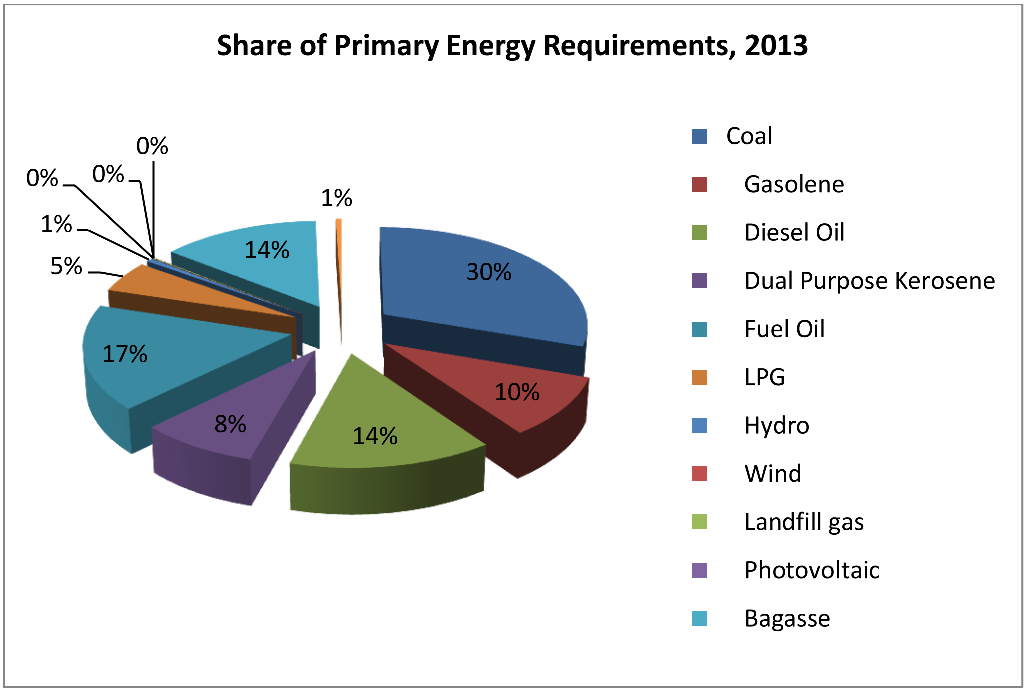


Figure 30: Share of Primary Energy Requirements, 2013

3.1.3 Final Energy Consumption by Sector and Type of Fuel

Final energy consumption is the total amount of energy required by end users as a final product. End-users are mainly categorised into five sectors namely: manufacturing, transport, commercial and distributive trade, households and agriculture. Final energy consumption increased by 2.0% from 854 ktoe in 2012 to 871 ktoe in 2013 as per ***Table 18***.

The two main energy-consuming sectors were "Transport" and "Manufacturing", accounting respectively for 50.4% and 24.4% of the energy consumed. They were followed by the household sector (14.2%), commercial and distributive trade (10.1%) and agriculture (0.5%).

Table 18: Final Energy Consumption by Sector and Type of Fuel, 2006 – 2013 (ktoe)

Sector	2006	2007	2008	2009	2010	2011	2012	2013
Manufacturing	**266.6**	**259.4**	**243.5**	**220.4**	**231.2**	**222.4**	**215.5**	**212.3**
Fuel oil	51.6	53.5	48.3	41.4	39.8	38.7	37.4	37.6
Diesel oil	50.3	48.8	46.8	46.3	47.0	43.5	41.7	35.8
LPG	4.3	4.4	5.3	5.4	5.5	5.7	5.9	5.8
Coal	13.4	12.4	25.8	13.4	15.4	15.0	15.9	17.1
Fuelwood	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Electricity	72.3	75.6	78.5	77.1	80.3	79.9	79.9	82.8
Bagasse	74.2	64.1	38.3	36.3	42.6	39.1	34.1	32.7
Transport	**430.0**	**415.6**	**410.6**	**394.9**	**421.6**	**435.3**	**427.3**	**438.8**
Land	***275.5***	***263.6***	***265.7***	***276.7***	***290.6***	***293.1***	***304.2***	***310.1***
Gasoline	93.8	104.2	106.8	117.6	124.5	126.8	133.2	139.2
Diesel oil	174.2	152.2	153.4	154.2	161.1	161.5	166.3	166.5
LPG	7.4	7.2	5.6	5.0	5.0	4.9	4.7	4.4
Air: Jet Fuel	**146.7**	**143.6**	**136.9**	**110.5**	**123.3**	**134.3**	**115.0**	**120.7**

Sector	2006	2007	2008	2009	2010	2011	2012	2013
Sea	**7.8**	**8.4**	**8.0**	**7.7**	**7.7**	**7.8**	**8.0**	**8.0**
Fuel Oil	4.2	4.7	4.2	3.6	3.4	3.4	3.5	3.4
gasoline	2.4	2.7	2.7	3.0	3.2	3.3	3.4	3.4
Diesel oil	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.2
Commercial and Distributive Trade	**62.7**	**65.2**	**69.1**	**72.3**	**76.4**	**80.7**	**83.7**	**88.1**
LPG	12.4	11.8	10.9	11.4	11.8	12.2	12.9	14.3
Charcoal	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
Electricity	50.0	53.1	57.8	60.5	64.3	68.1	70.4	73.4
Household	**108.9**	**108.8**	**110.1**	**113.1**	**116.9**	**117.4**	**120.1**	**123.4**
Kerosene	4.1	1.3	1.8	1.5	1.8	0.5	0.3	0.2
LPG	44.9	45.5	45.8	46.7	47.6	48.2	49.0	50.1
Fuelwood	6.6	6.6	6.4	6.3	6.3	6.2	6.1	5.9
Charcoal	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Electricity	53.1	55.3	56.1	58.5	61.1	62.4	64.7	67.1
Agriculture	**4.8**	**4.9**	**4.5**	**4.1**	**4.4**	**4.3**	**4.5**	**4.5**
Diesel oil	2.3	2.5	2.3	2.3	2.3	2.4	2.4	2.3
Electricity	2.5	2.4	2.2	1.8	2.0	1.9	2.1	2.2
Other (n.e.s) and Losses	**3.4**	**3.6**	**3.8**	**3.8**	**3.5**	**3.0**	**3.4**	**3.5**
TOTAL	**876.3**	**857.5**	**841.6**	**808.6**	**854.0**	**863.0**	**854.4**	**870.6**

Source: Digest of Energy and Water Statistics, Statistics Mauritius, 2015

3.2 Energy Industries (Category 1A1)

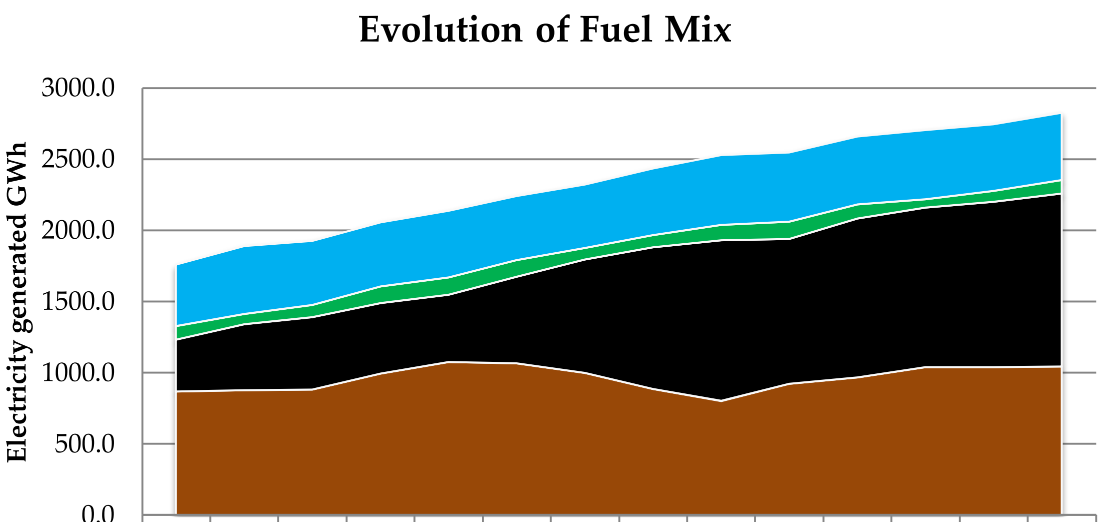
Energy Industries in RoM comprises principally of sub-category 1.A.1.a – Main Activity Electricity and Heat Production. Within this category, Electricity Generation (1.A.1.a.i) is solely considered. The other sub-categories are not occurring.

3.2.1 Source Category Description

Electricity generation in RoM has a long history, where in the past, hydropower was the only form of electricity generation. In the early 1960, the sugar industry provided the opportunity to use bagasse as a source of renewable energy. With time, the increasing demand for electricity has led to the use of fossil fuels, namely coal, and Heavy Fuel Oil (HFO) in engine driven power plants. The Central Electricity Board (CEB) power stations run mainly on Heavy Fuel Oil (HFO), while the Independent Power Producers (IPPs) run mainly on coal as fossil fuel, which complements the primary renewable fuel, bagasse, which is available only during part of the year. Some kerosene is also used for running gas turbines for peaking purposes. Gas/diesel oil is used for start-up in HFO driven power plants. There are 10 hydro power plants scattered around the island and this contributes to about 4% of the total electricity demand. The total effective generation capacity increased from 571.8 MW in the year 2000 to 687.3 MW in the year 2013 as per ***Table 19*** and ***Figure 31***. The consumption of fossil fuels for electricity generation has been steadily increasing over the years. A summary of the trends for this category is included in Chapter 2.

Table 19: Effective Plant Capacity, Peak Demand and Electricity Generation, 2000 to 2013

Year	Electricity Effective Generation Capacity (MW)	Peak Demand (MW)	Amount of Electricity Generated (GWh)
2000	571.8	283.9	1777.51
2001	573.8	297.4	1910.82
2002	569.7	308.6	1948.86
2003	568.3	323.8	2081.52
2004	549.9	332.6	2165.22
2005	577.9	353.1	2272.15
2006	609.4	367.3	2350.23
2007	660.3	367.6	2464.65
2008	617.7	378.1	2557.24
2009	647.3	388.6	2577.44
2010	655.2	404.1	2688.71
2011	659.2	412.5	2738.59
2012	682.6	430.1	2797.14
2013	687.3	441.1	2885.29



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Bagasse	430.5	477.6	452.1	448.9	469.6	452.9	445.7	467.9	486.4	485.0	474.1	486.5	470.5	472.8
Hydro	95.7	70.8	85.9	117.8	122.3	114.9	76.6	83.9	108.0	122.4	100.7	56.5	74.1	94.8
Coal	363.3	465.3	505.5	497.6	470.3	609.7	798.3	993.6	1128.7	1015.3	1115.9	1119.4	1162.3	1213.6
Fuel oil	868.5	876.5	882.8	992.9	1075.8	1064.6	998.7	888.4	802.9	923.0	966.0	1040.0	1038.0	1045.8

Figure 31: Evolution of Fuel Mix over the years 2000 to 2013

3.2.2 Methodological Issues

The methodologies used for the Energy sector are summarised in ***Table 16***. Following are additional detailed methodologies.

This category was assessed as a key category. The adopted approach was Tier 1 but with country specific Net Calorific Values (NCVs). There are a number of fuel types used to produce electricity in RoM. Around 80% of these fuels are of fossil origin. The remaining is a renewable resource, of which bagasse is the main one and others include hydro, wind and solar which constitute minute amounts in the energy mix. As required by the 2006 IPCC Guidelines, only the non-CO_2 emissions from the bagasse (biomass) were accounted for in the national totals while the CO_2 emissions were taken as a memo item.

For each fuel used, its country specific NCV were used. After entry of each of the activity data (AD), NCV and EF, the emissions were calculated in the 2006 IPCC Inventory Software. The results for each fuel were then aggregated to obtain the emissions.

a. <u>Calculations</u>

The equation 2.1 from Chapter 2, Volume 2 of the 2006 IPCC Guidelines was used:

EQUATION 2.1
GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

$$\textbf{Emissions}_{GHG,\ fuel} = \textbf{Fuel Consumption}_{fuel} \times \textbf{Emission Factor}_{GHC,\ fuel}$$

Where:

- Emissions $_{GHG,\ fuel}$= emissions of a given GHG by type of fuel (Gg GHG)
- Fuel Consumption $_{fuel}$ = amount of fuel combusted (TJ)
- Emission Factor $_{GHG,\ fuel}$ = emission factor of a given GHG by type of fuel (kg gas/TJ).

To calculate the total emissions by gas from the source category, the emissions as calculated in Equation 2.1 are summed over all fuels.

b. <u>Activity Data</u>

The activity data (AD) comprised of the fuels used for electricity generation, which is presented in the table below. These were obtained for each power plant, be it owned by the CEB or the IPPs. Use of coal by the IPPs, were seen to rise substantially from year 2000 to 2013. The type of coal used was sub-bituminous coal. The use of kerosene has declined over the years. This is due to the fact that the marginal cost of electricity production from kerosene is much higher compared to other fossil fuels. Kerosene is now used only for peaking purposes and as a last option in generation use. Diesel Oil is used only for start-up of the engines in the HFO power plants. ***Table 20*** below shows the fuel consumption for electricity generation.

Table 20: Fuel consumed for Electricity Generation, 2006 -2013 (Gg)

Fuels	2006	2007	2008	2009	2010	2011	2012	2013
Other Kerosene	1.8	1.1	2.1	4.9	6.0	3.7	3.4	0.6
Gas/Diesel Oil	2.5	2.7	1.9	2.8	2.0	1.5	1.9	1.3
Residual Fuel Oil	226.5	201.8	167.5	190.6	196.9	214.5	213.0	216.2
Sub-Bituminous Coal	462.8	552.6	609.7	574.1	643.0	617.3	649.2	683.2
Bagasse (primary solid biomass)	1036.6	1040.3	1300.9	1135.6	1140.4	1119.0	1077.8	1056.1

The activity data was provided in terms of Gg and then this was converted to TJ using Net Calorific values (NCVs).

c. Emission Factors

The NCVs were derived from National Energy Statistics (Statistics Mauritius, 2013). All fuel consignments come with the certificate of analysis that includes the Calorific Values. The latter is cross verified at the local laboratory facilities.

The EFs for each fuel were adopted from the 2006 IPCC Guidelines, as shown in ***Table 21*** below.

Table 21: Energy Conversion and Emission Factors for Electricity Generation

Fuel	Conversion Factor /NCV (TJ/Gg)	CO_2 Emission Factor (kg CO_2/TJ)	CH_4 Emission Factor (kg CH_4/TJ)	N_2O Emission Factor (kg N_2O/TJ)
Other Kerosene	43.54 (CS)	71900	3	0.6
Gas/Diesel Oil	43.3 (CS)	74100	3	0.6
Residual Fuel Oil	40.19 (CS)	77400	3	0.6
Sub-Bituminous Coal	25.5 (CS)	96100	1	1.5
Bagasse	11.6 (CS)	100000	30	4

(Source: EEMO[18]: original source: SM[19]; CO_2, CH_4, N_2O EF: 2006 IPCC GL) CS- Country specific

[18] http://eemo.govmu.org/English/report/Documents/EOReport_2013.PDF
[19] IEA Energy unit convertor was used to convert toe values to TJ: https://www.iea.org/statistics/resources/unitconverter/

3.2.3 Results

Aggregated emissions from the Energy Industries (public electricity and heat production) increased from 1024.03 Gg CO_2-eq in the year 2000 to 2386.04 Gg CO_2-eq in 2013, which represented an increase of 133%. The share for electricity production increased from 44.2% to 60.2% in the Energy Sector during the same period (***Table 22***).

Table 22: GHG Emissions (Gg CO_2-eq) from Energy Industries

Year	Total for Energy Sector	Energy Industries	Share for Energy Industries (%)
2000	2315.18	1024.03	44.2
2001	2504.45	1167.93	46.6
2002	2521.42	1164.22	46.2
2003	2692.43	1290.67	47.9
2004	2692.66	1293.72	48.0
2005	2855.23	1429.94	50.1
2006	3327.83	1806.02	54.3
2007	3477.1	1979.17	56.9
2008	3595.3	2059.8	57.3
2009	3553.5	2055.7	57.9
2010	3789.0	2246.0	59.3
2011	3752.7	2207.1	58.8
2012	3875.8	2302.9	59.4
2013	3964.9	2386.0	60.2

3.2.4 Quality Control

Most of the activity data for fuel consumption have been obtained from the respective power plants. The data are sent on a monthly basis to the Statistics Mauritius. The latter then present these data annually in the Digest of Energy and Water Statistics. The values from this document have been used for calculation of the GHG emissions.

In order to ensure the right data has been used, the values obtained from Statistics Mauritius were cross verified with the official log data at the CEB. The latter keeps a registry of fuel consumption and electricity generation on a monthly basis from all the power stations, including the Independent Power Producers (IPP).The Calorific Value for fuels used in electricity generation are obtained from the Test Certificates available from the State Trading Corporation.

The QC was conducted by the Energy Industries Sub-TWG. The Energy Industries Sub-TWG was chaired by the representative from the Central Electricity Board. The other members of Energy Industries Sub-TWG are from:

- Statistics Mauritius
- Ministry of Energy and Public Utilities
- Omnicane Ltd
- Teragen Ltd
- University of Mauritius
- Mauritius Standards Bureau
- ESDD (Climate Change Division)

The Energy Industries Sub-TWG was mandated to oversee the technical implementation of data collection, conducting quality control and verifying results of GHG inventory for the Energy Industries.

For NIR, the Energy Industry Sub-TWG conducted regular meetings at-least once per month from January to September 2016.

The QC consisted of verification of the activity data, emission factors, inventory results and reporting. QC dully completed template is highlighted as follows:

- Personal responsible for data and software entry;
- Data review;
- Discuss the issues related to data collection;
- Discuss the correctness of data;
- Discuss on emission factors ;
- Consultation and knowledge exchange for data entry in the software and generating results;
- Crosscutting check for overall inventory quality; and
- Detailed check for document.

3.2.5 Uncertainty Assessment and Time-series Consistency

The method used was that from the 2006 IPCC Software, based on the data series for the period 2006 to 2013. The combined uncertainty in the AD and in EF is 7.81% (electricity generation – liquid fuel). The highest uncertainties in national emission trend introduced by emission factors, by activity data and combined uncertainty in the total national emissions are related to Electricity Generation - Solid Fuels.

3.2.6 Recalculations

Recalculations were not carried out as consistency was found in the time series[20].The GHG emissions over the time horizon shows consistency in the values. No recalculation was therefore done for the purpose of this inventory.

3.2.7 Planned Improvements

The activity data used for this category are quite detailed and obtained at plant level. However, this is not the case for EFs. It is therefore anticipated to empower the owners of the power plants to keep track of the emissions through regular monitoring of emissions. It would also be useful for the carbon content of fuels to be tested, so that country specific carbon emission factors could be used rather than default ones from the 2006 IPCC Guidelines.

This will lead to easy development of plant level EFs for all required gases and will facilitate calculations at higher tier levels to ensure more accuracy. An information system for data sharing will also ensure sustainable preparation of GHG inventories.

Online Continuous Emission Monitoring System is available in most thermal power plants. The data obtained from these units can be used to generate plant specific emission factors. With this facility, higher tier levels will be achieved for the next GHG Inventory exercises.

An attempt was made to process local emission factors from the Coal/Bagasse power generation plants. The values were compared with the default IPCC guidelines and were not consistent. It is therefore required to refine the methodologies for the calculation of local emission factors. It is therefore proposed to carry out a research based emission monitoring exercise with the collaboration of the research institutions in RoM

By the time of development of 4th National Communication, a consistent time series and possible recalculations are also envisaged as from year 2000 or before.

In particularly, the following is planned:

- To complete a time series as from 2000 or if possible as from year 1990 for fuel consumed.
- Net calorific values (NCVs): to ask Statistics Mauritius to use average for all consignments so that national values for each fuel can be obtained – source: STC and Coal terminal+ IPPs for bagasse.
- Emission factors: Alteo Ltd (IPP) developed an EF for its factory for CO_2 from coal. Others stakeholders including CEB need to be contacted to develop their own EF and validate by competent bodies such as the UoM.

[20] The series from SNC was used for the year 2000 to 2005 –recalculations are kept as ongoing process until next reporting.

3.3 Manufacturing Industries and Construction (Category 1A2)

Manufacturing industries and construction in RoM comprises principally of sub-categories 1.A.2.a: Iron and Steel, 1.A.2.c: Chemicals, 1.A.2.e: Food processing, Beverages and Tobacco, 1.A.2.k: Construction and 1.A.2.l: Textile and Leather. It is to be noted that these sub categories were updated from the Second National Communication.

3.3.1 Source Category Description

Manufacturing and Construction activities are one of the main drivers of the economy in RoM. Both fossil (Diesel, HFO, LPG, and Coal) and renewable energy (bagasse and fuel wood) are used as fuel. Boilers are used to generate steam as a main transformed energy source for the various operations in this source category.

GHG emissions from manufacturing industries and construction result from combustion of fuels in industry. The main sub category "Textile Industries", burns fossil fuels in boilers for generating steam, and others like the 'Food Processing, Beverages and Tobacco' use boilers for food processing, sugar and tea manufacture, bakeries and chemical productions. The Construction sector uses fuels mainly in machineries for building and civil engineering works. A summary of the trends for this category is included in ***Chapter 2***.

3.3.2 Methodological Issues

The methodologies used for the Energy sector are summarised in ***Table 12***. Following are additional detailed methodologies.

The category was assessed as a *key category* and the approach adopted was a Tier 1 since not enough country specific EFs were available. There is a number of fuel types used for this category as described below. As required by the 2006 IPCC Guidelines, only the non-CO_2 emissions from the bagasse (biomass) were considered for in the national totals while the CO_2 emissions were taken as a memo item.

a. <u>Calculations</u>

The equation 2.1 from Chapter 2, Volume 2 of the 2006 IPCC Guidelines was used:

EQUATION 2.1
GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

$$\mathbf{Emissions}_{GHG,\ fuel} = \mathbf{Fuel\ Consumption}_{fuel} \times \mathbf{Emission\ Factor}_{GHC,\ fuel}$$

Where:

- Emissions $_{GHG,\ fuel}$= emissions of a given GHG by type of fuel (Gg GHG)
- Fuel Consumption $_{fuel}$ = amount of fuel combusted (TJ)

- Emission Factor $_{GHG,\ fuel}$ = emission factor of a given GHG by type of fuel (kg gas/TJ).

To calculate the total emissions by gas from the source category, the emissions as calculated in Equation 2.1 are summed over all fuels.

b. Activity Data

The activity data (AD) comprised the fuel used for the Manufacturing sector in the Energy Statistics published by Statistics Mauritius. The split among the sub categories required the estimations of fuels used in boilers based on the proportions of boilers available in each of these sub categories. The annual fuel consumed is presented in ***Table 23*** below. Fuel used decreased slightly from year 2000 to 2005 before a marginal rise from 2006 to 2008 due to increased use of coal and LPG. From 2008 to 2013, a gradual decline was noted for most fuels used. The type of coal used was sub-bituminous coal.

Table 23: Fuel consumed for Manufacturing Industries and Construction, 2006 -2013 (Gg)[21]

Fuels	2006	2007	2008	2009	2010	2011	2012	2013
Gas/Diesel Oil	49.8	48.3	46.3	45.8	46.5	43.1	41.3	35.4
Residual Fuel Oil	53.7	55.7	50.2	43.1	41.4	40.3	38.9	39.2
Liquefied Petroleum Gases	3.9	4.1	4.9	5.0	5.1	5.2	5.4	5.3
Sub-Bituminous Coal	21.7	19.9	41.6	21.6	24.8	24.2	25.6	27.5
Wood/Wood Waste	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4[22]
Bagasse -Other Primary Solid Biomass	463.5	400.6	239.2	226.7	265.9	244.2	213.1	204.6

c. Conversion and Emission Factors

The EFs and conversion factors (NCVs) are shown in ***Table 24***. The NCVs were derived from national Energy Statistics (Statistics Mauritius, 2013a). The Emission factors were adopted from 2006 IPCC Guidelines.

Table 24: Energy Conversion Factors and Emission Factors

Fuel	Conversion Factor (TJ/Unit)	CO_2 Emission Factor (kg CO_2/TJ)	CH_4 Emission Factor (kg CH_4/TJ)	N_2O Emission Factor (kg N_2O/TJ)
Gas/Diesel Oil	43.3	74100	3	0.6
Residual Fuel Oil	40.19	77400	3	0.6
Liquefied Petroleum Gases	47.3	63100	1	0.1
Sub-Bituminous Coal	25.5	96100	1	1.5

[21] Small quantities of gasoline are also used in construction and wastes oils in iron and steel.
[22] Estimated

Fuel	Conversion Factor (TJ/Unit)	CO_2 Emission Factor (kg CO_2/TJ)	CH_4 Emission Factor (kg CH_4/TJ)	N_2O Emission Factor (kg N_2O/TJ)
Wood/Wood Waste	15.6	112000	300	4
Bagasse	11.6	100000	30	4

(Source: EEMO[23]: original source: SM; toe to TJ conversion from IEA tool[24], CO_2, CH_4 and N_2O EF: 2006 IPCC Guidelines)

3.3.3 Results

Aggregated emissions from the Manufacturing Industries and Construction decreased from 358.41 Gg CO_2-eq in the year 2000 to 342.3 Gg CO_2-eq in 2013, which represented a decrease of 4.5%. The share for Manufacturing Industries and Construction decreased from 15.5% to 8.6% in the Energy Sector during the same period (***Table 25***).

Table 25: GHG Emissions (Gg CO_2-eq) from Manufacturing Industries and Construction

Year	Total for Energy Sector	Manufacturing Industries and Construction	Share for Manufacturing Industries and Construction (%)
2000	2315.18	358.41	15.5
2001	2504.45	385.30	15.4
2002	2521.42	385.23	15.3
2003	2692.43	385.54	14.3
2004	2692.66	362.82	13.5
2005	2855.23	352.53	12.3
2006	3327.83	426.56	12.8
2007	3477.08	423.82	12.2
2008	3595.34	450.78	12.5
2009	3553.48	374.71	10.5
2010	3788.98	380.40	10.0
2011	3752.71	362.73	9.7
2012	3875.80	356.47	9.2
2013	3964.89	342.34	8.6

3.3.4 Quality Control

The QC was conducted by the Energy Other Sectors Sub-TWG. This Sub-TWG is in charge of Residential, Commercial, Manufacturing Industries and Construction. The Sub-TWG was chaired by the representative from Statistics Mauritius. The other members of this Sub-TWG were from:

- Ministry of Industry, Commerce and Consumer Protection (Commerce Division)
- ESDD (Climate Change Division and Pollution Prevention and Control Division)

[23] http://eemo.govmu.org/English/report/Documents/EOReport_2013.PDF
[24] https://www.iea.org/statistics/resources/unitconverter/

- Association des Hôteliers et Restaurateurs de l'île Maurice (AHRIM)
- Mauritius Export Association

The Energy Other Sectors Sub-TWG was mandated to oversee the technical implementation of data collection, conducting quality control and verifying results of GHG inventory in Energy Other Sectors.

Specifically for NIR, the Energy Other Sectors Sub-TWG conducted regulars QC meetings at-least once per month from January to September 2016.

The QC consisted of verification of the activity data, emission factors, inventory results and reporting. QC dully completed template is highlighted as follows:

- Personal responsible for data and software entry;
- Data review;
- Discuss the issues related to data collection;
- Discuss the correctness of data;
- Discuss on emission factors ;
- Consultation and knowledge exchange for data entry in the software and generating results;
- Crosscutting check for overall inventory quality; and
- Detailed check for document.

3.3.5 Uncertainty Assessment and Time-series Consistency

The method used was that from the 2006 IPCC Software, based on the data series for the period 2006 to 2013. The combined uncertainty in the AD and in EF was 7.0%. Based on the good practice, to ensure an accurate estimation of emissions, the uncertainties have been kept at an acceptable level.

3.3.6 Planned Improvements

The activity data used for this category are quite detailed but need to be included as regular energy statistics[25]. However, this was not the case for EFs. It is therefore, anticipated to empower the industries to keep track of the emissions and fuel consumption through regular monitoring. This will lead to easy development of plant level EFs for all required gases and will facilitate calculations at higher tier levels to ensure more accuracy. An information system for data sharing will also ensure sustainable preparation of GHG inventories.

[25] Statistics Mauritius may need to produce detailed energy consumptions for the sub sectors of Manufacturing.

Particularly, it is planned to:

- Include gasoline used in constructions mainly and wastes oil in iron and steel (scrap metals).
- Include fuel wood for food beverage, amongst others, from 2007 onwards – this contributes to minor emissions of CH_4 and N_2O.

3.4 Transport (Category 1A3)

3.4.1 Overview

The transport sector involves Civil Aviation (1.A.3.a), Road Transportation (1.A.3.b) and Water-borne Navigation (1.A.3.d). Transport by rail does not apply in the case of RoM as there is no rail-based transport system in the country for the time being. As per the 2006 IPCC Guidelines, emissions from this sector resulted from combustion of liquid fuels from transport activities. A summary of the trends for this category is included in Chapter 2.

3.4.1.1 Civil Aviation

Emissions from this sub-category include domestic aviation only. Air transport is used to connect the outer-islands, which form part of the Republic of Mauritius with the main land. Aircrafts of the types of ATR72, National Coast Guard aircraft (DORNIER D228) provide domestic air-transport services. Between 5- 6 flights are daily operated on domestic services.

In 2013, over 10,300 flights were operated of which 8,100 were international and 2,200 were domestic. A clear distinction between domestic and international aviation has been made easy due to reliable data recording by the Civil Aviation Department and the national carrier Air Mauritius.

Table 26 shows the ktoe of jet kerosene consumed by air transport, including fuel used by the national carrier on international flights. The domestic consumption has been worked out from the number of domestic flights carried out daily and weekly until annual values were obtained.

3.4.1.2 Road Transportation

Road Transportation is the only mode of land transport in RoM. It caters for both the passenger and freight transport needs of the country. The fleet of vehicles which was 319,440 in the year 2006 increased to 443,495 vehicles in 2013, experiencing a cumulative growth of 39% over the base year[26].

[26] Statistics Mauritius: http://statsmauritius.govmu.org/English/StatsbySubj/Pages/Transport.aspx

Rodrigues is an outer island forming part of the Republic. It had a fleet of 9,332 vehicles as at 2013. The fleet increased by 2,964 vehicles during the inventory period representing a cumulative growth of 47%.

The fuel consumption in road transportation (Gasoline, Diesel and LPG) is more than 70% of the total energy consumption in transport.

Fuel consumption and emissions for vehicles used in the agricultural sector but which operate on public roads have been taken on board in the road-transportation sub-category as shown in ***Table 26***. Combustion emissions from other transport activities for unregistered vehicles have been accounted for either under the Manufacturing Industries and Construction (Category 1A2) or under the Agriculture/Forestry/Fishing source category (Category 1A4c).

Table 26: Final Energy Consumption – Transport Sector

Fuel Consumption transport sector 2013	**ktoe**					
	Gasoline	**Diesel**	**Aviation fuel (local aircraft)**	**LPG**	**Fuel oil**	**Total**
Land	139.2	166.5		4.4		310.1
Aviation			120.7			
Sea	3.4	1.2			3.4	8.0
Total	**142.6**	**167.7**	**120.7**	**4.4**	**3.4**	**438.8**

3.4.1.3 Water-borne Navigation

Water-borne navigation in the case of RoM consisted of inter-island traffic for both cargo and passengers, tugs used in port activities and pleasure crafts in the tourism industry. Domestic maritime transport is provided mainly by two passengers-cum cargo vessels. The main fuels consumed in this sub-category are fuel oil, gasoline and diesel.

Fuel oil is mainly used by large vessels. In 2013, 395,000 tonnes of that fuel were imported of which 143,800 tonnes were accounted for bunkering and re-export. Only 3,384 tonnes were used for domestic navigation needs, the rest being allocated to the energy industries for electricity generation and for a marginal stock change.

Around 6,200 tonnes of diesel were also consumed by stakeholders in this sub-category, namely, by the Mauritius Ports Authority for the operation of tugs and 2,100 tonnes of gasoline by the National Coast Guard and by pleasure crafts.

3.4.2 Methodological Issues

The methodologies used for the Energy sector are summarised in ***Table 16***. Following, are additional detailed methodologies for the Transport sector.

The methodological choice for the sub-category **Civil Aviation** (Tier 1) for emissions calculations depended largely on the data availability and details thereof. While care in compilation of data has been taken to clearly distinguish between domestic and international flights, this data has only been restricted to total fuel consumed enabling use of Tier 1.

In the **Road Transportation** sector, Tier 1 was used due to availability of disaggregated data on vehicle type, fuel used, engine technology, vehicle kilometres travelled, emission technologies, amongst others. The lack of country-specific emission factors prevented use of either Tier 2 for CO_2 emissions or even Tier 3.

In the **Water-borne Navigation** sub-category, data available concern fuel combusted only by fuel type. There is no differentiation based on engine and ship type, ship movement, amongst others. Emissions from that sub-category have been estimated using the Tier 1.

a. <u>Calculations</u>

The equation 2.1 from Chapter 2, Volume 2 of the 2006 IPCC Guideline was used and applies to all transport subcategories.

EQUATION 2.1
GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

$$\textit{Emissions}_{\text{GHG, fuel}} = \text{Fuel Consumption}_{\text{fuel}} \cdot \text{Emission Factor}_{\text{GHC, fuel}}$$

Where:

- $\text{Emissions}_{\text{GHG, fuel}}$= emissions of a given GHG by type of fuel (kg GHG)
- Fuel Consumption $_{\text{fuel}}$ = amount of fuel combusted (TJ)
- Emission Factor $_{\text{GHG,fuel}}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ).
- For CO_2, it includes the carbon oxidation factor, assumed to be 1.

To calculate the total emissions by gas from the source category, the emissions as calculated in Equation 2.1 are summed over all fuels.

b. <u>Activity Data</u>

AD for Civil Aviation source category was provided mainly by the Civil Aviation Department, which is the regulatory body for air traffic operations. Data submitted by that department made a distinction between domestic and international aviation.

Domestic use of Jet-kerosene only concerns daily flights to Rodrigues and Air Mauritius helicopters. This sector also included the police helicopters, the National Coast Guard Aircraft, the Dornier and the Defender for security carry out surveillance flights. There exists other domestic aviation activities such as the Skydive operating at Mon Loisir and many other small ultra-light motorised (ULM) aircraft over the island but they are using normal gasoline. The activity data was collected using daily flight details and from data submitted by the national carrier Air Mauritius on fuel consumption for domestic flights. This validation process confirmed that less than 2% of the fuel consumption allocated was used on domestic flights. Emissions from international aviation were also worked out and reported separately as memo items. The Emissions from international aviation is accounted under the States' Action Plan for CO_2 Emission Reduction. The first Action Plan was issued in May 2014 and submitted to the International Civil Aviation Organisation (ICAO) and uploaded on their website. It is a living document and is in the process to be updated.

AD from road vehicles has been obtained from the National Transport Authority, which is the body responsible for the registration of vehicles. Vehicle database has been computerised almost for a decade and detailed information is available on all types of vehicles, including, light duty and heavy duty split into fuel types.

This source category has the most disaggregated data due to the compilation of the emissions for the Second National Communication. Data for any type of vehicle has been compiled per age groups, as per engine capacity, with or without 3-way catalysts and controlled or uncontrolled fuel injection technology. Operation details on fuel consumption and vehicle kilometres travelled, has been sourced through sample surveys and from reliable large fleet operators.

AD in this sub-category meets all the requirements for a Tier 2 method of GHG estimation, except that country specific EFs for fuels were not available. So, due to unavailability of country-specific emission factors, the refined data has not been used with better purpose. Default CO_2, CH_4 and N_2O emission factors provided for the different fuel types were instead used as set out in Table 3.2.1 of the 2006 IPCC Guidelines to make a Tier 1 estimate.

AD for Water-borne Navigation source category was sought from the Mauritius Ports Authority for fuel combustion in port activities and on domestic navigation, from the National Coast Guard for surveillance and rescue activities and from the Tourism Authority for fuel consumption of pleasure crafts operated in the tourism sector.

Fuel consumption for international water-borne navigation was taken from official re-export and bunkering statistics in the absence of data from other relevant sources. Emissions on bunkering have been reported as memo items.

c. Emission Factors

Emission factors used for all three sub-categories, that is, Civil Aviation, Road Transportation and Water-borne Navigation were default values provided for each sub-category and fuel type as provided in Chapter 3, Volume 2 of the 2006 IPCC Guidelines relating to mobile combustion and were as tabulated in ***Table 27***.

Table 27: Emission Factors used for Transport Sector Emission Calculations

Type of Fuel	CO_2 (kg/TJ)	CH_4 (Kg/TJ)	N_2O (kg/TJ)
Gasoline	69300	33	3.2
Diesel 0.7	74100	3.9	3.9
LPG	63100	62	0.2
Fuel Oil	77400	7.0	2.0
Jet Kerosene	71500	0.5	2.0

Source: 2006 IPCC Guidelines, Volume 2, Chapter 3 on mobile combustion, Tables 3.2.1 and 3.2.2

3.4.3 Results

Aggregated emissions from the Transport increased from 732.70 Gg CO_2-eq in the year 2000 to 1007.44 Gg CO_2-eq in 2013, which represented an increase of 37.5%. The share for Transport decreased from 31.6% to 25.4% in the Energy Sector during the same period (***Table 28***). Road transportation contributed the most among all the sub-categories in Transport.

Table 28: GHG Emissions (Gg CO_2-eq) from Transport

Year	Total for Energy Sector	Transport	Share for Transport (%)
2000	2315.18	732.70	31.6
2001	2504.45	748.70	29.9
2002	2521.42	769.80	30.5
2003	2692.43	796.60	29.6
2004	2692.66	814.00	30.2
2005	2855.23	844.60	29.6
2006	3327.83	869.27	26.1
2007	3477.08	865.96	24.9
2008	3595.34	867.24	24.1
2009	3553.48	895.85	25.2
2010	3788.98	936.37	24.7
2011	3752.71	948.23	25.3
2012	3875.80	987.11	25.5
2013	3964.89	1007.44	25.4

3.4.4 Quality Control

The QC was conducted by the Transport Sub-TWG. The Transport Sub-TWG was chaired by the national expert representing the National Transport Authority. This Sub-TWG was in charge of Road Transportation, Civil Aviation and Water-borne Navigation.

The Experts Members of Transport Sub-TWG were from:

- Statistics Mauritius
- Civil Aviation Department
- Air Mauritius Ltd
- Ministry of Public Infrastructure and Land Transport (Land Transport Division)
- Ministry of Public Infrastructure and Land Transport (Mechanical Enginering Division)
- Albion Fisheries Research Centre
- Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping
- Mauritius Shiping Coorporation Ltd
- Mauritius Ports Authority
- ESDD (Climate Change Division and Pollution, Prevention and Control Division)

The Transport Sub-TWG was mandated to oversee the technical implementation of data collection, conducting quality control and verifying results of GHG inventory in the Transport sector.

From January to September 2016, the Transport Sub-TWG met at-least once per month.

The QA/QC consisted of verification of the activity data, emission factors, inventory results and reporting. QC dully completed template is highlighted as follows:

- Personal responsible for data and software entry;
- Data review;
- Discuss the issues related to data collection;
- Discuss the correctness of data;
- Discuss on emission factors ;
- Consultation and knowledge exchange for data entry in the software and generating results;
- Crosscutting check for overall inventory quality; and
- Detailed check for document.

3.4.5 Uncertainty Assessment and Time-series Consistency

The method used for assessment was that from the 2006 IPCC Inventory Software as per 2006 IPCC Guidelines in Volume 1, Chapter 3, based on data series for the period 2006 to 2013. The combined uncertainty was 7% and in the AD 5% and the EF also 5%. The highest uncertainties in national emission trend introduced by emission factor, activity data and combined uncertainty in the total national emissions are related to passenger cars without 3-way catalyst and to heavy-duty trucks and buses and are 0.24% and 0.21% respectively. Based on good practice, the uncertainties have been kept at an acceptable level to ensure an accurate estimation of emission.

3.4.6 Planned Improvements

During the TNC report development, remarkable progress was made in the compilation of data in the transport categories. Disaggregated data on amount of fuel consumed, type of fuel used, vehicle kilometres, fuel consumption technologies and emission technologies were available and were used for more accuracy in emission estimation for the road transportation sub-category. For future reporting needs, there is need for similarly disaggregated data in civil aviation (e.g., in number of domestic/international flights to obtain LTO data and to work out cruise consumption figures, amongst others).

More accurate operational data also need to be compiled in the water borne navigation sub-category for improving completeness and for having an alternative data source besides the energy balance.

Inventory preparation and reporting should move from Tier 1 to higher levels of estimation of emissions in the Transport category. For that purpose, country-specific emission factors should be developed and steps for capacity building should be considered. Guidance from the ESDD and follow up on data recording with stakeholders will ensure time-series consistency, relevance and completeness for future reporting.

Due to unavailability of country-specific emission factors, the refined data has not been used with better purpose. Default CO_2, CH_4 and N_2O emission factors provided for the different fuel types were instead used as set out in Table 3.2.1 of the 2006 IPCC Guidelines to make a Tier 1 estimate.

3.5 Energy Other Sectors (Category 1A4)

The Energy Other Sector involves 1.A.4.a: Commercial, 1.A.4.b: Residential, and 1.A.4.c: Agriculture/Forestry/Fishing and Fish Farming.

The methodologies used in previous sub-categories of energy are the same for this category 1A4.

3.5.1 Source Category Description

The category has activities that are mainly commercial and social in nature. Stationary combustion involves use of LPG for food preparation in hotels and households while fishing activities involves mobile combustions. GHG emissions from residential buildings and commercial and public services contain all emissions from fuel combustion. A summary of the trends for this category is included in ***Chapter 2***.

a. Commercial (1.A.4.a)

The sub category "Commercial" burns fossil fuels (mainly LPG) for food preparation and a few other activities in hotel and catering sector as well as institutional sectors including hospitals and schools. Non fossil fuel use include wood and charcoal e.g. for barbecues.

b. Residential (1.A.4.b)

The fuels used in this sector include mainly LPG, kerosene and wood for cooking. Since transport is accounted in its respective sector, this sector comprises only the stationary combustion.

c. Agriculture/Forestry/Fishing and Fish Farming (1.A.4.c)

The sub category includes both stationary and mobile emissions. The stationary parts are minimal and the mobiles sources include field operations and fishing activities involving fishing vessels (small boats and other vessels).

3.5.2 Methodological Issues

The category was not assessed as a key category and the approaches adopted were Tier 1. Around 80% of these fuels are of fossil origin and the remaining is a renewable resource, of which wood is the main one. As required by the 2006 IPCC Guidelines, only the non-CO_2 emissions from the biomass were accounted for in the national totals while the CO_2 emissions were taken as a memo item.

a. <u>Calculations</u>

The equation 2.1 from Chapter 2, Volume 2 of the 2006 IPCC Guideline was used.

EQUATION 2.1
GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

$$Emissions_{GHG,\ fuel} = \text{Fuel Consumption}_{fuel} \cdot \text{Emission Factor}_{GHC,\ fuel}$$

Where:

- $Emissions_{GHG,\ fuel}$= emissions of a given GHG by type of fuel (Kg GHG)
- Fuel Consumption $_{fuel}$ = amount of fuel combusted (TJ)
- Emission Factor $_{GHG,fuel}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ).
- For CO_2, it includes the carbon oxidation factor, assumed to be 1.

To calculate the total emissions by gas from the source category, the emissions as calculated in Equation 2.1 are summed over all fuels.

b. Activity Data

The activity data (AD) comprised the fuel used for this category which is presented in the table below. These were obtained from the national energy statistics. Use of LPG by the households and commercial sectors, were seen to rise from year 2000 to 2013. On the other hand, the use of kerosene, wood and charcoal have been decreased. ***Table 29*** shows the Activity Data for Energy and Other sectors in Gg.

Table 29: Activity Data for Energy Other Sectors (Gg)

Fuel	Conversion Factor (TJ/Unit)	2006	2007	2008	2009	2010	2011	2012	2013	2014
Other Kerosene	43.54	3.92	1.24	1.77	1.47	1.73	0.515	0.243	0.202	0.153
Liquefied Petroleum Gases	47.3	41.60	42.09	42.39	43.24	44.06	44.64	45.239	46.36	47.57
Wood/ Wood Waste	15.6	17.47	17.49	16.72	16.62	16.60	16.336	16.003	15.466	14.529
Charcoal	29.5	0.12	0.12	0.12	0.12	0.12	0.116	0.114	0.111	0.103

c. Emission Factors

The EFs comprised NCVs and some carbon content factors. The NCVs were derived from National Energy Statistics (Statistics Mauritius 2013a) as tabulated in ***Table 30***.

Table 30: Emission Factors for Energy Other Sectors

Fuel	Consumption Unit	Conversion Factor (TJ/Unit)	CO_2 (Kg/TJ)	CH_4 Kg/TJ)	N_2O Kg/TJ)
Other Kerosene	Gg	43.54	71900	3	0.6
Liquefied Petroleum Gases	Gg	47.3	63100	5	0.1
Wood/Wood Waste	Gg	15.6	112000	300	4
Charcoal	Gg	29.5	112000	200	1

(Source: EEMO[27]: original source: SM; toe to TJ conversion from IEA tool[28], CO_2 EF: 2006 IPCC GL)

3.5.3 Results

Aggregated emissions from the Energy Other Sector increased from 200.0 Gg CO_2-eq in the year 2000 to 229.1 Gg CO_2-eq in 2013, which represented an increase of 14.6%. The share for Energy Other Sector decreased from 8.6% to 5.8% in the Energy Sector during the same period (***Table 31***). Residential contributed the most among all sub-categories, with 62% of the GHG emissions in the Energy Other Sector.

Table 31: GHG Emissions (Gg CO_2-eq) from Energy Other Sector

Year	Total for Energy Sector	Energy Other Sector	Share for Energy Other Sector (%)
2000	2315.18	200.04	8.6
2001	2504.45	202.52	8.1
2002	2521.42	202.17	8.0
2003	2692.43	219.62	8.2
2004	2692.66	222.12	8.2
2005	2855.23	228.16	8.0
2006	3327.83	225.99	6.8
2007	3477.08	208.20	6.0
2008	3595.34	217.49	6.0
2009	3553.48	227.17	6.4
2010	3788.98	226.20	6.0
2011	3752.71	234.62	6.3
2012	3875.80	229.31	5.9
2013	3964.89	229.07	5.8

3.5.4 Quality Control

Refer to 3.3.4 above.

[27] http://eemo.govmu.org/English/report/Documents/EOReport_2013.PDF
[28] https://www.iea.org/statistics/resources/unitconverter/

3.5.5 Uncertainty Assessment and Time-series Consistency

The uncertainty levels were assessed by the method from the 2006 IPCC Software, based on the data series for the period 2006 to 2013. The combined uncertainty in the AD and in EF is 7.07%.

3.5.6 Planned Improvements

The activity data used for this category was sufficiently detailed. Improvements should encourage fuel suppliers to keep track of fuel sales to type of customers for monitoring of emissions.

This will be conducted through discussions with Statistics Mauritius and with regulatory stakeholders. As outcome, this will lead to improved development of sub sector level EFs for all required gases and will facilitate calculations at higher tier levels to ensure more accuracy. An information system to data sharing will also ensure sustainable preparation of GHG inventories.

CHAPTER 4 INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)

4.1 Overview

Greenhouse gas (GHG) emissions occur from industrial processes where materials are chemically or physically transformed. The use of some products such as refrigerants, foams and aerosols can also release GHGs. Hydrofluorocarbons (HFCs) are commonly used as alternatives to Ozone Depleting Substances (ODS) substitute in various products.

The main emission sources for the IPPU sector in RoM are iron and steel production (construction iron and steel bars) and lime production, as well as some emissions from ODS Substitutes[29]. The main GHG emitted in this sector is carbon dioxide (CO_2). A summary of the trends for this category is included in ***Chapter 2***.

4.1.1 Quality Control

The QC was conducted by the Industrial Process Sub Technical Working Groups (Sub-TWG). The Industrial Process Sub-TWG was chaired by the representative of the Ministry of Industry, Commerce and Consumer Protection (Industry Division)

The other Members of Industrial Process Sub-TWG are from:

- Statistics Mauritius
- ESDD (National Ozone Unit)
- Mauritius Chamber of Commerce and Industry
- Samlo Ltd
- Mauritius Chemical and Fertilizer Industry (MCFI) Ltd
- ESDD (Climate Change Division)

The Industrial Process Sub-TWG was mandated to oversee the technical implementation of data collection, conducting quality control and verifying results of GHG inventory in the IPPU sector.

For NIR, the Industrial Process Sub-TWG conducted regulars meetings from January to September 2016, at-least once per month.

The QA/QC consisted of verification of the activity data, emission factors, inventory results and reporting. QC dully completed template is highlighted as follows:

- Personal responsible for data and software entry;
- Data review;
- Discuss the issues related to data collection;

[29] Lubricants use is still in process and will be included

- Discuss the correctness of data;
- Discuss on emission factors;
- Consultation and knowledge exchange for data entry in the software and generating results;
- Crosscutting check for overall inventory quality; and
- Detailed check for document.

4.1.2 Assessment of Completeness

For RoM, the source categories covered by the IPPU sector are: 2A 'Mineral Products' (2A2 'Lime Production), 2C 'Metal Production' (2C1 Iron and Steel Production), and 2F 'Product Uses as Substitutes for Ozone Depleting Substances' (2F1 'Refrigeration and Air Conditioning Equipment').

Based on the 2006 IPCC Guidelines, the industrial processes and product uses as substitutes to ODS substitute in RoM and their possible emission sources are shown in Appendix 1. ***Table 32*** shows the Industrial Processes and Product Use Categories and their possible emissions.

Table 32: Industrial Processes and Product Use Categories and their Possible Emissions[30]

Industrial Process and Product Use	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other Halogenated Gases
2.A. Mineral Products							
2.A.2: Lime Production	**X**	NA					
2.B. Chemical Industry [a]	NO	NO	NO	NO	NO	NO	NO
2.C Metal Industry							
2.C.1 Iron and Steel Production [b]	**X**	X	NO				
2.D - Non-Energy Products from Fuels and Solvent Use	NO	NO	NO	NO	NO	NO	NO
2.E - Electronics Industry [c]	NO	NO	NO	NO	NO	NO	NO
2.F Product Uses as Substitutes for Ozone Depleting Substances	NO	NO	NO	X	NO	NO	NO
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NO	NO	NO	NO	NO	NO	NO

X: Estimated; NO: Not Occurring; NA: Not Applicable

[30] Following 2006 IPCC Guidelines, since this is not a key category, not much time and effort was put to use or develop higher tier methods for this category and the simplest one was adopted.

4.1.3 Key Categories

According to the Key Category Analysis described in section ***Chapter 2*** above, only the Iron and Steel Production (2C1) was the main category of IPPU, which was qualified as a key one. Although this is a key category at national level, its contribution to GHG emissions is only 1.4% and therefore, the emissions from IPPU do not contribute much to the total emissions in RoM.

4.1.4 General Methodology

The general methods used were Tier 1 because no categories were found to be key. A summary of the methods is presented in ***Table 33*** below for activities occurring in RoM.

Table 33: Summary of Methodology used for the IPPU Sector in RoM

Industrial Processes and Product Use	**CO_2**		**CH_4**		**N_2O**		**HFCs**		**PFCs**		**SF_6**		**Other Halogenated gases**	
	Method	**EF**	**Method**	**EF**	**Method**	**EF**	**Method**	**EF**	**Method**	**EF**	**Method**	**EF**	**Method**	**EF**
2.A. Mineral Products														
2.A.2: Lime Production	**T1**	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.C Metal Industry														
2.C.1 Iron and Steel Production [b]	**T1**	**D**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.F Product Uses as Substitutes for Ozone Depleting Substances	NA	NA	NA	NA	NA	NA	T1	D	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

T1: Tier 1; D: Default Values; NA: Not Applicable

4.2 Mineral Industry (Category 2.A)/ Lime Production (2.A.2)

In the category of mineral industry, only lime production activities were carried out in RoM. The lime production involving a series of steps, including the quarrying of raw materials, crushing and sizing, calcining the raw materials to produce lime, and (if required) hydrating the lime to calcium hydroxide. Shafts or rotary kilns are used to heat limestone at high temperatures in order to decompose the carbonates. Calcium oxide (CaO) or quick lime is formed. This process releases carbon dioxide (CO_2).

4.2.1 Source Category Description

During this inventory period (2006–2013), there was only one manufacturer, which does the quarrying of the raw material and processing it into hydrated lime. In RoM, lime is mainly used in the sugar factories to remove impurities from the raw cane juice. Any excess lime is then removed through carbonation.

4.2.2 Methodological Issues

According to the 2006 IPCC Guidelines, the Tier 1 method is based on applying default emission factor to national level lime production data.

a. Calculations

The calculations were done in the 2006 IPCC Software where the following simplified formula was applied:

$$\boldsymbol{E = AD \times EF}$$

Where

E: Emissions
AD: Activity Data, and
EF: Emissions Factor

b. Activity Data

Activity data for the years 2006 -2013, as shown in ***Table 34*** below, were obtained from an annual data collection carried by the Statistics Unit of the ESDD.

Table 34: Lime Production in RoM (2006-2013)

	2006	2007	2008	2009	2010	2011	2012	2013
Lime Produced (tonnes)	2610	2530	2530	2530	2530	2530	2530	2530

Source: Environment Statistics Unit, ESDD

From 2007 to 2013, production remained constant at 2,530 tonnes of lime per year.

c. **Emission Factors**

Tier 1 method, being an output based method, applies an emission factor to the total quantity of lime produced. Based on information obtained from the lime manufacturer, the type of lime produced is hydrated lime and the EF adopted from the 2006 IPCC Guidelines is 0.59[31].

4.2.3 Results

GHG emissions from the Lime Production decreased from 2.57 Gg CO_2-eq in the year 2000 to 1.49 Gg CO_2-eq in 2013 which represented a decrease of 42.3%. This was mainly due to a significant decrease in the production of hydrated lime as most of the sugar indurates in RoM import lime from other countries to refine their sugar produced. The share for Lime Production decreased from 5.8% to 3.4% in the IPPU Sector during the same period (***Table 35***).

Table 35: GHG Emissions (Gg CO_2-eq) from Lime Production

Year	Total for IPPU	Lime Production	Share for Lime Production (%)
2000	44.12	2.57	5.8
2001	44.10	2.52	5.7
2002	43.93	2.31	5.2
2003	43.85	2.19	5.0
2004	43.48	1.79	4.1
2005	43.56	1.84	4.2
2006	42.91	1.53	3.6
2007	44.83	1.49	3.3
2008	47.14	1.49	3.2
2009	49.28	1.49	3.0
2010	49.91	1.49	3.0
2011	54.43	1.49	2.7
2012	50.97	1.49	2.9
2013	43.71	1.49	3.4

[31] Following IPCC (2006), since this is not a key category, not much time and effort was put to use or develop higher tier methods for this category and the simplest one was adopted.

4.2.4 Quality Control

Refer to Section 4.1.1.

4.2.5 Uncertainties Assessment and Time-series Consistency

The uncertainties were automatically calculated by the 2006 IPCC Software. The combined AD and EF uncertainty were 15%.

4.2.6 Planned Improvements

Since this category was not key and the production of lime is about to be phased out, no improvement is expected for this industrial activity.

4.3 Iron and Steel Production (Category 2C1)

In this Category, only the iron and steel manufacturing (2.C.2) was occurring in RoM. According to Volume 3 of the 2006 IPCC Guidelines, the iron and steel industry broadly consists of: primary facilities that produce both iron and steel; secondary steelmaking facilities; iron production facilities; and offsite production of metallurgical coke.

4.3.1 Source Category Description

In RoM, all iron and steel production are manufactured from the recycling of ferrous scrap metals. The scrap metals are firstly segregated by magnets in a shed and then sent to a furnace operating at 1800^{o}C to be melted. High quality fluxes, imported by the manufacturer, are used to purify the melt. High strength and superior quality steel ingots are produced. These steel ingots are then used as raw material in the steel rolling mill to finally produce steel construction bars.

4.3.2 Methodological Issues

Electric Arc Furnaces (EAFs) use scrap metal and not iron as raw material. Since the EAF process is mainly one of melting scrap and not reducing oxides, CO_2 emissions are mainly associated with the consumption of the carbon electrodes.

a. <u>Calculations</u>

According to the 2006 IPCC Guidelines, the Tier 1 approach for emissions from iron and steel production was adopted.

Emissions per unit of steel production however varied widely, depending on the method of steel production. According to the 2006 IPCC Guidelines, it is good practice to determine the share of steel produced in different types of steel making processes. Emissions from each process are calculated and eventually all emissions are summed up to obtain a total estimate.

Carbon dioxide emissions from the production of iron and steel have been calculated using the 2006 IPCC Software. When applying the Tier 1 methodology, the following simplified formula was applied:

$$E = AD \times EF$$

Where

E: Emissions
AD: Activity Data
EF: Emissions Factor

b. Activity Data

Activity data, as shown in ***Table 36*** below, were obtained from Statistics Mauritius.

Table 36: Iron and Steel Production in RoM (2006-2013)

	2006	2007	2008	2009	2010	2011	2012	2013
Iron and Steel Produced (tonne)	30,000	30,000	31,000	32,000	32,000	35,000	32,200	26,700

Source: Statistics Mauritius

c. Emission Factor

Tier 1 method, being an output based method, applies an emission factor to the total amount of iron and steel produced. The emission factor (EF) is 1.35 tonnes of CO_2 per tonne pig iron produced according to the 2006 IPCC Guideline.

4.3.3 Results

GHG emissions from the Iron and Steel Production decreased from 41.56 Gg CO_2-eq in the year 2000 to 36.05 Gg CO_2-eq in 2013 which represented a decrease of 13.3%. The share for Iron and Steel Production decreased from 94.2% to 82.5% in the IPPU Sector during the same period (***Table 37***). The emissions continued to increase from 2007 to 2010, with an increase in the amount of iron and steel produced. In 2011, CO_2 emissions amounted to as high as 47.3 Gg CO_2-eq due to a higher production of iron and steel. In 2013, the manufacturer produced a lower amount of iron and steel bars that could meet the national measurements standard.

Table 37: GHG Emissions (Gg CO_2-eq) from Iron and Steel Production

Year	Total for IPPU	Iron and Steel Production	Share for Iron and Steel Production (%)
2000	44.12	41.56	94.2
2001	44.10	41.59	94.3
2002	43.93	41.62	94.8
2003	43.85	41.66	95.0
2004	43.48	41.69	95.9
2005	43.56	41.72	95.8
2006	42.91	40.50	94.4
2007	44.83	40.50	90.3
2008	47.14	41.85	88.8
2009	49.28	43.20	87.7
2010	49.91	43.20	86.6
2011	54.43	47.25	86.8
2012	50.97	43.47	85.3
2013	43.71	36.05	82.5

4.3.4 Quality Control

Refer to Section 4.1.1.

4.3.5 Uncertainties Assessment

The uncertainties were automatically calculated by the 2006 IPCC Software and the AD uncertainty was 10%.

4.3.6 Planned Improvements

The planned improvement expected for this activity is to build a consistent time series by finding out if any iron and steel was manufactured before the year 2006.

4.4 Product Uses as Substitutes for Ozone Depleting Substances (Category 2.F)

4.4.1 Source Category Description

According to Voluategorme 7 of the 2006 IPCC Guidelines, HFCs are serving as alternatives to ODS substitute being phased out under the Montreal Protocol. Current application areas of HFCs in RoM include refrigeration and air conditioning systems (stationary and mobile) as well as in fire extinguishers. These appliances and refrigerants are not produced locally and are all imported. This sub-sector will therefore concentrate on emissions of the use of these appliances.

Sulphur hexafluoride (SF_6) is used in electrical equipment such as gas insulated switchgear and substations and in gas circuit breakers. In RoM, SF_6 are mostly used in breakers, which are categorised as Sealed Pressure Systems or Sealed-for-life Equipment. This type of equipment does not require any refilling with gas during its lifetime and generally contains less than 5 kg of gas per functional unit. Emissions of SF_6 have therefore been assumed to be insignificant as the breakers have been installed since the 1990s and have not exceeded their lifetime during the inventory period.

4.4.2 Methodological Issues

In this category, use of refrigeration and air conditioning systems were considered.

a. <u>Calculations</u>

According to the 2006 IPCC Guidelines, the Tier 1a approach (emission-factor approach) relies on the availability of basic activity data at application level, rather than at the level of equipment or product type. The calculation formula for Net Consumption with this approach is as follows:

Net Consumption = production + Imports – Exports – Destruction

Net consumption values for each HFC are then used to calculate annual emissions for applications exhibiting prompt emissions as follows:

$$\textit{Annual Emissions} = \textit{Net Consumption} \times \textit{Composite EF}$$

Where

- Net Consumption = net consumption for the application
- Composite EF = composite emission factor for the application (2% of consumption assumed)

b. <u>Activity Data</u>

Activity data, as shown in ***Table 38*** below, were obtained from the National Ozone Unit of the Ministry of Social Security, National Solidarity, and Environment and Sustainable Development. For future improvement (i.e. during the development of upcoming BUR), data for net consumption of ODS substitute will be more detailed to explain clearly data source, data collection, data gaps and methodology to adapting data for inventory use.

Table 38: Net Consumption of ODS Substitute in RoM (2006-2013)

Product Use	ODS Substitute	Consumption (Tonnes)							
		2006	2007	2008	2009	2010	2011	2012	2013
Refrigeration and Stationary Air Conditioning	HFC-23	-	0.21	-	-	-	-	0.05	0.26
	HFC-32	1.30	3.01	5.57	15.16	6.98	12.85	16.73	12.01
	HFC-125	7.42	14.85	14.97	27.27	22.36	45.65	45.45	52.73
	HFC-134a	12.37	26.96	79.65	33.99	23.74	41.25	32.20	23.74
	HFC-143a	7.21	13.03	10.95	13.68	17.97	36.68	33.54	164.40

Product Use	ODS Substitute	Consumption (Tonnes)							
		2006	2007	2008	2009	2010	2011	2012	2013
	HFC-152a	-	-	-	-	-	-	-	-
	HFC-227ea	-	-	-	-	-	-	-	0.78
	HFC-236fa	-	-	-	-	-	-	-	-
Mobile Air Conditioning	HFC-23	-	-	-	-	-	-	-	-
	HFC-32	-	-	-	-	-	-	-	0.78
	HFC-125	-	-	-	-	-	-	-	-
	HFC-134a	2.59	4.45	17.04	5.94	4.90	9.23	5.74	4.99
	HFC-143a	-	-	-	-	-	-	-	-
	HFC-152a	-	-	-	-	-	-	-	0.78
	HFC-227ea	-	-	-	-	-	-	-	-
	HFC-236fa	-	-	-	-	-	-	-	-

Source: National Ozone Unit, ESDD

c. <u>Emission Factor</u>

A composite emission factor is required to complete a Tier 1 method. The composite EF used was 2%.

4.4.3 Results

HFCs data from the SNC was not used for year 2000 to 2006 as they were still to be improved by the National Ozone Unit of the ESDD. HFCs emissions from Product Uses as Substitutes to ODS increased from 0.88 Gg CO_2-eq in the year 2006 to 6.17 Gg CO_2-eq in 2013. The share of GHG emissions for this sub-sector increased from 2.1% to 30.6% in the IPPU Sector during the same period (***Table 39***). The emissions continued to increase from 2006 to 2012 due to an increase use of the gases in air conditioning and refrigeration. From 2012 to 2013, there was one refrigerant that was banned and it was preferably substituted by HFC-143a, which witnessed a sharp rise in importations.

Table 39: GHG Emissions (Gg CO_2-eq) from Product Uses as Substitutes to ODS

Year	Total for IPPU	Iron and Steel Production	Share for Iron and Steel Production (%)
2006	42.91	0.88	2.1
2007	44.83	2.84	6.3
2008	47.14	3.79	8.0
2009	49.28	4.58	9.3
2010	49.91	5.21	10.4
2011	54.43	5.69	10.5
2012	50.97	6.01	11.8
2013	43.71	6.17	14.1

4.4.4 Quality Control

Refer to Section 4.1.1.

4.4.5 Uncertainties Assessment and Time-series Consistency

There may be a wide range of other applications of ODS substitutes and it is, therefore, not possible to give default uncertainties for all the sources. Procedures should therefore be put in place to assess levels of uncertainty as outlined in Volume 1, Chapter 3 of the 2006 IPCC Guidelines.

The time series was consistent as data pertaining to imports and use were well regulated and recorded during the inventory period 2006-2013.

4.4.6 Planned Improvements

Nitric acid production was not taken into consideration in the GHG computation for years 2000 to 2004 though data were available. This is recommended to be considered during the 4th NC.

The way for recording data for the consumption of halocarbons and sulphur hexafluoride will be improved by constructing a database including the period from 2000 to 2005 at the Dangerous Chemical Control Board. This is an on-going process and data will be available for use during the GHG inventory for 4th NC.

CHAPTER 5 AGRICULTURE, FORESTRY AND OTHER LAND USE (AFOLU)

5.1 Overview

The Agriculture, Forestry and Other Land Use (AFOLU) sector represents a restructuring of the GHG inventory, as compared to previous inventories. Agriculture and land use, land use change and forestry (LULUCF) have been combined as AFOLU in the 2006 IPCC Guidelines, and the structure of the national inventory has been updated to match this.

This sector is particularly important as carbon sinks are present, predominantly as forests, and are large compared to agricultural emissions. In RoM, agricultural emissions primarily arise from managed soils as nitrous oxide (N_2O), enteric fermentation as methane (CH_4) and in addition some nitrous oxide from manure management. The CO_2 emissions are minor and removals result from C stock changes in biomass, dead organic matter and mineral soils, for all managed lands. This sector also includes the emissions from the application of compost and fertilisers in crop production systems (managed soils).

Six land-use categories (i.e., Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land) are considered and these land categories are further sub-divided into land remaining in the same category and land converted from one category to another. The land-use categories are designed to enable inclusion of all managed land area within a country, and this approach follows the most up to date guidance published by the IPCC.

In view of the small size of RoM, land is a prized asset for food production and economic development. Intensive agriculture and grazing land occupies 52% of the land surface, Forestland 25%, Built up areas 17% and other land 6 %.

In RoM, most of the GHG emissions/removals from AFOLU sector are generated by Forestland (which is a Key category), enteric fermentation, manure management, agricultural soils and field burning.

In the AFOLU sector, there is more carbon sequestered than emitted. The forests are the largest component of the AFOLU sector and are net carbon sinks. Agricultural emission sources include the livestock sector where enteric fermentation and manure management emit CH_4 and some N_2O, and from direct and indirect N_2O on managed soils. A summary of the trends for this category is included in ***Chapter 2***.

The forests and other land categories sequester carbon, with an average of about 370 Gg yearly (Rodrigues contributes some 32 Gg). Fertiliser application to soils is common practice, especially in the sugarcane cultivations, and contributes to soils emissions that an average 94 Gg CO_2-eq yearly, primarily as N_2O. Livestock (enteric fermentation and manure management) contributes to include almost half of the total emissions from Rodrigues, which has important livestock populations.

5.1.1 General Methodology

A summary of the methods are shown in ***Table 40***. While most of the AD has been obtained locally, the EFs have mainly been drawn from the 2006 IPCC Guidelines and hence are default values. A Tier 1 with local AD and default EF has been used to calculate the emissions/removals in the AFOLU sector.

Table 40: Methodologies and Data Sources

IPCC 2006 category	Sub category	Method used	EF	Notes	Data source
3.A.1: - Enteric Fermentation	3.A.1.a - Cattle 3.A.1.c - Sheep 3.A.1.d - Goats 3.A.1.f - Horses 3.A.1.h - Swine	T1	D	Improved level of Tier 1 full local AD and Default EF	FAREI
3.A.2 - Manure Management	3.A.2.a - Cattle 3.A.2.c - Sheep 3.A.2.d - Goats 3.A.2.f - Horses 3.A.2.h – Swine 3.A.2.i - Poultry	T1	D	Improved level of Tier 1 full local AD and Default EF	FAREI
3.C - Aggregate sources and non-CO_2 emissions sources on land	3.C.1 - Emissions from biomass burning	T1	D	Improved level of Tier 1 full local AD and Default EF	FAREI
	Direct N_2O emission from managed soil	T1	D	Improved level of Tier 1 full local AD and Default EF	FAREI
	Indirect N_2O emission from managed soil	T1	D	Improved level of Tier 1 full local AD and Default EF	FAREI, MSIRI
	Field burning of agricultural residues	T1	D	Improved level of Tier 1 full local AD and Default EF	FAREI, MSIRI
3.B.1. Forest Land	3.B.1.a Forest Lands Remaining Forest Lands	T1	D, CS	Improved level of Tier 1 full local AD and Default EF (Consideration of forests area and biomass and wood removals).	Forestry Services AD and default EF and a few CS EF
	3.B.1.b. Land converted to forest land -	T1	D, CS		
	3.B.1.b.i. Cropland converted to forest land				
3.B.2 Cropland	2.B.2.a. Cropland remaining cropland	T1	D	Mainly sugarcane, but including orchards, food crops and trees in croplands	FAREI and Estimated from a national methodology # Default EF
	3.B.2.b - Land Converted to Cropland -	T1	D		Estimated from a national methodology # Default EF
	3.B.2.b.i - Forest Land converted to Cropland				Estimated from a national methodology # Default EF

IPCC 2006 category	Sub category	Method used	EF	Notes	Data source
3.B.3 - Grassland	3.B.3.a - Grassland Remaining Grassland	T1	D		Estimated from a national methodology #
3.B.4 - Wetlands	3.B.5.a – Wetlands Remaining Wetlands	T1	D		Estimated from a national methodology # Default EF
	3.B.5.a.ii – Flooded lands Remaining flooded lands	T1	D		Estimated from a national methodology # Default EF
3.B.5 - Settlements	3.B.5.a - Settlements Remaining Settlements	T1	D		Estimated from a national methodology # Default EF
	3.B.5.b - Land Converted to Settlements	T1	D		Estimated from a national methodology # Default EF
	3.B.5.b.i - Forest Land converted to Settlements	T1	D		Estimated from a national methodology # Default EF
	3.B.5.b.ii - Cropland converted to Settlements	T1	D		Estimated from a national methodology # Default EF
3.B.6 - Other Land	3.B.6.a - Other land Remaining Other land	T1	D		Estimated from a national methodology # Default EF
	3.B.6.b - Land Converted to Other land	T1	D		Estimated from a national methodology # Default EF
	3.B.6.b.i - Forest Land converted to Other Land	T1	D		Estimated from a national methodology # Default EF
	3.B.6.b.ii - Cropland converted to Other Land	T1	D		Estimated from a national methodology # Default EF

T1, T2 – Tier 1 and Tier 2 Methods; CS – Country Specific Emission/ Removal Factors; D –Default Emission/ Removal Factors; #Still under development

5.1.2 Uncertainty Assessment

The uncertainty introduced was qualitatively assessed for activity data mainly and the software was used to calculate the uncertainty from the values entered as both AD and EF. There is a plan for making this improvement (which is a particularly important improvement to make, as it will help prioritise other improvement activities).

5.1.3 Time-series Consistency

The time series were checked with the previous inventory reported in NIR under SNC. Lack of raw data meant that it was not possible to source a completely consistent time series of activity data for all of the sub categories. However, it is envisaged to use good practices from IPCC 2006 Guidelines to build the time consistent series. This is planned during the inventory for 4th National Communication.

5.1.4 *Quality Control*

The quality assurance/quality control was carried out throughout the inventory preparation process for all activity data collections and choice of emission factors. The values were cross checked with available statistics on agriculture and environment, including forestry. Documents such as the FAO forest resources assessments were also consulted to check the data consistency[32].

The QC was conducted by the AFOLU Sub-TWG and was chaired by the representative from Food and Agricultural Research and Extension Institute (FAREI). The other Members of AFOLU Sub-TWG were from:

- Statistics Mauritius
- Food and Agricultural Research and Extension Institute (Livestock Section)
- Food and Agricultural Research and Extension Institute (Crop Section)
- Ministry of Agro-Industry and Food Security
- Mauritius Meat Producer Association
- Ministry of Housing and Lands
- Mauritius Cane Industry Authority
- Omnicane Ltd
- Medine Sugar Miling Company Ltd
- Mauritius Chamber of Agriculture
- ESDD (Climate Change Division)

The AFOLU Sub-TWG is mandated to oversee the technical implementation of data collection, conducting quality control and verifying results of GHG inventory for the AFOLU sector.

For NIR, the AFOLU Sub-TWG conducted regulars QC meetings from January to September 2016, at-least once per month.

The QC consisted of verification of the activity data, emission factors, inventory results and reporting. QC dully completed template is highlighted as follows:

- Personal responsible for data and software entry;
- Data review;
- Discuss the issues related to data collection;
- Discuss the correctness of data;
- Discuss on emission factors;
- Consultation and knowledge exchange for data entry in the software and generating results
- Crosscutting check for overall inventory quality; and
- Detailed check for document.

[32] Global Forest Resources Assessment 2015; http://www.fao.org/3/a-i4808e.pdf

5.1.5 *Recalculations*

The results from the TNC were compared with those from the SNC and it was found that due to changes in emission factors, the emissions changed as presented in ***Table 41***.

Table 41: Recalculations for Livestock Enteric Fermentation and Manure Management Emissions ($Gg\ CO_2$ eq) for Mauritius only

		2000	2001	2002	2003	2004	2005	2006
Enteric Fermentation	Previous inventory	65.28	67.24	59.73	59.31	55.96	58.85	60.04
	Present inventory	15.99	16.3	16.56	16.22	14.54	15.82	14.98
	Difference	49.29	50.94	43.17	43.09	41.42	43.03	45.06
	% change	-75.5	-75.8	-72.3	-72.7	-74.0	-73.1	-75.0
Manure Management	Previous inventory	18.5	18.46	18.62	17.97	17.56	19.25	18.00
	Present inventory	6.56	6.38	6.79	6.76	6.73	7.30	11.70
	Difference	11.94	12.08	11.83	11.21	10.83	11.95	6.30
	% change	-64.5	-65.4	-63.5	-62.4	-61.7	-62.1	-35.0

It was found that due to a few updated factors in the land category, the values were changed for carbon uptakes by forests, particularly, for one tree species (pinus). The values for the annual above ground biomass growth rate were underestimated for this species in SNC. This has had a significant impact on the emission estimates, and the recalculations are summarised in the ***Table 42*** below.

Table 42: Recalculations for FOLU sector ($Gg\ CO_2$)

	SNC Inventory	TNC	Difference	% change
2000	-280.3	-359.62	-79.32	28.3
2001	-284.3	-361.32	-77.02	27.1
2002	-253.4	-316.07	-62.67	24.7
2003	-287.7	-367.52	-79.82	27.7
2004	-267.7	-325.87	-58.17	21.7
2005	-270	-327.25	-57.25	21.2
2006	-269.4	-324.55	-55.15	20.5

5.1.6 *Assessment of Completeness*

The categories and their sub categories assessed are presented in table below. It is recognised that this sector needs improvement, because there is currently a lack of data on some land use change categories. ***Table 43*** shows the assessment of completeness for the AFOLU Sector.

Table 43: Assessment of Completeness for the AFOLU Sector

IPCC 2006 Category	CO_2	CH_4	N_2O	Notes
3.A.1 - Enteric Fermentation	NO	X	NO	
3.A.2 - Manure Management	NO	X	X	
3.C.1 - Emissions from biomass burning	NA	X	X	Sugarcane
3.B.1. Forest Land	X	X	X	
3.B.2 Cropland	X	NA	NA	Lack of data
3.B.3 - Grassland	NA	NA	NA	Lack of data
3.B.4 - Wetlands	NA	NA	NA	Lack of data
3.B.5 - Settlements	X	NA	NA	Lack of data
3.B.6 - Other Land	X	NA	NA	Lack of data

X: Estimated NO: Not Occurring; NA: Not Applicable

5.2 Livestock

5.2.1 *Overview*

Livestock production can result in methane (CH_4) emissions from enteric fermentation and both CH_4 and nitrous oxide (N_2O) emissions from livestock manure management systems. (2006 IPCC Guidelines, Volume 4, Chapter 10)

According to the 2006 IPCC Guidelines for National GHG Inventories (pp10.23-10.24), methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. The amount of methane that is released depends on the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed consumed. Ruminant livestock (e.g., cattle, sheep) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses). The ruminant gut structure fosters extensive enteric fermentation of their diet.

Manure management is the process by which animal wastes (e.g. dung + urine =manure) are stored, treated and used after its decomposition (e.g. in field application). During the storage as well as stall littering, CH_4 is emitted out of anaerobic (without oxygen) decomposition of the organic matter in the animal waste. Emissions of CH_4 related to manure handling and storage are reported under 'Manure Management.' This section describes how to estimate CH_4 produced during the storage and treatment of manure, and from manure deposited on pasture. The term 'manure' is used here collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock.

The Agriculture sector shares 3% of the total GDP; out of which the livestock and poultry sub sector contribute 23% in this sector. Livestock production is carried out by some 5,000 farmers engaged mainly in cattle, goat, sheep, pig, deer, poultry and rabbit farming. The Livestock sector in RoM is dominated by poultry (broiler chicken and eggs) for which self-sufficiency was reached a number of years ago.

For the period 2006 -2013, FAREI's resource profile study revealed that most cattle are kept in stall, and pasture to a lesser extent. Grazing large areas is non- existent in RoM. Goats, pigs and sheep are mostly confined in buildings. Broilers are reared on litter flooring whereas for layers, the birds are kept in cages (except for pullets, the birds are reared on litter floor for a period of 5 months). All broilers and layers are confined in buildings. For deer, two types of deer farming can be observed namely extensive ("wild") and intensive (paddocks).

The table below shows the livestock population trend by number of heads per type of livestock (cattle, goat, sheep, deer, swine, etc.) and poultry. Looking at the table below, a drastic fall in pig population was noted in year 2008 due to 'African Swine Fever', during which, many pigs were slaughtered. The poultry population, on the other hand, shows an increasing trend from 2006 to 2013; the deer population on paddock has remained stagnant; but the cattle and sheep numbers decrease until 2011, from which, then, there is a slight increase afterwards. ***Table 44*** shows the livestock population for the Island of Mauritius for the years 2006 to 2013.

Table 44: Livestock population for Island of Mauritius, 2006 – 2013

Livestock	2006	2007	2008	2009	2010	2011	2012	2013
Cattle, dairy[2]	2237	2163	2457	2316	2679	2525	3022	2874
Cattle, non-dairy[1]	7016	6815	6967	7006	6846	5991	6099	6127
Goats[1]	24547	25300	26598	26696	28267	28284	27529	25933
Sheep[1]	1278	1191	1652	2130	2096	1994	2262	2540
Buffaloes	0	0	0	0	0	0	0	0
Asses	NE	NE	NE	NE	NE	NE	N/A	N/A
Horses[4]	NE	NE	NE	NE	NE	NE	824	855
Mules	NE	NE	NE	NE	NE	NE	NE	NE
Swine, breeding[2]	2375	2774	1387	3003	4338	3873	3178	3270
Swine, market[2]	12944	14639	5312	11105	17989	19412	12109	12691
Swine (Total)[2]	15319	17413	6699	14108	22327	23285	15287	15961
Poultry[3]	48474 14	5263179	549459 4	5586732	586308 9	597802 0	605995 6	599793 2
Deer[3]	16,000	16,000	16,000	16,000	16,000	16,000	16,000	16,000

NE: Not estimated; NA: Not Available

Source: Digest of Agricultural Statistics Mauritius and Food and Agricultural Research and Extension Institute (period 2006 - 2013)

[1] Digest of Agricultural Statistics Mauritius

[2] Food and Agricultural Research and Extension Institute (FAREI)

[3] Estimated figure from Food and Agricultural Research and Extension Institute (FAREI)

[4] Data from Statistics Mauritius

The livestock population for Rodrigues is an important source of GHG emissions and was estimated as in ***Table 45***.

Table 45: Livestock population for Island of Rodrigues, 2006 - 2013

	2006	2007	2008	2009	2010	2011	2012	2013
3.A.1.a - Cattle	10133	11478	6870	5996	7943	9817	8112	9207
3.A.1.a.i - Dairy Cows	4053	4591	2748	2398	3177	3927	3245	3683
3.A.1.a.ii - Other Cattle	6080	6887	4122	3598	4766	5890	4867	5524
3.A.1.c - Sheep	5723	6730	4628	6494	9188	7206	7558	8323
3.A.1.d - Goats	10542	10718	8406	10547	19685	18700	16013	17007
3.A.1.h - Swine	17469	17389	18087	16314	14719	16134	15803	13330

Note: Estimated

5.2.2 Methodological Issues

a. <u>Calculations</u>

For Enteric Fermentation

The calculations involve simply multiplying the number of animals (as AD) by the respective EF:

$$Emissions = EF_{(T)} \bullet \left(\frac{N_{(T)}}{10^6} \right)$$

Where:

- Emissions = methane emissions from Enteric Fermentation, Gg CH_4 yr^{-1}
- EF(T) = emission factor for the defined livestock population, kg CH_4 $head^{-1}$ yr^{-1}
- N(T) = the number of head of livestock species / category T in the country
- T = species/category of livestock

$$\text{Total } CH_{4\text{Enteric}} = \sum_i E_i$$

Where:

- Total CH_4Enteric = total methane emissions from Enteric Fermentation, Gg CH_4 yr^{-1}
- Ei = is the emissions for the *i*th livestock categories and subcategories

This means that for each animal type, its population in a particular year is multiplied by its EF to obtain its emissions. The emissions for each animal types are then added together to get the emissions for enteric fermentation.

For Manure Management System

The calculations, adapted from 2006IPCC Guidelines, involve simply multiplying the number of animals (as AD) by the respective EF:

$$CH_{4Manure} = \sum_{(T)} \frac{\left(EF_{(T)} \bullet N_{(T)}\right)}{10^6}$$

Where:

- $CH_{4Manure}$ = CH_4 emissions from manure management, for a defined population, Gg CH_4 yr^{-1}
- EF(T) = emission factor for the defined livestock population, kg CH_4 $head^{-1}$ yr^{-1}
- N(T) = the number of head of livestock species/category *T* in the country
- T = species/category of livestock

The emissions are calculated in a similar way as explained above for enteric fermentation.

b. Activity Data

Livestock in RoM consists of livestock raised on the island, and live imports that are held for a relatively short period of time before slaughter. Population data for dairy cows, other cattle, sheep, goats and swine raised in RoM were obtained from Food and Agricultural Research and Extension Institute (FAREI) and Digest of Agricultural Statistics. Imported sheep, goats and cattle figures were obtained from MMA slaughter statistic; the data was annualised by dividing by 4 (assuming the animals are reared over a period of 3 months before slaughter). The imported data figure exclude animals slaughtered for religious purposes.

The deer population of 16,000 on paddock was estimated based on previous records available at FAREI. The data for poultry was deduced from production data quoted from Food Balance sheet of the Digest of Agricultural Statistics and formulated production technical assumptions. For annualised broilers estimation, the yearly production data was divided by 1.5 kg carcass weight and by 6 (representing minimum production cycles per year).

The broiler parent stocks are deduced by dividing the estimated yearly broiler production by 300 (maximum eggs per bird). The layers population is estimated by dividing the yearly production by 300 (maximum eggs per bird). The layer parent stock is estimated by dividing the layer population by 300 (maximum eggs per bird). The data for duck was from FAREI and Animal Production Division of the MoAIFS. The total poultry population includes total estimates for broiler, layers, broiler parent stocks, layer parent stocks and ducks.

The live weight of poultry, pigs, cattle, goat and sheep were agreed by livestock expert from FAREI based on weighing data collected at FAREI Curepipe Livestock Research Station (CLRS) and on farms.

For Rodrigues the agricultural census carried out in 2014 was used to estimate the livestock population. As some of the livestock are annually exported to RoM, the ratio on exports to total population for each livestock was used to extrapolate the populations for other previous years, based on statistics on exports are available annually from the Digest of Statistics for Rodrigues published by Statistics Mauritius.

The activity data (AD) for manure management comprised the different livestock species and poultry population, which is presented in above ***Table 44*** denoting the number of heads by type of livestock and poultry. These livestock data were then characterised according to agro climatic region 22^{o}C, 24^{o}C and 25^{o}C, type, weight, manure management system.

The common manure management system/fraction (as defined in the 2006 IPCC Guidelines, pp10.62-10.63 table 10.21) which has been observed locally have been summarised as follows: in Cattle (pasture, solid storage, anaerobic digester, dry lot and anaerobic lagoon), goats and sheep (pasture and solid storage), Pig (solid storage and anaerobic digester), poultry (poultry with beddings and poultry without beddings) and deer (paddock).

c. Emission Factors

For Enteric Fermentation

The following default emission factors[33] in Kg CH_4/ (head. Year) are used:

- 46 for dairy cows
- 31 for other cattle
- 5 for sheep and for goats
- 1 for swine
- 20 for deer (Paddock)

[33] IPCC. (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Agriculture, Forestry and Other Land Use. 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Agriculture, Forestry and Other Land Use. Retrieved March 3, 2014, from http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

For Manure Management System

The default CH_4 emission factors for enteric fermentation and manure management in kg CH_4/ (head. year) used are summarised in ***Table 46*** as follows:

Table 46: Summary for Emission Factors for Manure Management System

Livestock sub Category	Typical Animal Mass (kg)	CH_4 Emission Factor from Manure Management (kgCH_4/(head year)	N Excretion rate/mass/day (kg N/kg of animal/day)
Dairy cow	400	1	0.73
Bull	200	1	0.73
Calf	75	1	0.73
Heifer	150	1	0.73
Imported bull	500	1	0.73
Sheep	45	0.15	1.17
Goat	30	0.17	1.37
Horse	377	1.64	0.46
Mule & Asses		0.9	0.46
Boar	150	1	0.55
Fattener	90	1	1.57
Piglet	13	1	1.57
Sow/gilt	125	1	0.55
Broiler	1.8	0.02	1.1
Broiler Parent Stock	2.1	0.03	0.82
Layer/Layer Parent Stocks	1.8	0.03	0.82
Duck	2.5	0.03	0.83
Deer	60	0.22	1.17

The default N_2O Emission Factors used are as shown in ***Table 47***.

Table 47: Emission Factors for Direct N_2O from Manure Management System

	Emission Factor for direct N_2O from Manure Management System						
Livestock subcategory	**Solid storage**	**Pasture range paddock**	**Dry lot**	**Anaerobic digester**	**Aerobic treatment**	**Poultry with litter**	**Poultry without litter**
Dairy cow	0.005						
imported bull			0.02				
Bull	0.005						
Calf	0.005						
Heifer	0.005						
Boar	0.005			0	0.01		
Fattener	0.005			0	0.01		
Piglet	0.005			0	0.01		
sow/gilt	0.005			0	0.01		
Sheep	0.005		0.02				
Goat	0.005		0.02				
Broiler						0.01	0.01
Broiler parent						0.01	0.01
Layer/ Layer Parent Stocks						0.01	0.01
Duck						0.01	0.01

5.2.3 Results

GHG emissions from enteric fermentation increased from 24.03 Gg CO_2-eq in the year 2000 to 27.23 Gg CO_2-eq in 2013, representing a increase of 13.3%. The share for enteric fermentation increased from 17.8% to 19.2% in the Agriculture Sector during the same period (***Table 48***). GHG emissions from manure management system increased from 7.00 Gg CO_2-eq in the year 2000 to 11.58 Gg CO_2-eq in 2013.

Table 48: GHG Emissions (Gg CO_2-eq) from Livestock (Enteric Fermentation & Manure Management System)

Year	Total for Agriculture	Livestock		Share for Livestock (%)	
		Enteric Fermentation	Manure Management System	Enteric Fermentation	Manure Management System
2000	134.89	24.03	7.00	17.8	5.2
2001	134.71	24.49	6.84	18.2	5.1
2002	132.88	24.89	7.26	18.7	5.5
2003	130.79	24.69	7.25	18.9	5.5
2004	127.46	23.16	7.23	18.2	5.7
2005	122.07	24.58	7.81	20.1	6.4
2006	127.06	24.93	12.41	19.6	9.8
2007	123.06	26.50	10.91	21.5	8.9
2008	116.71	24.73	10.75	21.2	9.2
2009	113.84	23.63	11.00	20.8	9.7
2010	127.56	26.93	12.29	21.1	9.6
2011	162.83	27.41	12.28	16.8	7.5
2012	141.08	27.55	12.00	19.5	8.5
2013	141.55	27.23	11.58	19.2	8.2

5.2.4 Quality Control

The AD, EFs and GHG enteric emissions were verified and validated by immediate supervisors in FAREI (QC), in view, to reduce the level of uncertainties. The accuracy of emission data generated, depended on the expert knowledge of the livestock subsector with a good level of confidence, the methodology adopted to make estimations for certain livestock categories and QC approach for verification and validation exercise across the whole inventory period.

The secondary AD, default manure management EFs and the corresponding CH_4 and N_2O emissions, throughout the inventory period, were then verified and validated by supervisors (QC) in view to improve accuracy of the generated data with a good level of confidence. The accuracy of emission data generated depended on the profound knowledge of the livestock species and manure management system, proper entry of data in software and QC approach for verification and validation exercise across the whole inventory period.

More general detail on quality control for AFOLU is in 5.1.4 above.

5.2.5 *Uncertainties and Time Series Consistency*

FAREI have provided primary data on the livestock population based on different sources namely; Digest of Agricultural Statistics Mauritius, Food and Agricultural Research and Extension Institute (FAREI) farm surveys and estimation, as well as data from Statistics Mauritius.

The accuracy of activity data collected depended on the expert knowledge of the livestock subsector, the methodology adopted to make estimations for certain livestock categories and QC approach for verification and validation across the whole inventory period with a good level of confidence. An overall uncertainty of 15% was thought to be a suitably conservative estimate.

The combined uncertainty for emissions trend for enteric fermentation by type of livestock emissions for the period 2006 to 2013 indicated zero in the 2006 IPCC Software and therefore were not assessed. This will be assessed in upcoming the Fourth National Communication.

5.2.6 *Planned Improvements*

Some AD and default EFs had to be estimated by using expert knowledge. Therefore, it is anticipated to:

- Empower the FAREI to improve collection of population data and development of local EFs to reduce uncertainty level.
- Setting up of an information system for data archiving, backup and sharing is essential to ensure sustainable preparation of GHG inventories in the near future;
- Building a database for livestock population by type and their characterisation, including, mass, feeding habits and other factors related to GHG emissions;
- Applying the methodology for filling data gaps; and
- Improvement of the methodology for uncertainty assessment and time series consistency.

This will also include the application of some extrapolation for gap filling.

5.3 Land (Category 3B)

The land use category is subdivided into the six IPCC land subcategories, namely: Forestland, Cropland, Grassland, Settlements, Wetlands and Other lands. Each of the 2006 IPCC categories is briefly described below.

5.3.1 Land Use Sub-Categories

5.3.1.1 Forestland (3B1)

In RoM, there is no legal definition for forestland. However, any land area of 0.5 ha or more and having a natural or planted forest tree canopy cover of 30% or more is considered as forestland. Forestland includes plantations and natural forest. This category covers estimation of CO_2 removals and includes above-ground biomass and the soil carbon pool. There has been very little change in the forested areas across the time series. However, the reason that remaining forestland is a net sink is because there is an increase in the standing biomass per hectare.

Forests are the major sinks in RoM and currently about 47,108 ha are estimated as this land cover type. The area of forests was revised in the year 2004 by the Forestry Service and it was found to decline from about 57,000 ha to about 47,108 ha. The majority of the losses occurred from private forests which were reviewed and updated on the basis of data obtained from the Remote Sensing Centre and a subsequent survey carried out by the Forestry Service in 2004 (SNC 2010).

Rodrigues has estimated area of about 3,400 ha which represent about 31% of the island. Though in Rodrigues there are other land classes such as grassland, settlements and croplands, no proper assessments exists and hence only the forests has been considered. For this NIR, almost all forestlands have been considered as Forest Land Remaining Forest Land when compiling the inventory.

The detailed assessment of other lands in Rodrigues will be conducted in future inventory planned during the development of Fourth National Communication.

Both the native and planted forests are considered, as they are all managed. They have been classified according to types and ecological zone to be used in the 2006 IPCC Inventory Software. Timber exploitation is carried out mainly in planted forests under Pine and Eucalyptus species. Both these species are moderately resistant to cyclones and suffer substantial damage during their passages. The amount of carbon stored through biomass increment exceeds by far the amount lost through commercial felling, fuel wood gathering and disturbances such as cyclones and fires.

Timber exploitation is limited and will be further reduced in the future, in line with the National Forest Policy (2006). Forest fires occur mostly in dry lowland forests with an average of about 100 ha affected annually (SNC). The sub classes include:

- Dry land (*Araucaria columnaris, Araucaria cunninghamii Casuarina equisetifolia, Eucalyptus tereticornis, Tabebuia pallida,* Scrubland forest);
- Mangrove forest;
- Moist Forest (*Araucaria columnaris, Eucalyptus tereticornis, Eucalyptus robusta, Tabebuia pallida,* amongst others, Scrubland forest, Natural forest);

- Wet upland forest (*Eucalyptus robusta,, Cryptomeria japonica, Pinuselliottii, Araucaria columnaris*, amongst others); and
- Natural Forest.

5.3.1.2 Cropland (3B2)

Cropland comprises mostly sugarcane cultivation which covers about 56,391 ha (2013) or 30% of the total surface area (Statistics Mauritius 2014). Since the late 1990s, cropland has been declining due to abandonment and conversion of sugarcane lands (SNC). The sub classes considered are:

- Fruits;
- Mixed Cropping;
- Orchard;
- Sugarcane;
- Tea; and
- Cropland Trees.

5.3.1.3 Grassland (3B3)

According to 2006 IPCC Guidelines, this category includes range lands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, consistent with national definitions.

In RoM, this category includes land that are left as unoccupied that are invaded by bushes and a few patches of trees, part of hunting areas in private forests and along mountain sides. Since they include some woody biomass, they have been accounted for.

5.3.1.4 Wetlands (3B4)

This category includes areas of land that are covered or saturated by water for all or part of the year and that do not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.

This category in RoM is considered to be managed as reservoirs and rivers and their surrounding areas. Hence, the trees around them have been considered. However, the 2006 IPCC Guidelines does not provide methods to account for these sinks and therefore the calculations have been included in forests. This also includes mangroves which are classified in the forests categorisation.

5.3.1.5 Settlements (3B5)

This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. The trees within the compounds of houses, along roads, parks and others within settlements form an additional sink of carbon in RoM.

5.3.1.6 Other Land (3B6)

Other Land includes bare soils, rocky lands and unmanaged land that do not fall into any of the other five categories. According to the 2006 IPCC Guidelines, this land-use category is included to allow the total of identified land areas to match the national area and there is no need to estimate emissions from it.

5.3.2 The Land Cover and Use

The land cover in RoM has been classified according to ecological zones and these include climate type. The different land classes considered, as described above, is presented in ***Figure 32***.

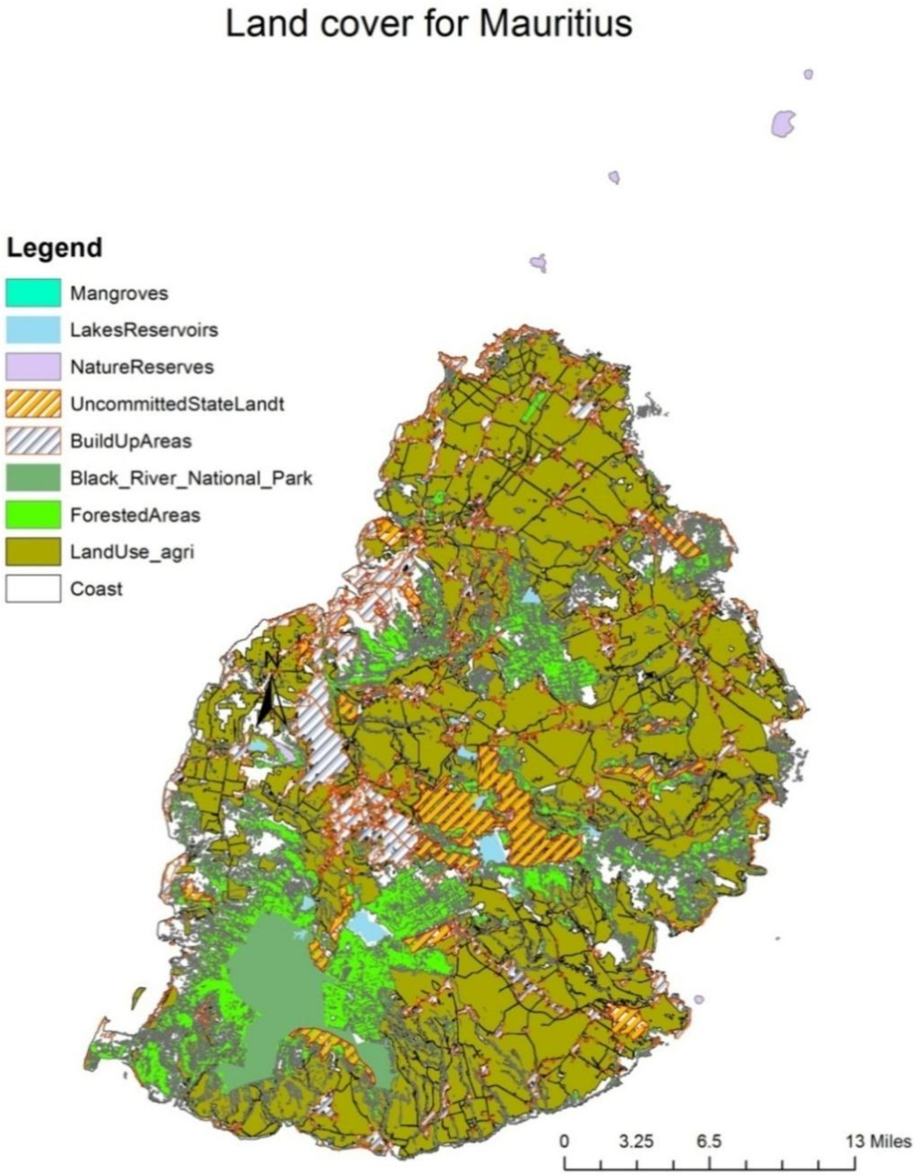


Figure 32: Land Cover of Mauritius (Circa 2010)

5.3.3 Land Cover Change Assessment

According to a recent study by International Institute for Applied Systems Analysis (IIASA) (Fischer et al. 2013), the land cover for RoM was as follows: cultivated 53% , forests 11% , others 27%, Settlements 8% and water bodies 1%. This study has its own definitions for forests and obviously much of the forest lands are under the others category.

An assessment of land use change was made using a national methodology, which is still under development. The methodology uses satellite imagery from online sources as developed by the

US Forest Department (USDA 2014)[34] and has been used in a few studies (e.g. Song et al. 2012). Since longer time slots change are not available a 10 to 12 years change is adopted. The estimates in the TNC are as presented in ***Table 49*** below:

Table 49: Land Cover Change

	2004-2009		2014		
Cover Class	**Extent Ha**	**Share %**	**Extent Ha**	**Share %**	**Change %**
Forest and Other Wooded Lands[35]	52,867	28.3	52,867	28.34	0.000
Cropland	91,424	49.0	90,320	48.42	-1.208
Wetland	3,690	2.0	3,690	1.98	0.000
Grassland	1,779	1.0	1,779	0.95	0.000
Settlements	27,840	14.9	28,880	15.48	3.736
Other lands	8,940	4.8	8,980	4.81	0.447
Total	186,540	100.0	186,516	100.00	

The estimates were verified against other publications such as statistical digests, study by Fischer et al. (2013), MSIRI map and others to calibrate the land classifications and their proportions. It is to be noted that different studies may have some land classes that are differently defined, such as Fisher et al. (2013) which uses FAO forest classes which is not applied in Mauritius.

5.4 Forest Land (Category 3B1)

The carbon stock in forests changes is due to:

- biomass increments in forests;
- losses from deforestation;
- harvesting of round wood and fuel wood;
- disturbances such as fires;
- cyclones; and
- pests and diseases.

The 2006 IPCC Guidelines were used for the estimation of the emissions of the forest sector. CO_2 emissions from living biomass, dead organic matter and soil were calculated using a Tier 1 approach. In accordance with this approach, net change of CO_2 for dead organic matter is equal to zero as it is assumed that the average transfer rate of CO_2 into the dead wood pool is equal to transfer rate out of the dead wood pool.

[34] iTree canopy software

[35] According to A. Sookun et al. (nd), - work in progress, Forests include other wooded lands not captured in forest statistics; Croplands, Settlements, and Other lands include trees outside forests and other green belts and areas, e.g., abandoned lands. Therefore, the figures for Forest and Other Wooded lands provided in above table are different with the total forest area for RoM provided in executive summary, page xviii.

5.4.1 Source Category Description

Historically, RoM was totally covered with luxurious native forests. However, following its colonisation, extensive forest areas have been cleared for agriculture, settlement and infrastructural development. In parallel, several invasive species which contributed to the degradation of the forests have been introduced. Large areas of native forests were also cleared and replaced by economically fast growing species such as pine and eucalyptus. However, over the last decades, the Government has recognised that halting and reversing the trend of deforestation and forest degradation will help to curb the country's carbon emission and provide other environmental and ecosystem services. As a result, the rate of deforestation has greatly reduced despite the intense competition for other land uses. The average annual rate of deforestation for the period 2006-2013 was approximately 0.02%.

There are only two types of forest ownership in Mauritius: public and private. In the year privately owned forestland are estimated to be some 25,000 ha (53% of total forest area) and state owned forestland is estimated to be 22,103 ha. Trees on State Lands are legally protected under the Forests and Reserves Act (1983). In contrast, only about 6,540 ha of the total private forest lands (including river and mountain reserves) are legally protected by the Act. Public access to private forestland is also limited and information on tree species on private land is not well known. The number of trees along roads, rivers and household premises is also not well documented.

For the purpose of the inventory, the forests were grouped into the following three ecological zones: wet upland forests, moist forests and dry lowland forests (***Table 50***).

Only 73 ha of forestland was lost between 2006 and 2013. The total extent of Forest Cover for the island of Mauritius in 2013 was approximately 47,108 ha and represented approximately 25% of the land area. Among these, 14,686 ha were exotic plantation species such as *Pinus elliottii*, *Eucalyptus tereticornis*, *Eucalyptus robusta*, *Cryptomeria japonica*, *Araucaria columnaris* and *Tabebuia pallida.* Natural forest was estimated to cover an area of 20,179 ha. However, the area of good quality native forest, i.e., with more than 50% native plant cover is estimated to be approximately 3,730 ha. A reforestation programme of Mangrove is also ongoing. As a result, the mangrove area has increased from 45 ha in 1980 to 178 ha in 2013.

The total volume of standing wood mass in RoM in the inventory year 2013 was on average 120 m^3 /ha. The average forest increment was 2.8 m^3/yr/ha.

Native species are not commercially logged in RoM and are now legally protected by the Native Terrestrial Biodiversity and National Parks Act (2015). Only exotic plantation is commercially harvested in RoM. However, in line with the National Forest Policy (2006), timber exploitation is gradually being phased out and exotic species are gradually being replaced by native species. As a result, the harvested round wood and firewood has steadily decreased from 8,474 m^3/year and 6,058 m^3/year respectively in the inventory year 2006 to 1,244 m^3/year and 2102 m^3/year respectively in the inventory year 2013 (***Table 51***). The harvested timber was mostly Pine, Araucaria and Eucalyptus.

Table 50: Land Area for Major Forest Types

Ecological Zone (Tropical)	Category	Species	2006	2007	2008	2009	2010	2011	2012	2013
			Extent (ha)							
Wet Upland Forest R > 2000mm	Plantation	*Pinus elliottii*	8,162	8,195	8,165	8,197	8,199	8,176	8,179	8,179
	Plantation	*Eucalyptus*	546	546	550	550	565	565	565	565
	Plantation	*Cryptomeria japonica*	967	967	967	967	965	965	965	965
	Plantation	*Araucaria*	62	62	62	62	60	60	60	60
	Natural	native forests severely invaded by alien plant species	15,146	15,113	15,143	15,111	15,100	15,100	15,100	15,100
Moist Forest 2000 mm> R > 1000 mm	Plantation	*Eucalyptus*	889	889	889	889	889	889	889	889
	Plantation	*Tabebuia pallida*	139	139	139	139	139	139	139	139
	Plantation	*Araucaria*	176	176	176	176	174	174	174	174
	Plantation	*Casuarina equisetifolia*	110	110	110	110	110	110	110	110
	Natural	native forests severely invaded by alien plant species	5,085	5,085	5,085	5,085	5,079	5,079	5,079	5,079
Dry Lowland Forest R <1000mm	Plantation	*Eucalyptus*	2,389	2,410	2,413	2,413	2,433	2,437	2,437	2,402
	Plantation	*Tabebuia pallida*	710	710	710	710	710	710	710	710
	Plantation	*Araucaria*	408	384	384	384	382	382	382	382
	Plantation	*Casuarina equisetifolia*	116	112	112	112	112	112	112	111
	Scrublands	Mainly exotics	12,276	12,278	12,254	12,254	12,242	12,242	12,242	12,243
		Total	**47,181**	**47,176**	**47,159**	**47,159**	**47,159**	**47,140**	**47,143**	**47,108**

Note: R stands for rainfall

Table 51: Harvest of Round Wood and Fuel Wood Gathering

Year	Harvest of roundwood (m^3/year)	Fuelwood gathering (m^3/year)
2006	8,474	6,058
2007	6,885	7,067
2008	5,614	5,217
2009	5,094	5,482
2010	4,916	9,412
2011	4,488	6,472
2012	3,136	3,480
2013	1,244	2,102

5.4.2 Methodological Issues

All forest data are available at the Forestry Service. The growing stock data were obtained from Global Forest Resource Assessment for RoM (2005, 2010 and 2015). The growing stock data were available for the following species: *Pinus elliottii*, *Eucalyptus sp*, *Araucaria sp*, T*abebuia pallida*, *Cryptomeria japonica* and *Casuarina equisetifolia*. Forest coverage data, harvested wood and area affected by disturbances were available in Forestry Service Annual Reports (2006-2013).

The methodologies and equations used are those available in the 2006 IPCC Guidelines. Most of the country specific factors were not available (basic wood density, biomass expansion factors, root-to-shoot ratio, amongst others). The removal factors utilised were mostly default values.

Estimating Change in Carbon Stocks in Biomass on Forestlands

- Carbon stock change in biomass on Forest Land is an important sub-category due to substantial fluxes arising from management and harvest, natural disturbances, natural mortality and forest regrowth.
- Changes in C stocks in biomass pool were estimated using the *Gain-Loss method*.
- The *Gain-Loss Method* requires the biomass carbon loss to be subtracted from the biomass carbon gain.
- *Gain-Loss Method* is the basis of Tier 1 method, for which default values for calculation of increment and losses are provided in the 2006 IPCC Guidelines.

a. Calculations

Annual increase in biomass carbon stocks (Gain-Loss Method), ΔC_{G-} (Land remaining in same land use category):

$$\Delta \mathbf{C_G} = \sum_{i,j} \left(\mathbf{A}_{i,j} \times \mathbf{G}_{TOTAL_{i,j}} \times \mathbf{CF}_{i,j} \right)$$

Where:

- ΔC_G = annual increase in biomass carbon stocks due to biomass growth in land remaining in the same
- land-use category by vegetation type and climatic zone, tonnes C yr^{-1}
- A = area of land remaining in the same land-use category, ha
- G_{TOTAL}= mean annual biomass growth, tonnes d. m. ha^{-1} yr^{-1}
- *i* = ecological zone (*i* = 1 to *n*)
- *j* = climate domain (*j* = 1 to *m)*
- CF = carbon fraction of dry matter, tonne C (tonne d.m.)$^{-1}$

Equation 2.9 page, 2.15, Vol 4, 2006 IPCC Guidelines

Average annual increment in biomass (G_{TOTAL}):

$$\mathbf{G_{TOTAL}} = \sum(\mathbf{I}_V \times \mathbf{BCEF_I} \times (\mathbf{1} + \mathbf{R}))$$

Where:

- G_{TOTAL} = average annual biomass growth above and below-ground, tonnes d. m. ha^{-1} yr^{-1}
- R = ratio of below-ground biomass to above-ground biomass for a specific vegetation type, in tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$. R must be set to zero if assuming no changes of below-ground biomass allocation patterns (Tier 1).
- I_V = average net annual increment for specific vegetation type, m^3 ha^{-1} yr^{-1}
- $BCEF_I$ = biomass conversion and expansion factor for conversion of net annual increment in volume (including bark) to above-ground biomass growth for specific vegetation type, tonnes above-ground biomass growth (m^3 net annual increment)$^{-1}$

(Equation 2.10- page, 2.15, Vol 4, 2006 IPCC Guidelines).

Biomass carbon stocks losses (Gain-Loss Method), ΔC_L

$$\Delta \boldsymbol{C_L} = \boldsymbol{L_{wood-removal}} + \boldsymbol{L_{fuelwood}} + \boldsymbol{L_{disturbance}}$$

Where:

- Δ_{CL} = annual decrease in carbon stocks due to biomass loss in land remaining in the same land-use category, tonnes C yr^{-1}
- $L_{wood\text{-}removals}$ = annual carbon loss due to wood removals, tonnes C yr^{-1}
- $L_{fuelwood}$ = annual biomass carbon loss due to fuelwood removals, tonnes C yr^{-1}
- $L_{disturbance}$ = annual biomass carbon losses due to disturbances, tonnes C yr^{-1}

(Equation 2.11, Vol 4, Page 2.16, 2006 IPCC Guidelines)
Note: for equations $L_{wood\text{-}removals}$, $L_{fuelwood}$ and $L_{disturbance}$ (Equation 2.12, 2.13 and 2.14 pg 2.17-2.18, 2006 IPCC Guidelines)

Biomass: Land Converted to Other Land-Use Category

$$\Delta \boldsymbol{C_B} + \Delta \boldsymbol{C_{CONVERSION}} - \Delta\, \boldsymbol{C_L}$$

Where:

- ΔC_B = annual change in carbon stocks in biomass on land converted to other land-use category, in tonnes C yr^{-1}
- ΔC_G = annual increase in carbon stocks in biomass due to growth on land converted to another land-use
- category, in tonnes C yr^{-1}

- $\Delta C_{CONVERSION}$ = initial change in carbon stocks in biomass on land converted to other land-use category, in tonnes C yr^{-1}
- ΔC_L = annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use category, in tonnes C yr^{-1}

(Equation.2.15, page 2.20, Vol 4, 2006 IPCC Guidelines)

Initial change in biomass carbon stocks in Land Converted to Other Land-Use Category *

$$\Delta\, C_{Conversion} = \sum_{i} \{(B_{AFTER_i} - B_{BEFORE_i}) \times A_{TO\_OTHERS_i}\} \times CF$$

Where:

- $\Delta C_{CONVERSION}$ = initial change in biomass carbon stocks on land converted to another land category, tonnes C yr^{-1}
- $B_{AFTER\,i}$ = biomass stocks on land type immediately after conversion, t d.m.ha^{-1}
- $B_{BEFORE\,i}$ = biomass stocks on land type before conversion, t d.m. ha^{-1}
- $\Delta A_{TO\_OTHERS\,i}$ = area of land use converted to another land-use category in a certain year, ha yr^{-1}
- CF = carbon fraction of dry matter, tonne C $(t\ d.m.)^{-1}$
- *i*= type of land use converted to another land-use category

(Equation 2.16, Page 2.20, Vol 4, 2006 IPCC Guidelines)

Change in C stocks in DOM: Land Remaining in the Same Land Use

- Tier 2 methods for estimation of carbon stock changes in DOM pools calculate the changes in dead wood and litter carbon pools by *Gain-Loss Method* (*GPG LULUCF* provides guidance on DOM only for FL)
- These estimates require either detailed inventories that include repeated measurements of dead wood and litter pools, or models that simulate dead wood and litter dynamics.

$$\Delta C_{DOM} = A \times \{(DOM_{in} - DOM_{out})\ X\ CF\}$$

Where:

- A = area of managed land, ha
- DOM_{in} = average annual transfer into DW/litter pool (due to
- mortality, slash due to harvest and natural disturbance),t d.m./ha/yr
- DOM_{out} = average annual transfer out of DW/litter pool, t d.m./ha/yr

- CF = carbon fraction of dry matter, tC/(t d.m.)

(Equation 2.18, page 2.23, Vol 4, 2006 IPCC Guidelines)

5.4.3 Results

The Net CO_2 emissions resulting from: (i) the land remaining the same and (ii) the land converted to other land use was estimated for the period 2006 to 2013. The land use sector represented a net removal of CO_2 for the period 2006 to 2010. Forestland remaining forestland represented a net carbon sink form living biomass during the period 2006-2013, as shown in ***Table 52*** below. Very little variation in the total CO_2 removal was observed for this land category with the average being -370 Gg CO_2-eq.

Table 52: GHG Emissions (Gg CO_2-eq) from Livestock (Enteric Fermentation & Manure Management System)

Year	Total for FOLU
2000	-396.13
2001	-397.47
2002	-351.86
2003	-402.95
2004	-360.94
2005	-361.96
2006	-361.42
2007	-352.06
2008	-371.51
2009	-362.23
2010	-358.12
2011	-364.65
2012	-370.13
2013	-367.53

5.4.4 Quality Control

All field data collected (e.g. Plantation sites, area, silvicutural operations, dbh, tree height, volume of forest produce harvested, among others) are verified at every stages of the Forestry Service organisational hierarchy (7 Levels). Data are compiled and recorded at the record office of the Forestry Service.

The QC consisted of verification of the activity data, emission factors, inventory results and reporting. QC dully completed template is highlighted as follows:

- Personal responsible for QC;
- QC category-specific procedures, tasks completed and specific measures taken;
- Crosscutting check for overall inventory quality; and
- Detailed check for document.

More details on quality control for AFOLU are at 5.1.4 above.

5.4.5 Uncertainty Assessment

Qualitative uncertainty assessed. Uncertainties are:

- In land-use and management activity and environmental data (land area estimates, fraction of land area burnt etc.);
- Uncertainty in the stock change/emission factors for Tier 1 or 2 approaches (carbon increase and loss, carbon stocks, and expansion factor terms); and
- Uncertainty in model structure/parameter error for Tier 3 model-based approaches, or measurement error/sampling variability associated with a measurement-based inventories.

Uncertainty was reduced by using higher tier methods (Tier 2) with more representative national parameter (i.e., land categories subcategories, trees height, diameters, among others) The quantification of uncertainties is planed during the inventory for Fourth National Communication.

5.4.6 Time Series Consistency and Recalculation

To rebuild a consistent time series for the land sector, recalculations were carried out mostly because of the availability of new activity data and emission factors. These changes in both activity data and emission factors resulted from:

(i) adoption of a new methodology and software for generating the emission factors;
(ii) new field surveys and data collection for above ground biomass estimates of dry lowland native forests and dry lowland forests, roadside trees);
(iii) New estimates for areas occupied by trees outside forest areas (trees along rivers, settlements, and agricultural lands) and availability of new data sets (trees outside forests); and
(iv) Refinement using expert knowledge. The recalculated values and differences from previous inventory are shown in the AFOLU sectoral overview above.

5.4.7 *Planned Improvements*

The major data gaps identified were lack of data and maps for general land cover changes and land uses for the past ten years and lack of data on private forests lands. To address some of these gaps the adoption of GIS and remote sensing with complementary ground truthing exercise is essential. In this context, several stakeholders were trained in GIS and remote sensing. However, because of the untimely acquisition of historical and current high resolution satellite imagery (with infrared bands), new land cover and time series of land use maps could not be produced for the current NIR.

Land cover maps produced will have to be overlaid with climatic and soil maps and data reprocessed to produce a time series of land use maps.

In order to move to a higher tier approach for future NIRs, the whole forest inventory system will have to be reviewed. Improved data collection and record keeping including distribution of forest by species, age class distribution and biomass estimates is essential for both natural and plantations. Actions aimed at simulations, creation and verification of country specific emissions/removals factors (annual net increment in volume, basic wood density, biomass expansion factors, root-to-shoot ratio, amongst others) will be have to be explored.

5.5 Aggregate Sources and non-CO_2 Emissions Sources on Land (3.C)

5.5.1 *Overview*

Agriculture occupied around 36% of the land area of RoM in 2010. There has been a constant decrease of agricultural land over the years, mainly due to a decrease in the area under sugar cane for economic reasons, and the expansion of settlements and infrastructures.

The agricultural sector is dominated by sugar cane, which is planted on around 92 % of the arable land, the rest being used for food crops (general vegetables and ornamentals), fruits, tea and livestock production. The extent of land under the different agricultural land use in 2014 is given in ***Table 53***.

Table 53: Harvested Area and Production in 2014

Crops	Harvested area (ha)	Production (tonnes)
Sugar cane	57,081	400,173
Potato	821	19,409
Tomato	857	10,997
Onion	282	5,912
Carrot	319	4,430
Other general vegetables and food crops	5,266	52,402
Pineapple	450	10,788

Crops	Harvested area (ha)	Production (tonnes)
Banana	464	8,833
Tea (black tea)	672	1,504
Paddy (rice)	412	1,186

Source: Digest of Agricultural Statistics 2014

Around 12,000 ha of the arable land are under irrigation and 90 % of this irrigation area is used for sugar cane production.

General vegetables and food crops include major crops such as potato, onion, carrot, crucifers, tomatoes and creepers, as well as many other species regularly cultivated by farmers. This sector is dominated by small scale farmers, cultivating between 0.5 to 2.0 ha of land using mainly a mixed cropping system. Food crops are also cultivated on rotational lands of sugar cane. In 2014, around 113,950 tonnes of vegetables food crops and fruits including banana and pineapple was produced from a harvested area of around 8,450 ha. The sugar industry produced 400,173 tonnes of sugar in 2014.

Synthetic fertilisers are extensively used in the production of sugar cane and food crops. In addition, compost and manure from the livestock sector and scum are also used as organic fertilisers in sugar cane and food crop production.

Livestock production is carried out by some 5,000 farmers engaged mainly in cattle, goat, sheep, pig, deer, poultry and rabbit farming.

5.6 Emissions from Biomass Burning (3. C.1)/Biomass Burning in Cropland (Category 3C 1b)

5.6.1 Source Category Description

The burning of agricultural residues releases GHG such as CH_4, N_2O, CO, NO_x and NMVOCs. These gases are formed from carbon and nitrogen in the plant material during the combustion process. As per the 2006 IPCC Guidelines, the CO_2 emissions from burning of agricultural residues are not included in the inventory total since it is assumed that an equivalent amount of CO_2 was removed by the growing crop.

In RoM, biomass burning is mostly practised during the harvest period of sugarcane although cases of accidental burning in sugar cane fields are also reported. This practice represents a physical advantage to reduce the obstacle represented by trash around the stalk of sugar cane during manual or mechanical harvesting. Sugar cane burning was practised in 1995 on approximately 35% of land managed by corporate miller-planters on both mechanically and manually harvested fields. However, this figure decreased to 15% in 2005 and has gradually been reduced to around 10 % of cultivated sugar cane areas in recent years. All over the world, the trend is to avoid sugar cane burning before the harvest for environmental reasons.

5.6.2 Methodological Issues

a. <u>Calculations</u>

The Tier 1 methodology based on the 2006 IPCC Guidelines was applied to calculate the emissions from sugar cane burning using the following equation:

$$L_{fire} = A \times M_b \times C_f \times G_{EF} \times 10^{-3}$$

Where,

L_{fire} = mass of GHG emission from fire (t GHG)

A = area burnt (ha)

M_b= mass of fuel available for combustion (t dm ha^{-1})

Cf = combustion factor (dimensionless)

G_{ef} = emission factor (g kg^{-1} dm burnt)

b. <u>Activity Data</u>

The acreage of sugar cane burnt prior to harvest is available for the corporate miller-planters and has been decreasing over the past decade to reach less than 10% of the cultivated sugar cane area. Generally, small planters do not burn their fields prior to harvesting and also cases of accidental field burning fluctuate over the years. Taking all the sugar cane fields into consideration and based on past trends, an average of 10 % of total annual cultivated area was considered to be burnt during the reporting period covering the eight years.

c. <u>Emission Factors</u>

Emission factors for pre-harvest burning of sugarcane residue were determined by using default values within the 2006 IPCC Inventory Software.

The choice of emission factors for GHG emissions from biomass burning used are enumerated in ***Table 54*** below.

Table 54: Emission Factors used to calculate GHG Emissions from Biomass Burning

Source	Parameter	Unit	EF	Source
Biomass burning in crop land	Mass of fuel available for combustion	t/ha	6.5	2006 IPCC Guidelines
	Combustion factor	-	0.8	2006 IPCC Guidelines
	Emission factor	g GHG/ kg dry matter burnt	2.7	2006 IPCC Guidelines

5.6.3 Results

Aggregated emissions from the Biomass Burning decreased from 2.84 Gg CO_2-eq in the year 2006 to 1.66 Gg CO_2-eq in 2013 , mainly attributed to the decrease in area under sugarcane cultivation and thus a lower acreage is devoted to burning prior to harvest. ***Table 55*** shows the GHG emissions in Gg CO_2-eq, from biomass burning.

Table 55: GHG Emissions (Gg CO_2-eq) from Biomass Burning

Year	Total for Agriculture	Biomass Burning	Share for Biomass Burning (%)
2000	134.89	2.84	2.1
2001	134.71	3.16	2.3
2002	132.88	3.08	2.3
2003	130.79	3.05	2.3
2004	127.46	2.83	2.2
2005	122.07	2.94	2.4
2006	127.06	2.61	2.1
2007	123.06	1.04	0.8
2008	116.71	0.99	0.8
2009	113.84	1.00	0.9
2010	127.56	0.97	0.8
2011	162.83	1.82	1.1
2012	141.08	1.69	1.2
2013	141.55	1.66	1.2

5.6.4 Quality Control, Uncertainty Analysis and Planned Improvements

This source category is covered by the same general QC procedures detailed in the section relating to the emissions from managed soils (see below). Furthermore, the uncertainty analysis and planned improvements described are applicable to this category also.

5.7 Agricultural Soils (Category 3C)

This category combines 3.C.4 and 3.C.5.

5.7.1 Source Category Description

In RoM, contribution to direct emissions from the agricultural soils occur mainly from the use of synthetic N fertiliser, recycling of crop residues and organic amendments such as compost and animal manures during crop production. Emissions also occur from soil organic matter mineralisation during such practices like ploughing and tillage. The indirect emissions of nitrous oxide arise mainly from atmospheric of N deposition and from leaching and surface runoff of applied N mineralised into groundwater and surface water.

Emissions due to liming of agricultural soils have not been accounted for because only limited amount of carbonate lime is used in RoM. Rice cultivation is undertaken over a limited area without flooding, and therefore, has been included as a normal crop.

5.7.2 Methodological Issues

Nitrous oxide (N_2O) is produced naturally in soils through the microbial processes of nitrification and denitrification. A number of agricultural activities add nitrogen (N) to soils, increasing the amount of nitrogen available for nitrification and denitrification, and ultimately the amount of N_2O emitted. The emissions of N_2O that result from anthropogenic N inputs occur through both a direct pathway (i.e. directly from the soils to which the N is added), and through two indirect pathways (i.e. through volatilisation as NH_3 and NO_x and subsequent redeposition, and through leaching and runoff). In the 2006 IPCC Guidelines, direct and indirect emissions of N_2O from agricultural soils are estimated separately. The 2006 IPCC Guidelines method for estimating direct N_2O emissions from agricultural soils has two parts: (i) estimation of direct N_2O emissions due to N-inputs to soils (excluding N-inputs from animals on pasture, range, and paddock); and (ii) estimation of direct N_2O emissions from unmanaged animal manure (i.e. manure deposited by animals on pasture, range, and paddock).

The 2006 IPCC Guidelines were used to estimate emissions from agricultural soils. The guidelines divide the Agricultural Soil Management source category into five components:

1) direct emissions due to N additions to cropland and grassland mineral soils, including synthetic fertilisers, sewage sludge applications, crop residues, organic amendments, and biological N fixation associated with planting of legumes on cropland and grassland soils;
2) direct emissions from soil organic matter mineralisation due to land use and management change;
3) direct emissions from drainage of organic soils in croplands and grasslands;
4) direct emissions from soils due to the deposition of manure by livestock on grasslands; and
5) indirect emissions from soils and water due to N additions and manure deposition to soils that lead to volatilisation, leaching, or runoff of N and subsequent conversion to N_2O.

In RoM, emissions were estimated for direct N_2O emissions from synthetic N fertilisers and manure/compost application, indirect N_2O emissions from leaching and runoff, indirect N_2O emission from atmospheric N deposition and direct N_2O from crop residues. A Tier 1 methodology was applied to the extent that only few country specific emission factors were used in the inventory.

Direct and indirect N_2O emissions were estimated using the 2006 IPCC Inventory Software Version 2.17 (2016) which is based on the 2006 IPCC Guidelines.

a. Calculations

Emissions from managed soils were calculated using a Tier 1 method according to the IPCC Inventory Software which is based on the 2006 IPCC Guidelines. The equation 11.1, from Chapter 11, 2006 IPCC Guidelines, was however adapted to local conditions, as far as certain activities were excluded from it because of their limited extent in the local context. For instance, no flooded rice is practiced and the use of carbonated lime is not occurring.

The equation for direct N_2O emission is as follows:

$$\boldsymbol{N_2O_{Direct} - N = N_2O - N_{N\,inputs} + N_2O - N_{PRP}}$$

Where :

$$\mathbf{N_2O - N_{N\,inputs} = [(F_{SN} + F_{ON} + F_{CR}) \times EF_l]}$$

$$\mathbf{N_2O - N_{PRP} = [F_{PRP,CPP} \times EF_{3PRP,CPP}) + (\,F_{PRP,SO} \times EF_{PRP,SO})]}$$

Where :

N_2O_{Direct}– N = annual direct N_2O – N emissions produced from managed soils (kg N_2O – N yr^{-1});

N_2O – $N_{N\ inputs}$ = annual direct N_2O – N emissions from N inputs to managed soils (kg N_2O – N yr^{-1})

N_2O – N_{PRP}= annual direct N_2O – N emissions from urine and dung inputs to grazed soils (kg N_2O – N yr^{-1})

F_{SN} = annual amount of synthetic fertiliser N applied to soils (kg N yr^{-1})

F_{ON} = annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soil (kg N yr^{-1})

F_{CR} = annual amount of N in crop residues, including N- fixing crops, and forage/pasture renewal, returned to soils (kg N yr^{-1})

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N yr^{-1})

CPP = Cattle, Poultry and Pigs, SO = Sheep and Other;

EF_l = emission factor for N_2O emissions from N inputs (kg N_2O – N (kg N input)$^{-1}$);

EF_{3PRP} = emission factor for N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals (kg N_2O – N (kg N input)$^{-1}$), CPP = Cattle, Poultry and Pigs, SO = Sheep and Other.

b. <u>Activity Data</u>

To estimate direct and indirect N_2O emissions from managed soils, the 2006 IPCC Guidelines encourage, as far as possible, detailed activity data collection, in order to generate good estimate of emissions from agricultural soils. In this context the following activity data were collected locally:

1. Application rates of nitrogenous fertilisers and national consumption;
2. Crop residues returned to soil and their N content;
3. Animal manure, compost and other organic inputs applied to soil; and
4. Harvest areas and yield for the different crops.

The nitrogen was estimated by considering both local production and imports in estimating the amount of fertiliser applied to land (i.e., data from Statistics Mauritius and local manufacturers of fertilisers)

Crop residue data for food crop were gathered from past unpublished results of research projects available at the FAREI. The dry matter fraction of crop residues was obtained from a combination of unpublished data and expert knowledge from different crop specialists.

Data on the areas harvested and the yield for some thirty crops cultivated as well as areas under some common fruits, like banana and pineapple was available from the Biometry Division of FAREI and Statistics Mauritius. Good quality statistics are available for areas under sugar cane at the MCIA and for Tea at the NAPRO as well as from Statistics Mauritius.

Data on the use of compost, animal manure and other organic input on soil were based on an estimate of the annual number of heads available at the Livestock Department of FAREI as well as from Statistics Mauritius. The amount of scum, a by-product of the sugar industry, which is used as an organic amendment in soil, was obtained from the MCIA.

The activity data for determining emission from managed soils summarised in the ***Tables 56 and 57*** below.

Table 56: Area cultivated under the Different Crops over the Inventory Period 2006-2013

	Area Cultivated (ha)							
Crop	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Mixed cropping[1]	6521	6072	5536	6318	6780	6610	7121	7078
Sugar Cane[2]	70800	68520	65440	65850	64130	61730	57160	56464
Tea[1]	688	709	701	713	698	651	669	672
Rice (upland)[1]	0	0	0	0	0	120	309	304
Banana[1]	510	464	502	494	542	497	510	501
Pineapple[1]	176	204	228	271	248	377	493	610
Orchards (litchi, mango)[3]	300	300	300	300	300	300	305	310
Tobacco[1]	249	252	260	210	213	222	173	2

Source: [1]Digest of Agricultural statistics 2010, [1]Digest of Agricultural statistics 2013, [2]Crop Bulletin of Chamber of Agriculture, [3]2014 Census of Agriculture, [3]Fruit trees census 2011.

*Table 57: Summary N Inorganic Fertiliser used on Cropland for the whole Island**

Year	kg N/yr
2013	9,967,255
2012	9,700,004
2011	7,834,140
2010	7,468,310
2009	6,616,456
2008	6,807,140
2007	7,267,732
2006	7,526,219

* Figures obtained from local manufacturers and importers of fertilisers

c. Emission Factors

The choice of emission factors for direct and indirect N_2O emissions used are enumerated in ***Table 58*** below.

Table 58: Emission Factors used to calculate Direct and Indirect N_2O Emissions from Managed Soil

Source	Parameter	Unit	EF	Source
Direct N_2O emission from managed soil	N in synthetic fertilizer	Kg N_2O-N/kg N input	0.01	As per IPCC 2006 tool
	N in animal manure, compost, sewage sludge and other	Kg N_2O-N/kg N input	0.01	As per IPCC 2006 tool
	N in mineralised soil that is mineralised in association with loss of soil C from soil organic matter as result of changes to land use or management	Kg N_2O-N/kg N input	0.01	As per IPCC 2006 tool

Source	Parameter	Unit	EF	Source
	N in crop residues	Kg N_2O-N/kg N input	0.01	As per IPCC 2006 tool
Indirect N_2O emission from managed soil	Fraction of synthetic fertilisers that volatises frac (GASF)	Kg NH3-N + NO_x-N	0.1	As per IPCC 2006 tool
	Fraction of applied organic N fertiliser, urine and dung N deposited by grazing animal that volatilises	Kg NH3-N + NO_x-N	0.2	As per IPCC 2006 tool
	Fraction of all N addition that is loss through leaching and run-off	Kg N/kg N additions	0.3	As per IPCC 2006 tool
	N_2O from N leaching/ run-off	Kg N_2O-N/kg N leaching / run-off	0.0075	As per IPCC 2006 tool

5.7.3 Results

Aggregated emissions from Agricultural Soils increased from 101.02 Gg CO_2-eq in the year 2000 to 101.08 Gg CO_2-eq in 2013. There has been a slight decrease in emission for this sector between 2007 and 2009, followed by a gradual increase to 2013. Overall, there has not been any significant variation in GHG emissions over the inventory years, attributed mainly to stable acreage of land under cultivation and amount of fertiliser use. ***Table 59*** shows the GHG Emissions in Gg CO_2-eq, from Agricultural Soils.

Table 59: GHG Emissions (Gg CO_2-eq) from Agricultural Soils

Year	Total for Agriculture	Agricultural Soils	Share for Agricultural Soils (%)
2000	134.89	101.02	74.9
2001	134.71	100.23	74.4
2002	132.88	97.65	73.5
2003	130.79	95.80	73.2
2004	127.46	94.24	73.9
2005	122.07	86.73	71.0
2006	127.06	87.11	68.6
2007	123.06	84.61	68.8
2008	116.71	80.24	68.8
2009	113.84	78.21	68.7
2010	127.56	87.37	68.5
2011	162.83	121.32	74.5
2012	141.08	99.84	70.8
2013	141.55	101.08	71.4

5.7.4 Quality Control

The activity data were gathered mainly from officially published national documents such as Digest of Agricultural Statistics and Annual Reports of the Chamber of Agriculture. All the data appearing in these official documents were further cross checked with relevant institutions working in their respective sectors. Specific and relevant data were also obtained from research work published locally and in international journals as well as annual and technical reports from the different research institutions.

All the data used were reviewed during peer review meetings with stakeholders and research staffs. Moreover, the QC procedures were implemented by the inventory team by routine and consistent checks to identify errors and omissions. All calculations made during the exercise used approved standardised procedures for emissions calculations, measurements and documentations as per the 2006 IPCC Guidelines. Furthermore, the inventory process was carried out under close supervision of the local and international consultants to ensure compliance with the 2006 IPCC Guidelines.

More details on quality control for AFOLU are at 5.1.4 above.

5.7.5 Uncertainty Assessment

In spite of the proper approach followed to ensure accuracy of all activity data collected, there were still some cases of data gaps that demanded estimation from relevant experts and which may have resulted in varying degree of uncertainties of the data used. In addition, the following major uncertainties were identified:

i. Areas under the non-sugar crop were based on estimates due to lack of a comprehensive survey;
ii. Default IPCC emission factors were used and this carried large variations which may not reflect local circumstances;
iii. In some cases the use of expert judgement may not reflect the local situations;
iv. Some minor source categories has not been considered in the inventory calculation due to lack of data; and
v. The emission inventory considers a single climatic and soil condition for the island, which therefore does not reflect the diverse conditions prevailing.

5.7.6 Planned Improvements

The activity data needs to be improved so that accurate acreage under the different crops can be assessed through surveys and/or establishing routine data reporting from farmers. Moreover, research institutions need to be empowered to carry out more research in order to develop local emission factors to enable Tier 2 computation of GHG inventory. The GHG inventory in the future can also be improved by providing further capacity building to the inventory team. There are some sources which are not currently quantified. Whilst these are considered to be smaller sources, they will need to be estimated, documented and integrated into the inventory.

CHAPTER 6 WASTE

6.1 Overview

GHG emissions from the Waste sector include CH_4 emissions from the anaerobic decomposition of organic waste disposed in the sanitary landfill, biological treatment of solid waste and CH_4 emissions from handling domestic and industrial wastewater under anaerobic conditions. Waste emissions also include N_2O emissions from human sewage.

With increasing population and change in lifestyle of Mauritians, the amount of solid wastes landfilled has increased from approximately 407,000 tonnes in 2006 to 417,000 tonnes in 2013. The waste generation per capita has increased from 340 kg to 342 kg over the same time period.

In the year 2000, the Government Policy on solid waste management primarily focused on the closure of open dump sites and on regular collection of municipal solid wastes for landfilling. In 2011, a large-scale composting plant started operation and has been accepting, on average, 200 tonnes of mixed municipal solid wastes daily. After 2000, some of open site were still operating but no data was available on the quantity of waste from same.

Solid waste disposal in the sanitary landfill generates CH_4 as the main source of GHG emissions in the sector, while domestic wastewater treatment constitutes of both CH_4 and N_2O as GHG emissions.

6.1.1 Key Categories

A key category analysis was carried out for the years 2006 to 2013 data and it was found that Solid Waste Disposal (4A) was key category.

6.1.2 General Methodology

The methods applied for this sector are Tier 1 (emission factors) with detailed national data. The calculations generally involved the multiplication of local activity data (e.g., waste landfilled, population connected to wastewater sewer networks) with predominantly default emission factors, although a small number of country-specific factors are also applied. A summary of the methods is shown in ***Table 60***.

Table 60: Methods used in Calculations for the Waste Sector

	Method	EF	Notes
4 - Waste			
4.A - Solid Waste Disposal	T1	D, CS	Waste composition was local
4.B - Biological Treatment of Solid Waste	T1	D	Waste composition was local
4.C - Incineration and Open Burning of Waste	T1	D	Negligible
4.D - Wastewater Treatment and Discharge	T1	D,CS	BOD values were local
4.E - Other (please specify)	NA	NA	

6.1.3 Uncertainty Assessment

The 2006 IPCC Inventory Software was used to automatically calculate the uncertainties. For the waste sector, no results were generated from the software which indicated zero values. Uncertainty could be expected within the waste generation data, as the landfill (where all the waste is supposed to be disposed) has a weighbridge which has not been examined for errors. Another cause of uncertainty could be expected from the waste composition data, which is not regularly assessed. Default EF uncertainties have been taken from the 2006 IPCC Guidelines as follows:

Total Municipal Solid Waste: ±10%
Total uncertainty of Waste Composition: ±30%
Degradable Organic Carbon (DOC) ±20%
Fraction of Degradable Organic
Carbon Decomposed (DOCf) ±20%
Methane Correction Factor (MCF)

- = 1.0:–10%, +0% for managed landfill
- = 0.8: ±20%, for shallow open dump
- = 0.4±30%, for deep open dump

Fraction of CH_4 in generated Landfill Gas (F) = 0.5: For IPCC default value: ±5%
For Methane Recovery (R), the uncertainty range will depend on how the amounts of CH_4 recovered and flared or utilised are estimated: ± 10% if metering is in place, (± 50% if metering is not in place).

6.1.4 Quality Control

The QC was conducted by the Waste Sub-TWG. The Waste Sub-TWG was co-chaired by the national experts from ESDD (Solid Waste Management Division) and the Wastewater Management Authority. Other Experts Members of Waste Sub-TWG are from:

- Statistics Mauritius
- Ministry of Health and Quality of Life
- National Environment Laboratory of the ESDD

- Association des Hôteliers et Restaurateurs de l'île Maurice (AHRIM)
- Climate Change Division of the ESDD

The Waste Sub-TWG was mandated to oversee the technical implementation of data collection, conducting quality control and verifying results of GHG inventory in the Waste Sector.

For the current NIR the Waste Sub-TWG conducted regular meetings from January to September 2016 at-least once per month.

The QA/QC consisted of verification of the activity data, emission factors, inventory results and reporting. QC dully completed template is highlighted as follows:

- Personal responsible for data and software entry;
- Data review;
- Discuss the issues related to data collection;
- Discuss the correctness of data;
- Discuss on emission factors;
- Consultation and knowledge exchange for data entry in the software and generating results;
- Crosscutting check for overall inventory quality; and
- Detailed check for document.

6.1.5 Recalculations

The emissions were compared with the SNC data. For the 2006 inventory year, the difference between SNC and TNC emissions is less than 3%, the consistence between SNC and TNC was noted.

6.1.6 Assessment of Completeness

The waste sector was assessed for all sources of emissions and this assessment is presented in ***Table 61***.

Table 61: Assessment of Completeness

	CO_2	CH_4	N_2O
4 - Waste			
4.A - Solid Waste Disposal	NO	X	NO
4.B - Biological Treatment of Solid Waste	NO	X	NO
4.C - Incineration and Open Burning of Waste	X	NO	NO
4.D - Wastewater Treatment and Discharge	NO	X	X
4.E - Other (please specify)	NA	NA	NA

Note: NO: Not Occurring X: Estimated, NA: Not Applicable

6.1.7 Planned Improvements

The waste sector is reliant upon more accurate and regularly updated data on solid waste composition. The activity data for liquid wastes needs to be updated by treatment facilities. The parameters used in the calculations need to be studied with a view to develop country specific EFs. These are the planned improvements that need to be considered for future GHG inventories.

6.2 Solid Waste Disposal (Category 4A)

6.2.1 Source Category Description

The ESDD is responsible for the setting up and operation of waste management facilities, including landfill and transfer stations whilst Local Authorities, which operate under the aegis of the Ministry of Local Government, are responsible for the collection and conveyance of domestic wastes to the five transfer stations across the island. Domestic wastes are stored in appropriate storage receptacles by households. At the transfer stations, these wastes are compacted in truck trailers for transportation to Mare Chicose Sanitary Landfill. This Ministry has contracted out the operation of the five transfer stations and the Mare Chicose Sanitary Landfill.

Municipal Solid Waste

Municipal Solid Waste (MSW) comprises of waste from households, commercial centres and industries. It should be noted that CH_4 emissions are primarily from the organic content of the solid waste, which amounts to approximately 64% of the total waste generated. Since 2012, the bulk of the organic waste is deposited in the landfill, whereas the compost plant treats about 10% of the organic wastes. According to the Solid Waste Management Division, the sanitary landfill in RoM is modern and well managed, with capping works to minimise methane emissions and engineering installations to abstract landfill gas (methane) for flaring and power generation. A summary of the trends for this category is included in ***Chapter 2***.

The types of waste generated in RoM are shown in ***Figure 33***:

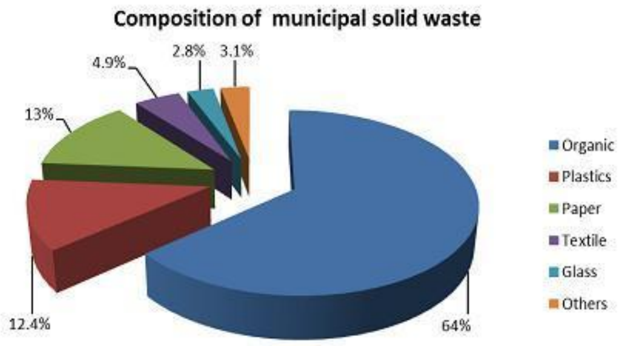


Figure 33: Type of Wastes generated in RoM
Source: MoSSNSESD, Solid Waste Management Division[36]

6.2.2 Methodological Issues

The IPCC Waste Model[37] has been applied for estimating CH_4 emissions from the sanitary landfill. The approach is based on the First Order Decay (FOD) method. This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly over a few decades, during which CH_4 and CO_2 are formed. If conditions are constant, the rate of CH_4 production depends solely on the amount of carbon remaining in the solid waste. As a result, emissions of CH_4 from waste deposited in a disposal site are highest in the first few years after deposition, and then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

From the year 2000 to 2013, the total growth of solid waste was 52%. From 2009, the amount of captured CH_4 for electricity generation varied from 11,900 tonnes to 15,420 tonnes corresponding to a total increase of 36%, as shown in ***Table 62*** below.

Table 62: Emissions Trend for Solid Waste compared with Solid Waste Disposal and Amount of CH_4 captured

Year	Solid Waste disposed (thousand tonnes)	Amount of gas captured in (thousand tonnes)
2000	265.82	
2001	306.69	
2002	363.91	
2003	372.44	
2004	365.43	
2005	382.33	
2006	407.03	
2007	394.11	

[36] (http://environment.govmu.org/English/PublishingImages/SWMD/graph.JPG)
[37] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/IPCC_Waste_Model.xls

Year	Solid Waste disposed (thousand tonnes)	Amount of gas captured in (thousand tonnes)
2008	399.48	
2009	415.94	11.9
2010	427.80	9.0
2011	414.54	10.2
2012	387.92	13.83
2013	429.93	15.42
Total Change (%)	**52.0**	**36.0**

a. <u>Calculations</u>

The CH_4 emissions from solid waste disposal for each year have been estimated using Equations 3.1. CH_4 emissions are generated as a result of degradation of organic material under anaerobic conditions. Part of the CH_4 generated is oxidised in the cover of the sanitary landfill, while another part is recovered for energy. The CH_4 actually emitted from the sanitary landfill will hence be reduced.

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T\right] \times [1 - OX_T]$$

Where:

CH$_4$ Emissions = CH_4 emitted in year T, Gg
T = inventory year
x = waste category or type/material
RT = recovered CH_4 in year T, Gg
OXT = oxidation factor in year T, (fraction)

The CH_4 recovered must be subtracted from the amount CH_4 generated. Only the fraction of CH_4 that is not recovered will be subject to oxidation in the SWDS cover layer.

The amount of CH_4 formed from decomposable material is found by multiplying the CH_4 fraction in generated landfill gas and the CH_4 /C molecular weight ratio.

CH_4 generated from decayed DDOCm:

$$CH_4\ generated_T = DDOCm\ decomp_T \times F \times 16/12$$

Where:

CH_4 generated $_T$ = amount of CH_4 generated from decomposable material
DDOCm decomp $_T$ = DDOCm decomposed in year T, Gg
F = fraction of CH_4, by volume, in generated landfill gas (fraction)
16/12 = molecular weight ratio CH_4/C (ratio)

Through the equations above from 2006 IPCC Guidelines[38] , the calculations of the amount of CH_4 formed from decomposable material requires other estimated (or documented) or calculated national values such as:

DDOCm = mass of decomposable DOC deposited, Gg
W = mass of waste deposited, Gg
DOC = degradable organic carbon in the year of deposition, fraction, Gg C/Gg waste
DOCf = fraction of DOC that can decompose (fraction)
MCF = CH_4 correction factor for aerobic decomposition in the year of deposition (fraction)
Lo = CH_4 generation potential, Gg CH_4
DDOCm = mass of decomposable DOC, Gg
F = fraction of CH_4 in generated landfill gas (volume fraction)
DDOCmaT = DDOCm accumulated in the SWDS at the end of year T, Gg
DDOCmaT^{-1} = DDOCm accumulated in the SWDS at the end of year (T-1), Gg
DDOCmdT = DDOCm deposited into the SWDS in year T, Gg
DDOCm decompT = DDOCm decomposed in the SWDS in year T, Gg
k = reaction constant, k = ln(2)/t1/2 (y-1)
$t_{1/2}$ = half-life time (y)

b. Activity Data

National data for Municipal Solid Waste (MSW) is presented in ***Table 63***. Data for sludge and MSW disposal is presented in ***Table 50***. Both data for MSW and sludge were collected from Solid Waste Management Division. In future improvement (i.e. during the development of upcoming BUR), data for solid waste will be more detailed by including text to explain clearly data source, data collection, data gaps and methodology to adapting data for inventory use.

Table 63: Municipal Solid Waste Activity Data

Years	Population [Million]	Solid Waste landfilled [000 Tonne]	Waste (Kg) per capita per year	SWDS [%]	Food [%]	garden [%]	Paper [%]	Wood [%]	Textile [%]	Nappies [%]	Plastic and Other inert [%]
2006	1.19568	407.03	340	100	15	50	12	2	5	0.3	15.7
2007	1.20089	394.11	328	100	15	50	12	2	5	0.3	15.7
2008	1.20496	399.48	331	100	15	50	12	2	5	0.3	15.7
2009	1.20784	415.94	344	100	15	50	12	2	5	0.3	15.7
2010	1.21039	427.80	353	100	15	50	12	2	5	0.3	15.7
2011	1.21197	414.54	342	100	15	50	12	2	5	0.3	15.7
2012	1.21499	387.92	319	100	15	50	12	2	5	0.3	15.7

[38] located in Chapter 3, Volume 5 of 2006 IPCC Guidelines (page 3.9)

Years	Population [Million]	Solid Waste landfilled [000 Tonne]	Waste (Kg) per capita per year	SWDS [%]	Food [%]	garden [%]	Paper [%]	Wood [%]	Textile [%]	Nappies [%]	Plastic and Other inert [%]
2013	1.21734	429.93	352	100	15	50	12	2	5	0.3	15.7
2014	1.21924	417.47	342	100	15	50	12	2	5	0.3	15.7

Source: Solid Waste Management Division

Note: The percentages of food, garden, paper and others have been assumed to be same for period 2006 to 2014, based on the waste characterisation study carried out in 2014, as shown in ***Table 64***.

Table 64: Sludge and CH_4 recovered from Municipal Solid Waste Disposal

Year	Sludge (Gg)	CH_4 recovered from the sanitary landfill Site
2006	8.056	**0**
2007	13.077	**0**
2008	12.148	**0**
2009	9.126	**11.9**
2010	10.949	**9.0**
2011	10.402	**10.2**
2012	7.370	**13.8**
2013	6.963	**15.42**
2014	5.191	**15.92**

Source: Solid Waste Management Division

For the years 2006 to 2008, no methane was recovered from the landfill site.

c. Emission Factors

Emission factors for Solid Waste include basic parameters, Degradable organic carbon (***Table 65***) and Methane generation rate constant (K) (***Table 66***).

Table 65: Basic Parameters of Degradable Organic Carbon

Fraction of Degradable Organic Carbon	**0.75**
Delay time	6 months
Fraction of methane (F) in developed gas	0.5
Oxidation fraction	0
% paper in industrial waste	0.25
% Wood in industrial waste	0.25

Table 66: Degradable Organic Carbon and Methane Generation Rate Constant (K)

Waste Type	*Degradable organic Carbon*	*Methane Generation rate constant (K)*
Food waste	0.19	0.04
Garden	0.58	0.17
Paper	0.13	0.70
Wood & Straw	0.005	0.035
Textile	0.040	0.70
Disposable nappies	0.02	0.05
Sewage sludge	0.03	0.03
Industrial waste	0.015	0.17

6.2.3 Results

Aggregated emissions from the Solid Waste Disposal on land increased from 447.30 Gg CO_2-eq in the year 2000 to 918.32 Gg CO_2-eq in 2013 (***Table 67***). The emissions from solid waste disposal on land are the main sources of GHG in the Waste Sector and continue to increase due to the increased amount of wastes landfilled. The emissions from solid waste dropped in 2009 due to decreased economic activities, production and consumptions.

Table 67: GHG Emissions (Gg CO_2-eq) from Waste Sector

Year	Total for Waste Sector	Solid Waste Disposal
2000	447.30	447.30
2001	527.30	527.30
2002	583.80	583.80
2003	606.40	606.40
2004	583.80	583.80
2005	707.70	707.70
2006	854.34	797.51
2007	956.56	899.40
2008	1034.62	976.92
2009	857.02	795.06
2010	980.56	922.85
2011	1022.84	960.73
2012	1004.66	929.52
2013	986.59	918.33

6.2.4 Quality Control

The QC consisted of verification of the activity data, emission factors, inventory results and reporting. More details on sector wise QC are in 6.1.4 above.

6.2.5 Uncertainty Assessment

Based on the fact that Mauritius has country specific and accurate data (no weighting), the uncertainties for the total MSW, Fraction of MSW sent to SWDS (MSWF) and total uncertainty of waste composition are estimated at +/-15%. For the remaining parameters such as: Degradable Organic Carbon (DOC), Fraction of Degradable Organic, Carbon Decomposed (DOCf), Methane Correction Factor (MCF), the IPCC default values equal to +/-20% were adopted. For methane recovery, since the metering is in place, the uncertainty is estimated to +/-10%. The overall uncertainty for solid waste disposal is +/-15%.

6.2.6 Planned Improvements

The Ministry has embarked in the process of procuring a second landfill gas to electricity project. This will involve higher abstraction rate of the landfill gas with upgraded design of wells and other installations. Data will therefore need to be gathered and included in future inventory improvement.

6.3 Biological Treatment of Solid Waste (Category 4B)

A large-scale compost plant has been operational since October 2011 and an average of 200 tonnes of municipal solid wastes per day has been accepted for production of compost at the plant. As a result, approximately 85 tonnes of solid waste per day has been diverted from the landfill during this period.

Table 68 below shows the amount of solid wastes accepted at the compost plant (diverted from landfill) together with estimated CH_4 from this amount of solid waste. However, N_2O was not estimated as per the methodology of the 2006 IPCC Guidelines and this will be considered in future improvement during the development of Fourth National Communication.

Table 68: Wastes Composted and Methane Emissions

Year	Amount of Wastes accepted at compost plant/diverted from landfill (Tonnes)	CH_4 emissions, Gg
2011	5,154	0.052
2012	34,785	0.348
2013	19,257	0.346

6.4 Incineration and Open Burning Of Wastes (Category 4C)

6.4.1 Waste Incineration (4C1)

Waste incineration has only been occurring for clinical waste. The emissions are shown in ***Table 69***. Default emission factors have been applied for calculating the emissions.

The CH_4 emissions of biological treatment can be estimated using the default method given in Equations 4.1 and 4.2 shown below (2006 IPCC Guidelines, Volume 5, and Chapter 4: Biological treatment of Solid Waste).

EQUATION 4.1

CH_4 EMISSIONS FROM BIOLOGICAL TREATMENT

$$CH_4\ Emissions = \sum_i (M_i \bullet EF_i) \bullet 10^{-3} - R$$

Where

- CH_4 Emissions = total CH_4 emissions in inventory year, Gg CH_4
- Mi = mass of organic waste treated by biological treatment type *i*, Gg
- EF = emission factor for treatment *i*, g CH_4/kg waste treated
- i = composting or anaerobic digestion
- R = total amount of CH_4 recovered in inventory year, Gg CH_4

The emission factor is 0.8 g CH_4/kg waste treated which is default value from 2006 IPCC Guidelines, Volume 5, and Chapter 4, table 4.1. Therefore, CO_2 emissions from clinical waste incinerated are presented in the table below. These emissions are just for reference and negligible and therefore not analysed together with other emissions in ***Chapter 2***.

Table 69: Clinical Waste incinerated and Emissions of CO_2, 2000-2013

Year	Clinical Waste (tonnes)	CO_2 Emissions (Gg)
2000	641.09	0.54
2001	627.36	0.52
2002	635.10	0.53
2003	589.55	0.49
2004	594.66	0.49
2005	593.78	0.49
2006	622.98	0.52
2007	601.64	0.50
2008	611.09	0.51
2009	589.04	0.49

Year	Clinical Waste (tonnes)	CO_2 Emissions (Gg)
2010	598.49	0.50
2011	645.74	0.53
2012	645.74	0.53
2013	667.79	0.55

6.4.2 Open Burning of Wastes (4C2)

Open burning of wastes is not permitted by law in Mauritius. Henceforth, GHG emissions from open burning of solid waste are considered negligible and have not been accounted for.

6.5 Wastewater Treatment and Discharge

6.5.1 Overview

Wastewater in RoM comprises of effluents from domestic, industrial and commercial activities, the latter also including the hotel sector. Being responsible for the wastewater sector in RoM, Waste Water Management Authority (WMA) manages the public wastewater system, which consists of 591 km of sewer network, 72 pumping stations and 10 treatment plants, including 4 main treatment plants which are located at St Martin, Grand-Baie, Baie-du-Tombeau, and Montagne Jacquot. As at end 2014, 25.1% of the Mauritian population has been connected to the public sewerage system and the remaining 74.9% makes use of onsite disposal systems like septic tanks, absorption pits and cesspits. A summary of the trends for this category is included in.

6.5.2 Source Category Description (Category 4D)

Methane and nitrous oxide are the main gases that are produced from wastewater treatment and discharge. The industrial and hotel wastewaters contribute to the emission of methane while the domestic and commercial wastewaters emitted both CH_4 and N_2O. Wastewater treatment processes produce sludge which also contributed to the emission of GHGs. The emission sources are as follows:

4D1: Domestic and Commercial Wastewater: Aerobic biological treatment processes, mainly of the activated sludge type, were used for public wastewater treatment. Methane generated in one of the operational tertiary treatment plants was recovered and burnt on-site to produce electricity for running the system. This will be reallocated to energy in future estimates.

Others (Hotel Sector): The number of tourist hotels ranged between 98 and 117 during the period 2006 to 2013. Almost all the hotels operated on-site wastewater treatment plants, namely, activated sludge process and septic tanks, followed by rotating bio-contactors. The resulting treated wastewater was used mainly for irrigating lawns and golf courses. A minor number of hotels which are smaller in size, used septic tanks and absorption pit systems.

4D2: Industrial Wastewater: Industries connected to the sewerage system are textile factories, dye houses, breweries, soft-drink bottling plants, wineries, slaughter houses, dairy processing units, fish and food canning plants. The two main industries that were not connected to the sewer network were sugar and poultry. The sugar industry was the most important industrial sector discharging treated wastewater into the environment. The yearly volume of wastewater varied from 4.04 million m^3 to 3.24 million m^3 during the period 2006 - 2013. Two main poultry industries were operating. One pre-treated its wastewater before discharging it into the public sewerage system while the other carried out the appropriate treatment before discharge into a water course. The yearly volume of wastewater varied from 354,973 m^3 to 405,920 m^3 during the period 2006 - 2013.

Table 70 indicates the Wastewater Treatment Plants (WWTP), including their respective types of treatment and the final disposal of the respective treated wastewater.

Table 70: Wastewater Treatment Plants

Treatment Plant	Type of Treatment	Disposal	Treatment Plant Design Capacity, m^3/day	Classification of types of treatment and disposal as per 2006 IPCC Guidelines - Table 6.3
Grand Baie	Tertiary Treatment	Borehole injection	3,500	Centralised aerobic wastewater treatment plants
Baie du Tombeau	Preliminary Treatment	Long Sea Outfall	45,000	Flowing sewers (Closed)
Montagne Jacquot	Primary Treatment followed by disinfection	Long sea outfall	48,000	Flowing sewers (Closed)
St Martin	Tertiary Treatment	Irrigation	69,000	Centralised aerobic wastewater treatment plants and Anaerobic digester for sludge

At the St Martin WWTP, all primary and secondary sludge produced is anaerobically digested and the resulting methane is recovered and used for generating about 25% of the plant's requirement in electricity. Apart from the St. Martin wastewater treatment plant, the methane produced from other wastewater treatment plants is not recovered.

6.5.3 Methodology, Emission Factors and Activity Data

The methodology recommended in the 2006 IPCC Guidelines for National Greenhouse Gas inventory has been adopted for calculating CH_4 and N_2O emissions for the wastewater treatment and discharge sector.

6.5.3.1 Domestic Wastewater Treatment and Discharge

Methane emissions from domestic and commercial wastewater (disposal particularly in rural areas where systems such as septic tanks are used) have been calculated using the methodology proposed in the 2006 IPCC Guidelines, by multiplying the total domestic organic wastewater in kg BOD/yr and emission factor which was obtained using default value for maximum methane producing capacity (0.6 kg CH_4/kg BOD- Pg 6.12).

a. <u>Calculations</u>

The general equation to estimate CH_4 emissions from domestic wastewater is as follows:

$$CH_4\ Emissions = \left[\sum_{i,j}\left(U_i \bullet T_{i,j} \bullet EF_j\right)\right]\left(TOW - S\right) - R$$

Where:
CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr
TOW = total organics in wastewater in inventory year, kg BOD/yr
S = organic component removed as sludge in inventory year, kg BOD/yr
Ui = fraction of population in income group *i* in inventory year
Ti,j = degree of utilisation of treatment/discharge pathway or system, *j*, for each income group fraction *i* in inventory year
i = income group: rural, urban high income and urban low income
j = each treatment/discharge pathway or system
EFj = emission factor, kg CH_4 / kg BOD
R = amount of CH_4 recovered in inventory year, kg CH_4/yr

b. <u>Activity Data</u>

AD relating to wastewater generated in the domestic, industrial and commercial sectors were sourced from operators of treatment plants and/or based on volume of metered water consumed and official statistics. Characteristics of the wastewater were obtained from actual laboratory analyses. The population for the period 2006-2013 was taken from national demography statistics. Data on the annual per capita Protein Intake Value (PIV), for the period 2006-2013, were adopted from the FAOSTAT Statistical Database (*Website: faostat.fao.org*). Statistical extrapolation has been made for generating missing data.

The AD used for computing CH_4 emissions in the subcategory Domestic and commercial activities are given in the ***Table 71***.

Table 71: AD for Domestic and Commercial Wastewater and Sludge Treatment (2006-2013)

Region, city	Unit	2006	2007	2008	2009	2010	2011	2012	2013
Sewered Plaine Wilhems region	X1000 persons	101.10	102.87	104.55	106.14	107.71	109.21	115.04	120.83
Absorption Pit	X1000 persons	804.24	805.23	805.46	804.91	804.12	859.57	849.77	839.49
Septic tank	X1000 persons	42.98	43.03	43.04	43.01	42.97	84.01	83.06	82.06
Pit Latrine	X1000 persons	133.81	133.98	134.02	133.93	133.79	44.26	43.76	43.23
Sewered Port Louis and Pte aux Sable	X1000 persons	141.54	144.01	146.37	148.60	150.80	152.89	161.05	169.16
6x CHAs Estate TPs	X1000 persons	7.58	7.71	7.84	7.96	8.08	8.19	8.63	9.06
G-Baie	X1000 persons	2.53	2.57	2.61	2.65	2.69	2.73	2.88	3.02
Methane Flared	Kg CH_4	354372	354372	354372	354372	397261	395263	460973	489140

Data for national population was obtained from the Statistics of Mauritius (SM). Population connected to sewer was from population SM 2011, for other years they were estimated and the unsewered population using on-site wastewater disposal systems was worked out by subtracting the sewered population from the total national population. The status of sewered and unsewered population for the period 2006-2013 is presented in the ***Table 72***.

Table 72: Status of Sewered and Unsewered Population (2006-2013)

Year	Total National Population (X 1000 persons)	Sewered Population (X 1000 persons)	Unsewered Population (X 1000 persons)
2006	1,234.00	252.74	981.25
2007	1,239.63	257.16	982.47
2008	1,244.12	261.37	982.75
2009	1,247.43	265.36	982.07
2010	1,250.40	269.29	981.11
2011	1,252.40	273.02	979.38
2012	1,255.88	287.60	968.29
2013	1,258.65	302.08	956.58

c. Emission Factors

The emission factor for a wastewater treatment and discharge pathway and system is a function of the maximum CH_4 producing potential (Bo) and the methane correction factor (MCF) for the wastewater treatment and discharge system. The Bo is the maximum amount of CH_4 that can be produced from a given quantity of organics (as expressed in BOD or COD) in the wastewater. The MCF indicates the extent to which the CH_4 producing capacity (Bo) is realised in each type of treatment and discharge pathway and system. Thus, it is an indication of the degree to which the system is anaerobic.

Since there was no country-specific data for Bo, a default value, 0.6 kg CH_4/kg BOD has been used and the default MCF values used are shown in ***Table 73*** below.

MCFs used for Wastewater Treatment and Discharge

Table 73: Methane Conversion Factors for Wastewater Treatment and Discharge (Source: 2006 IPCC Guidelines)

Type of Treatment and Discharge Pathway or System	Methane Conversion Factor (MCF)
Centralised, aerobic treatment plant	0.00
Anaerobic digester for sludge	0.8
Septic system	0.5
Latrine (3-5 persons)	0.1

The choice of the MCFs was based on the following considerations:

a) **Aerobic treatment:** The MCF for wastewater being treated aerobically is taken as zero (Pg 6.13, 2006 IPCC).

b) **Anaerobic Sludge Digestion:** The organic matter of secondary sludge is typically between 60-85% (Veenstra, 1999). Since about 20% of all wastewater coming to the St Martin WWTP is industrial wastewater, a value of 80% organic matter has been adopted. The MCF has been taken as 0.8. Taking the default value for the Maximum Methane Producing Capacity of 0.6 kg CH_4/kg BOD (pg 6.12-2006 IPCC), this yields a Methane Emission Factor of 0.48 (0.6 x 0.8) for anaerobic sludge digestion.

c) **Septic systems:** These systems consist of either individual cesspits or individual septic tanks followed by absorption systems. According to Doorn and Liles (1999), 50% of the incoming BOD in a septic tank system is deposited as sludge at the bottom of the tank which is considered to be anaerobic. The sludge deposited at the bottom of the tank remains for a long period of time and all the BOD can potentially be converted into methane. The MCF for sludge in septic systems is therefore adopted as 0.5 (default value).

d) **Latrine:** Sludge is generally spread to a thickness of 15-30 cm over the drying bed. At this thickness, it is assumed that the sludge remains aerobic due to surface aeration. The MCF for sludge drying bed (IPCC default) has, therefore, been taken as 0.1.

6.5.4 Results from Domestic, Commercial and Industrial Wastewater

Table 74: Emissions of CH_4 from Domestic, Commercial and Industrial Wastewater (2006-2013) [Gg]

Source Category	Year							
	2006	2007	2008	2009	2010	2011	2012	2013
Domestic, industrial & Commercial both connected and not connected to sewer network and hotel	1.00	1.09	1.13	1.25	1.06	1.23	1.26	1.24
Industries not connected to sewer network: Sugar & Poultry Industry	0.67	0.58	0.60	0.63	0.61	0.59	0.56	0.55
TOTAL	1.67	1.68	1.73	1.88	1.67	1.82	1.82	1.79

Emissions from wastewater treatment and discharge are estimated only from 2006 to 2013 (***Table 74***) because the activity data of this sub-sector from 2000 to 2005 need some refinements.

6.5.5 Industrial Wastewater Discharged into Environment- Meat, Poultry and Sugar refining

The main industries were sugar manufacturing and poultry production.

(i) Sugar Industry

The AD used for computing CH_4 emissions from Industrial activities in the Wastewater handling sector are given in ***Table 75***.

The annual sugar production in metric tons was obtained from the SM. The volume of wastewater production was calculated by using a figure of $8m^3$ of wastewater produced per tonne of cane crushed. This figure was obtained from a report entitled *"Implementation of the Multi-Annual Adaptation Strategy for the Mauritian Sugar Cane Cluster (2006-2015) – Strategic Environmental Assessment – Final Draft Report" (Agreco Consortium, 2006).* An average extraction rate of 10% reflected from the SM figures was used to convert sugar production into tonnage of cane crushed.

A COD value of 5,000 mg/L (5kg COD) for raw wastewater from the sugar industry was adopted. This was obtained from EIA report for production of granulated refined sugar (Arup SIGMA 2004).

Wastewater from sugar industry is treated in large ponds with significant surface re-aeration. The wastewater component was thus considered as being treated aerobically with no methane emissions. The sludge removed COD kg/year was estimated as 75 % of the total COD kg/year present in raw wastewater. The sludge removed COD kg/year was estimated as 75 % of the total COD kg/year present in raw wastewater. This was estimated by using expert simple judgment, however, during upcoming development of BUR, it will be improved by applying the protocol of expert judgment.

(ii) Poultry Production

The annual poultry production in metric tons was obtained from the SM. The volume of wastewater per tonne of poultry processed was calculated from actual figures obtained from the two largest poultry processing plants in RoM. A figure of 8.6 m^3 of wastewater per tonne of poultry was obtained. A figure of 1.75 kg/poultry head was used to convert tonnage into poultry head. A raw COD value of 3,500 mg/L was used to calculate the annual raw COD load in kilograms. This figure was obtained from actual test results reported for the design of a wastewater treatment plant for one major poultry processing plant. The sludge removed COD kg/year was estimated as 75 % of the total COD kg/year present in raw wastewater. This was estimated by using expert simple judgment, however, during upcoming development of BUR, it will be improved by applying the protocol of expert judgment.

The annual sugar and poultry production is shown in ***Table 75*** below.

(i) Calculations including equations used as in 2006 IPCC Guidelines.

The general equation to estimate CH_4 emissions from industrial wastewater is as follows:

TOTAL CH_4 EMISSIONS FROM INDUSTRIAL WASTEWATER

$$CH_4\ Emissions = \sum_i \left[\left(TOW_i - S_i \right) EF_i - R_i \right]$$

Where:

CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOW_i = total organically degradable material in wastewater from industry *i* in inventory year, kg COD/yr

i = industrial sector

S_i = organic component removed as sludge in inventory year, kg COD/yr

EF_i = emission factor for industry *i*, kg CH_4/kg COD for treatment/discharge pathway or system(s) used in inventory year

If more than one treatment practice is used in an industry this factor would need to be a weighted average.

R_i = amount of CH_4 recovered in inventory year, kg CH_4/yr

Table 75: Activity Data for Sugar and Poultry Industry (2006-2013)

Industry	Product	Unit	Year							
			2006	2007	2008	2009	2010	2011	2012	2013
Sugar Production (tons/yr)	Total Industrial output	t/yr	504857	435972	452062	467234	452473	435310	409200	404713
	Wastewater produced	m^3/t output	8	8	8	8	8	8	8	8
Poultry Production (tons/yr)	Total Industrial output	t/yr	41276	46700	42000	44000	46600	47000	47200	46700
	Wastewater produced	m^3/t output	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6

(ii) Emission Factor

Since there was no country-specific data for Bo, a default value, 0.25 kg CH_4/kg COD has been used and the MCF value used was 0.5 (expert judgement after consulting the Table 6.8- aerobic treatment plant of the 2006 IPCC Guidelines).

6.5.5 Hotel Sector

The annual tourist nights, and numbers of tourists were obtained from Statistics Mauritius.

The total water consumption for the tourist hotels for year 2006-2013 was computed as follows. *(1.72 m^3/room per day) x (365 days/year) x (total number of hotel rooms in year 2006) x 0.66 (Source: SNC).*

The total water consumption for tourist hotels for the other years was computed by applying the ratio of tourist nights for the year concerned to the value of tourist nights and the total water consumption for the period 2006-2013.

The average raw BOD value for wastewater from tourist hotels was calculated from actual data for the 5 hotels referred to in the report of the Ministry of Environment and NDU (these values were obtained from the report on wastewater from the Hotel Sector prepared by the Ministry of Environment & NDU in 2004). The average raw BOD was computed as 187 mg/l. (Source: SNC)

The total annual BOD load in kilogram (***Table 76***) was computed by multiplying the total annual water consumption by the average BOD value of 187 mg/l.

Table 76: Data and Annual BOD Load for Tourism Sector (2006-2013)

Parameter	Year							
	2006	2007	2008	2009	2010	2011	2012	2013
Tourist Night	7760679	8986934	9218625	8639304	9336446	9494297	10043683	10667071
Tourist Population	788276	906971	930456	871356	934827	964642	965441	993106
No. of Hotels	98	97	102	102	112	109	117	107
No. of Rooms	10666	10857	11488	11456	12075	11925	12527	12376
Total Water Consumption (Mm^3/yr)	4.42	4.50	4.76	4.75	5.00	4.94	5.19	5.13
BOD Load (tonne/year)	826.54	841.50	890.12	888.25	935.00	923.78	970.53	959.31
BOD Load (Kg BOD/capita/year)	1.05	0.93	0.96	1.02	1.00	0.96	1.01	0.97

(i) Emission Factors

The MCF for wastewater being treated aerobically is taken as zero (Pg 6.13, 2006 IPCC Guidelines) which is applicable for activated sludge process.

6.5.6 Human Sewage

Indirect Nitrous Oxide (N_2O) emissions from human sewage have been calculated using the methodology proposed by the 2006 IPCC Guidelines.

The population estimate of the Republic of Mauritius for the period 2006-2013 were taken from SM. Data on the annual per capita Protein Intake Value (PIV), for the period 2006-2013, were obtained by the FAOSTAT Statistical Database. Data for N_2O emission calculation from Human Sewage for the period 2006-2013 is presented in the ***Table 77***. ***Table 78*** shows the Emission Factors for N_2O Emissions and ***Table 79*** shows the Emission of N_2O from Human Sewage for the years 2006 to 2013.

Table 77: Activity Data for N_2O Emission Calculation from Human Sewage (2006-2013)

Year	Population	Per Capita Protein Consumption (Protein in kg/person/yr)
2006	1,233,996	25.97
2007	1,239,630	25.97
2008	1,244,121	25.16
2009	1,247,429	26.56
2010	1,250,400	26.56
2011	1,252,404	26.81
2012	1,255,882	27.05
2013	1,258,653	27.32

Table 78: Emission Factors for N_2O Emissions

Emission Factor (kg N_2O – Nkg)	Fraction of Nitrogen in Protein (kgN/kg protein)
0.005 (Default value)	0.16 (average of the default range)

Table 79: Emission of N_2O from Human Sewage (2006-2013)

Year	Total Annual N_2O Emissions (Gg N_2O/yr)	Total Annual (N_2O Emissions (Gg CO_2eq)
2006	0.0705	21.86
2007	0.0708	21.96
2008	0.0689	21.35
2009	0.0729	22.60
2010	0.0731	22.65
2011	0.0739	22.90
2012	0.0747	23.17
2013	0.0757	23.45

6.5.7 Quality Control

Refer to 6.1.4 above.

6.5.8 Uncertainties and Time-series Consistency

Uncertainties can arise in estimating emissions from wastewater due to:

1) a lack of data characterising;
2) Wastewater management practices;
3) BOD/COD load;
4) The extent to which methane is emitted under anaerobic conditions; and
5) Methane recovery or flaring practices.

The uncertainty based on the above considerations is as follow:

1. **Wastewater Management Practices:** An accurate inventory of wastewater management practices for all the sectors of activity has been used. Thus, the uncertainty level is ranked as 5%.

2. **BOD/COD Load:** BOD Lab test results have certain uncertainties during its testing process. For the sugar sector, which is by far the major emitter of methane, a value of $8m^3$ of wastewater produced per tonne of cane crushed has been adopted. This value has been adopted from the *"Implementation of the Multi-Annual Adaptation Strategy for the Mauritian Sugar Cane Cluster (2006-2015) – Strategic Environmental Assessment –*

Final Draft Report" (Agreco Consortium, 2006). The uncertainty level regarding volume of wastewater generated is ranked as 10%.

3. BOD loads for the sewer network were based on actual BOD average values of raw effluent entering public WWTPs. COD load for sugar effluent has been based on values published in EIA report mentioned at section 6.5.4 above. Uncertainty level regarding BOD/COD load of wastewater is ranked as 5%.

4. **The extent to which methane is emitted under anaerobic conditions:** Default values of 0.6kg CH_4/kg of BOD and 0.25 kg CH_4/kg of COD have been adopted. These figures are fairly consistent with the literature. The uncertainty level is ranked as 5%.

5. **Methane recovery or flaring practices:** Methane is produced from anaerobic sludge digestion at the St Martin WWTP since January 2005. It has been assumed that all BOD in the sludge can be potentially converted into methane. This may not be the case depending on a number of factors such as retention time in reactors, temperature, pH and COD/N/P ratio. The uncertainty level has been calculated as 15%.

6. The uncertainties contained in N_2O emissions estimates are primarily related to applied default emission factor and extrapolated values for protein intake. Emissions from Domestic, Commercial, Industrial and Hotel Wastewater have been calculated using the same method for every year in the time series.

In reference with the above consideration, the overall uncertainty for wastewater treatment and discharge was estimated by expert judgment at 15%.

6.5.9 Recalculations

No recalculation conducted.

6.5.10 Planned Improvements

Improvements in the sub-sector Disposal of Domestic and Commercial Wastewater are related primarily to establishment of an effective *Environment Information System* with base for systematic gathering and saving data needed for monitoring and planning of development of all wastewater treatment and discharge.

Data on population connected to each WWTP is needed for calculations, and can be provided by carrying out surveys in catchment areas of the unsewered network. This will be conducted through closer collaboration with Statistics Mauritius by the end of 2018.

Further waste characterisation will be carried out to have more accurate data for percentage of waste (paper, garden and others) as per ***Table 49***. GHG inventory from electricity produced through CH_4 generated from solid waste was not taken into account. This is recommended during development of the next NIR under the fourth NC.

CHAPTER 7 PLAN OF IMPROVEMENT

This Chapter highlights the plan of improvement not indicated in specific sectoral chapters of this report. For sectoral plan of improvement, please refer to the end of each sectoral chapter or in its parts (sub-chapters). The National GHG inventory requires continuous improvement. GHG inventory reporting requires detailed activity data collection and estimation of country-specific emission factors.

7.1 Strategies for Long Term Improvement in the National Inventory System

The Republic of Mauritius has an obligation to submit BUR as well as NC on a regular basis. It is vital that the process be strengthened and a system is developed and maintained in a robust manner to ensure that it functions on a continuous basis to meet RoM reporting requirement. There is a need to strengthen the existing institutional arrangements.

It is recommended that, during the upcoming development of future Biennial Update Reports (BURs) and National Communications, the methodology is improved further, taking into account the development of national emissions factors in key sectors for GHG Emissions and use of data from the emissions monitoring systems. In addition, the development of a sustainable national inventory system involving key organisations, in the regular update and improvement of the GHG inventory be established.

7.1.1 Institutional Arrangements

The National Inventory Report (NIR) was coordinated as a component under the Third National Communication (TNC) project by the Climate Change Division under the Director of Environment of the Ministry of Social Security, National Solidarity, and Environment and Sustainable Development.

The Ministry is also formulating a Low Carbon Development Strategy and Nationally Appropriate Mitigation Actions (NAMAs) for Mauritius.

According to Article 4 of UNFCCC, Parties are committed to communicate regularly the following information:

- Anthropogenic emissions and removals;
- Established measures and related policies to mitigate climate change;
- Established measures and related policies to adapt to climate change impacts;
- Existing and planned research and systematic observation; and
- Existing and planned programmes of education, training and public awareness.

Therefore, it is recommended to create a new Department of Climate Change (DCC) which will be empowered to manage the maintenance of Mauritius's GHG inventory (the National System) and to engage with other appropriate organisations for data collection and development of methods and assumptions. These institutional arrangements (via a National Systems) should ensure that the GHG inventory is continuously improved and that institutional memory is retained and developed. The National System should also be able to support the construction of GHG projection scenarios and to engage with policy makers and key decision makers on developing and tracking mitigation actions (including NAMAs).

It is proposed that Statistics Mauritius also has a formal role in the collection of Activity Data for the GHG inventory as they collect statistics for other purposes already.

7.1.2 Detailed Improvement Plan

It is recommended that RoM develops a detailed improvement plan using the details of improvements planned, in progress and completed presented in this NIR. This improvement plan should be prioritised using key category analysis. It should be used to engage stakeholders and schedule development work.

7.1.3 Capacity Building & Development of Technical Know-how and Institutional Memory

Despite the knowledge acquired during the preparation of the TNC, there are still need for more capacity building and empowerment of staff and institutions. The duration of training could be at least be two continuous weeks including theoretical training and practical exercise and could cover, amongst others:

- Data collection;
- Methodology development, including for deriving EFs;
- Use of software, including IPCC, GIS and others; and
- Report writing.

Concerning the information sharing it is recommended to:

- Create national registry/website/database or clearinghouse for the GHG inventory with tools, among others; and
- Open website for gathering public and private reviews.

7.1.4 Quality Control

It is recommended that, as part of the National System, Mauritius develops an efficient, transparent and pragmatic QC and verification system. According to the 2006 IPCC QA/QC and verification are described as follows:

Quality Control (QC) is a system of routine technical activities to assess and maintain the quality of the inventory as it is being compiled. It is performed by personnel compiling the inventory.

The QC system is designed to:

(i) Provide routine and consistent checks to ensure data integrity, correctness, and completeness;

(ii) Identify and address errors and omissions; and

(iii) Document and archive inventory material and record all QC activities. QC activities include general methods such as accuracy checks on data acquisition and calculations, and the use of approved standardised procedures for emission and removal calculations, measurements, estimating uncertainties, archiving information and reporting. QC activities also include technical reviews of categories, activity data, emission factors, other estimation parameters, and methods.

Quality Assurance (QA) is a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third parties, are performed upon a completed inventory following the implementation of QC procedures. Reviews verify that measurable objectives (data quality objectives, see IPCC 2006, Guidelines, Volume 1, Section 6.5, QA/QC Plan) were met, ensure that the inventory represents the best possible estimates of emissions and removals given the current state of scientific knowledge and data availability, and support the effectiveness of the QC programme.

Verification refers to the collection of activities and procedures conducted during the planning and development, or after completion of an inventory that can help to establish its reliability for the intended applications of the inventory.

Verification refers specifically to those methods that are external to the inventory and apply independent data, including comparisons with inventory estimates made by other bodies or through alternative methods. Verification activities may be constituents of both QA and QC, depending on the methods used and the stage at which independent information is used.

For upcoming Greenhouse gases inventory, it is recommended for RoM to develop a detailed QA and QC. Therefore, required information for QC and QA shall be recorded in templates located in ***Appendix 4 and 5*** accordingly.

7.2 Planned Improvement on the Methodology

The level of inventory reporting depends on the data quality and methodology employed. This is indicated as the Tier used (e.g., 1 = simplest and least accurate, 2 or 3 as the most complex and accurate) as per the IPCC Guidelines for National Greenhouse Gas Inventories (2006). Despite the comprehensive initiation of activities under the TNC project, there is considerable scope for improvement. Where possible, and for key categories as a priority, GHG estimates should be made at Tier 2 or 3 levels.

To achieve this, sub-sectoral level estimates of activity data and emission factors (EF) have to be developed. Similar and consistent formats have to be adopted for data reporting and ensuring consistency in generating activity data by organisations for collation of the GHG inventory into a centralised system.

The detailed planned improvements on data collection, research and emission factors with priority action, responsibility and expected time frame are detailed in sectoral chapters of the National Inventory Report (above).

For future improvement, a full recalculation staring from 2000 using 2006 IPCC Guidelines will be conducted.

7.3 Sectoral Improvement Plans

Table 80 shows the sectoral improvement plans.

Table 80: Sectoral Improvement Plans

Need	Inputs	Cost Factor	Leading Institutions	Participating Institutions	Timeline
Energy Industries					
Country specific Emission Factor (EF)	Monitoring data from CEB and IPP's	Cost incurred by operators in line with requirement to submit monitoring reports to the Ministry. Cost for test done by the UoM by external laboratories	CEB	MEPU, DoE, IPP's, Tertiary Institutions	2 to 3 years
Repository of data. Some important data are not available. Creation of an archiving system, for	Data inputs from all sectors to be validated by respective stakeholders and then sent to	None	Statistics Mauritius (SM)	MEPU. CEB, IPP's, Tertiary Institutions	1-2 years

Need	Inputs	Cost Factor	Leading Institutions	Participating Institutions	Timeline
keeping electronic and hard copy versions of the information.	Statistics Mauritius for compilation				
Recalculations. This has not been done during the TNC.	Time series consistency analysis must be carried during the BUR by using the most recent UNFCCC methodology and local emission factor if they are formulated.	Will be done during the current BUR	CEB/SM	Tertiary Institution/ MEPU	1-2 years
Transport					
1.Vehicles kilometres 2.Vehicles emission 3.Emission factor	Surveys Tests Country specific emission factor		NTA NTA NTA	NTA Fitness Centre UOM	
Crop Sector					
1. Determination of Emission factors from volatilisation of N_2O from synthetic N and organic N fertiliser application, and also from run-off and leaching	Capacity building including training. Expert mission. Measuring equipment and technology transfer.	5.0 M	1. FAREI (non sugar crop) 2. MCIA (sugar sector)	University of Mauritius. International Institution such as IAEA and FAO	July 2017 – June 2019
2. Determination of land use and land cover change in the Cropland sector.	Capacity building including training. Training/Expert contract out. Latest land use map. Training in GIS mapping of Mauritius.	2.5 M	1. FAREI (non sugar crop) 2. MCIA (sugar sector)	Ministry of Housing and Lands	July 2017 – July 2018

Need	Inputs	Cost Factor	Leading Institutions	Participating Institutions	Timeline
3. Determination of emission and combustion factor for burning of main crop biomass (e.g. Sugar cane leaves)	Capacity building including training. Related equipment.	3.0 M	1. FAREI (non sugar crop) 2. MCIA (sugar sector)	University of Mauritius.	September 2017 –July 2018
4. Assess Carbon sequestration in orchard trees and tea plants – modelling tree growth under local conditions.	Capacity building. Biomass analysis. Data analysis and interpretation.	1.8 M	FAREI	MAIFS	September 2017 – June 2018
5. Application of Statistical methodologies in GHG inventory and uncertainty analysis	Training on statistical methodologies	500,000	FAREI	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division)	October 2017 – November 2017
6. Determination of annual crop biomass, Carbon accumulation and N content in crop residues.	Capacity building. Logistics and related lab equipment	1.2 M	1. FAREI (non sugar crop) 2. MCIA (sugar sector	University of Mauritius. MAIFS	September 2017 – December 2018
7. Further trainings in GHG inventory software.	Capacity building	800,000	1. FAREI (non sugar crop) 2. MCIA (sugar sector	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division)	March 2018
Livestock Sector					
1. Setting up of an information system at FAREI (for both livestock and crop sector)	Capacity building, logistics, and finance.	700,000 for capacity building. Rs 300,000 for IT technologies.	FAREI (management of the information system)	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable	July 2017–June 2019

Need	Inputs	Cost Factor	Leading Institutions	Participating Institutions	Timeline
				Development Division)	
2. To improve the collection of livestock population data	Training on data collection and addressing data gaps	300,000	FAREI (Livestock sector)	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division) to make arrangement for capacity building	July 2017 – December 2017
3. Establishing and validating local Emission Factors for the livestock sector, including for manure management.	Capacity building and training. Research experiments to determine local EFs data	10 M	1. FAREI (Livestock sector)	University of Mauritius. Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division)	September 2017 –June 2019
4. Application of Statistical methodologies in GHG inventory, uncertainty analysis and quality control	Training on statistical methodologies	500,000	FAREI (Livestock and crop sector)	Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division) to arrange for consultant for capacity building.	October 2017 – November 2017
5. Elaborated data on livestock distribution from Rodrigues (primary and secondary	Collaboration and contribution from Rodrigues regional assembly (Agriculture)	nil	FAREI	Rodrigues regional assembly (Agriculture) Ministry of Social Security,	

Need	Inputs	Cost Factor	Leading Institutions	Participating Institutions	Timeline
livestock activity data)				National Solidarity, and Environment and Sustainable Development (Environment and Sustainable Development Division)	
Forestry Sector					
High-resolution satellite imagery on land cover, soil maps & climate maps. Develop a time series of Land Use maps. Classify soil & climate maps as per IPCC categories	Purchase from relevant institution Training in GIS and Remote Sensing	1.0 M 8.0 M	Ministry of Housing & Lands Ministry of Housing & Lands	Forestry Service, FAREI, MSIRI, Meteorological Services Forestry Service, FAREI, MSIRI, Meteorological Services	1 year 2 years
Updated data on private forest lands	Conduct surveys for ground-truthing	3.0M	Forestry Service	MoSSNSESD, Statistics Mauritius, Private land owners, NPCS	3 years
Updated data on Trees Outside Forests	Conduct surveys	15.0 M	Forestry Service	MoSSNSESD, Statistics Mauritius, Private land owners	3 years
Updated data on natural forests (age-class distribution, annual increment, etc)	Conduct surveys for ground-truthing	2.0 M	Forestry Service	NPCS, Private land owners	3 years
Country-specific emission/removal factors (annual net increment, basic wood density, biomass expansion	Develop country-specific emission/removal factors	4.0 M	Forestry Service	UoM	3 years

Need	Inputs	Cost Factor	Leading Institutions	Participating Institutions	Timeline
factors, root-shoot ratio, etc)					
Carbon stock in non-woody trees, namely *Ravenala madagascariensis*	Conduct survey on non-woody trees	1.5 M	Forestry Service	UoM	2 years
Calculate woody biomass of Scrubland	Conduct relevant exercises	2.5 M	Forestry Service	UoM	2 years
Extend GHG inventory to all islands constituting RoM, not limited to Mauritius and Rodrigues only	Conduct inventories and surveys	15.0 M	MoSSNSESD	All sectors involved in preparation of NIR	5 years

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APPENDIX 1: Completeness Table

Table 81: Completeness Table

	GHG						
Total National Emissions and Removals							
1 - Energy							
1.A.1 - Energy Industries	x	x	x				
1.A.2 - Manufacturing Industries and Construction	x	x	x				
1.A.3 - Transport	x	x	x				
1.A.4 - Other Sectors	x	x	x				
1.A.5 - Non-Specified							
1.B - Fugitive emissions from fuels							
1.B.1 - Solid Fuels	NA	NA	NA				
1.B.2 - Oil and Natural Gas	NA	NA	NA				
1.B.3 - Other emissions from Energy Production	NO	NO	NO				
1.C - Carbon dioxide Transport and Storage							
1.C.1 - Transport of CO_2	NO						
1.C.2 - Injection and Storage	NO						
1.C.3 - Other	NO						
2 - Industrial Processes and Product Use							
2.A - Mineral Industry							
2.A.1 - Cement production	NO						
2.A.2 - Lime production	x						
2.A.3 - Glass Production	NO						
2.A.4 - Other Process Uses of Carbonates	NO						
2.A.5 - Other (please specify)	NO	NO	NO				
2.B - Chemical Industry							
2.B.1 - Ammonia Production	NO						
2.B.2 - Nitric Acid Production			NO				

2.B.3 - Adipic Acid Production			NO				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			NO				
2.B.6 - Titanium Dioxide Production	NO						
2.B.7 - Soda Ash Production	NO						
2.B.8 - Petrochemical and Carbon Black Production	NO	NO					
2.B.9 - Fluorochemical Production							
2.B.10 - Other (Please specify)	NO	NO	NO				
2.C - Metal Industry							
2.C.1 - Iron and Steel Production	x						
2.C.2 - Ferroalloys Production	NO	NO					
2.C.3 - Aluminium production	NO				NO		
2.C.4 - Magnesium production	NO					NO	
2.C.5 - Lead Production	NO						
2.C.6 - Zinc Production	NO						
2.C.7 - Other (please specify)	NO	NO	NO				
2.D - Non-Energy Products from Fuels and Solvent Use							
2.D.1 - Lubricant Use	NA						
2.D.2 - Paraffin Wax Use	NA						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	NO	NO	NO				
2.E - Electronics Industry							
2.E.1 - Integrated Circuit or Semiconductor				NO	NO	NO	NO
2.E.2 - TFT Flat Panel Display					NO	NO	NO
2.E.3 - Photovoltaics					NO		
2.E.4 - Heat Transfer Fluid					NO		
2.E.5 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO
2.F - Product Uses as Substitutes for Ozone Depleting Substances							
2.F.1 - Refrigeration and Air Conditioning				x			
2.F.2 - Foam Blowing Agents				NA			
2.F.3 - Fire Protection				NA	NO		
2.F.4 - Aerosols				NA			
2.F.5 - Solvents				NA	NO		
2.G - Other Product Manufacture and Use							
2.G.1 - Electrical Equipment					NA	NA	

2.G.2 - SF6 and PFCs from Other Product Uses					NA	NA	
2.G.3 - N2O from Product Uses			NA				
2.G.4 - Other (Please specify)	NA	NA	NA	NA	NA	NA	NA
2.H - Other							
2.H.1 - Pulp and Paper Industry	NO	NO					
2.H.2 - Food and Beverages Industry	NO	NO					
2.H.3 - Other (please specify)	NO	NO	NO				
3 - Agriculture, Forestry, and Other Land Use							
3.A - Livestock							
3.A.1 - Enteric Fermentation		x					
3.A.2 - Manure Management		x	x				
3.B - Land							
3.B.1 - Forest land	x						
3.B.2 - Cropland	x						
3.B.3 - Grassland	x						
3.B.4 - Wetlands	x		NA				
3.B.5 - Settlements	x						
3.B.6 - Other Land	x						
3.C - Aggregate sources and non-CO_2 emissions sources on land							
3.C.1 - Emissions from biomass burning		x	x				
3.C.2 - Liming	NA						
3.C.3 - Urea application	NA						
3.C.5 - Indirect N2O Emissions from managed soils			x				
3.C.6 - Indirect N2O Emissions from manure management			x				
3.C.7 - Rice cultivations		NO					
3.C.8 - Other (please specify)		NO	NO				
3.D - Other							
3.D.1 - Harvested Wood Products	NA						
3.D.2 - Other (please specify)	NA	NA	NA				
4 - Waste							
4.A - Solid Waste Disposal		x					
4.B - Biological Treatment of Solid Waste		x					
4.C - Incineration and Open Burning of Waste			x				

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

APPENDIX 2: NAI Reporting Tables

Table 82: Inventory Year: 2006 – NAI

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	2984.8776	41.4131	0.5201	1.7139	0	0	0
1.A - Fuel Combustion Activities	3267.4233	0.7935	0.1411	0.0000	0	0	0
1.A.1 - Energy Industries	1775.5405	0.3997	0.0712				
1.A.2 - Manufacturing Industries and Construction	414.9268	0.1816	0.0252				
1.A.3 - Transport	853.7551	0.1076	0.0427				
1.A.4 - Other Sectors	223.2008	0.1046	0.0019				
1.A.5 - Non-Specified	0.0000	0.0000	0.0000				
1.B - Fugitive emissions from fuels	0.0001	0.0013	0.0000	0.0000	0	0	0
1.B.1 - Solid Fuels	0.0000	0.0000	0.0000				
1.B.2 - Oil and Natural Gas	0.0001	0.0013	0.0000				
1.B.3 - Other emissions from Energy Production	0.0000	0.0000	0.0000				
1.C - Carbon dioxide Transport and Storage	0.0000	0.0000	0.0000	0.0000	0	0	0
1.C.1 - Transport of CO2	0.0000						
1.C.2 - Injection and Storage	0.0000						
1.C.3 - Other	0.0000						
2 - Industrial Processes and Product Use	42.0399	0.0000	0.0000	1.7139	0	0	0
2.A - Mineral Industry	1.5399	0.0000	0.0000	0.0000	0	0	0
2.A.1 - Cement production	0.0000						
2.A.2 - Lime production	1.5399						
2.A.3 - Glass Production	0.0000						
2.A.4 - Other Process Uses of Carbonates	0.0000						
2.A.5 - Other (please specify)	0.0000	0.0000	0.0000				

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B.1 - Ammonia Production	0.0000						
2.B.2 - Nitric Acid Production			0.0000				
2.B.3 - Adipic Acid Production			0.0000				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0.0000				
2.B.5 - Carbide Production	0.0000	0.0000					
2.B.6 - Titanium Dioxide Production	0.0000						
2.B.8 - Petrochemical and Carbon Black Production	0.0000	0.0000					
2.C - Metal Industry	40.5000	0.0000	0.0000	0.0000	0	0	0
2.C.1 - Iron and Steel Production	40.5000	0.0000					
2.C.2 - Ferroalloys Production	0.0000	0.0000					
2.C.3 - Aluminium production	0.0000				0		
2.C.4 - Magnesium production	0.0000					0	
2.C.5 - Lead Production	0.0000						
2.C.6 - Zinc Production	0.0000						
2.C.7 - Other (please specify)	0.0000	0.0000	0.0000	0.0000	0	0	0
2.D - Non-Energy Products from Fuels and Solvent Use	0.0000	0.0000	0.0000	0.0000	0	0	0
2.D.1 - Lubricant Use	0.0000						
2.D.2 - Paraffin Wax Use	0.0000						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	0.0000	0.0000	0.0000				
2.E - Electronics Industry	0.0000	0.0000	0.0000	0.0000	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0.0000	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0
2.E.3 - Photovoltaics					0		

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.E.4 - Heat Transfer Fluid					0		
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0.0000	0.0000	0.0000	1.7139	0	0	0
2.F.1 - Refrigeration and Air Conditioning				1.7139			
2.F.2 - Foam Blowing Agents				0.0000			
2.F.3 - Fire Protection				0.0000	0		
2.F.4 - Aerosols				0.0000			
2.F.5 - Solvents				0.0000	0		
2.G - Other Product Manufacture and Use	0.0000	0.0000	0.0000	0.0000	0	0	0
2.G.2 - SF6 and PFCs from Other Product Uses					0	0	
2.G.3 - N2O from Product Uses			0.0000				
2.G.4 - Other (Please specify)	0.0000	0.0000	0.0000	0.0000	0	0	0
2.H - Other	0.0000	0.0000	0.0000	0.0000	0	0	0
2.H.1 - Pulp and Paper Industry	0.0000	0.0000					
2.H.2 - Food and Beverages Industry	0.0000	0.0000					
2.H.3 - Other (please specify)	0.0000	0.0000	0.0000				
3 - Agriculture, Forestry, and Other Land Use	-324.5858	0.9764	0.3085	0.0000	0	0	0
3.A - Livestock	0.0000	0.8521	0.0283	0.0000	0	0	0
3.A.1 - Enteric Fermentation		0.7131					
3.A.2 - Manure Management		0.1390	0.0283				
3.B - Land	-324.5496	0.0000	0.0000	0.0000	0	0	0
3.B.1 - Forest land	-317.0100						
3.B.2 - Cropland	-0.1980						
3.B.3 - Grassland	0.0000						
3.B.4 - Wetlands	0.0000		0.0000				
3.B.5 - Settlements	-7.3416						

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.B.6 - Other Land	0.0000						
3.C - Aggregate sources and non-CO2 emissions sources on land	0.0000	0.1243	0.2802	0.0000	0	0	0
3.C.1 - Emissions from biomass burning		0.1243	0.0000				
3.C.2 - Liming	0.0000						
3.C.3 - Urea application	0.0000						
3.C.4 - Direct N2O Emissions from managed soils			0.2236				
3.C.5 - Indirect N2O Emissions from managed soils			0.0566				
3.C.7 - Rice cultivations		0.0000					
3.C.8 - Other (please specify)		0.0000	0.0000				
3.D - Other	-0.0362	0.0000	0.0000	0.0000	0	0	0
3.D.1 - Harvested Wood Products	-0.0362						
3.D.2 - Other (please specify)	0.0000	0.0000	0.0000				
4 - Waste	0.0000	39.6419	0.0705	0.0000	0	0	0
4.A - Solid Waste Disposal	0.0000	37.9766	0.0000	0.0000	0	0	0
4.B - Biological Treatment of Solid Waste	0.0000	0.0000	0.0000	0.0000	0	0	0
4.C - Incineration and Open Burning of Waste	0.0000	0.0000	0.0000	0.0000	0	0	0
4.D - Wastewater Treatment and Discharge	0.0000	1.6653	0.0705	0.0000	0	0	0
4.E - Other (please specify)	0.0000	0.0000	0.0000	0.0000	0	0	0
5 - Other	0.0000	0.0000	0.0000	0.0000	0	0	0
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0.0000	0.0000	0.0000	0.0000	0	0	0
5.B - Other (please specify)	0.0000	0.0000	0.0000	0.0000	0	0	0
Memo Items (5)							
International Bunkers	764.5860	0.0053	0.0214	0.0000	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	764.5860	0.0053	0.0214				
1.A.3.d.i - International water-borne navigation (International bunkers)	0.0000	0.0000	0.0000				

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
1.A.5.c - Multilateral Operations	0.0000	0.0000	0.0000	0.0000	0	0	0

Table 83: Inventory Year: 2006 – NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO_2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.03516	0	1.71392	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2 - Industrial Processes	0.03516	0	1.71392	0	0	0	0
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.03516	0	1.71392	0	0	0	0
2G - Other (please specify)							

3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							
5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							
7 - Other (please specify)							

Table 84: Inventory Year: 2007 – NAI

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	3138.625009	46.335	0.507	2.838	0	0	0
1 - Energy	3416.14	0.85	0.139	0	0	0	0
1.A - Fuel Combustion Activities	3416.141017	0.8524	0.139	0	0	0	0
1.A.1 - Energy Industries	1947.70	0.40	0.074				
1.A.2 - Manufacturing Industries and Construction	413.58	0.16	0.022				
1.A.3 - Transport	849.37	0.19	0.041				
1.A.4 - Other Sectors	205.49	0.10	0.002				
1.A.5 - Non-Specified	0	0	0				
1.B - Fugitive emissions from fuels	0	0	0	0	0	0	0
1.B.1 - Solid Fuels	0	0	0				
1.B.3 - Other emissions from Energy Production	0	0	0				
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0						
1.C.2 - Injection and Storage	0						
1.C.3 - Other	0						
2 - Industrial Processes and Product Use	41.99	0	0	2.84	0	0	0
2.A - Mineral Industry	1.4927	0	0	0	0	0	0
2.A.1 - Cement production	0						
2.A.2 - Lime production	1.4927						
2.A.3 - Glass Production	0						
2.A.4 - Other Process Uses of Carbonates	0						
2.A.5 - Other (please specify)	0	0	0				

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B - Chemical Industry	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0						
2.B.2 - Nitric Acid Production			0				
2.B.3 - Adipic Acid Production			0				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0				
2.B.5 - Carbide Production	0	0					
2.B.6 - Titanium Dioxide Production	0						
2.B.7 - Soda Ash Production	0						
2.B.8 - Petrochemical and Carbon Black Production	0	0					
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0
2.C - Metal Industry	40.5	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	40.5	0					
2.C.2 - Ferroalloys Production	0	0					
2.C.3 - Aluminium production	0				0		
2.C.4 - Magnesium production	0					0	
2.C.5 - Lead Production	0						
2.C.6 - Zinc Production	0						
2.C.7 - Other (please specify)	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.D.1 - Lubricant Use	0						
2.D.2 - Paraffin Wax Use	0						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	0	0	0				
2.E - Electronics Industry	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.E.2 - TFT Flat Panel Display					0	0	0
2.E.3 - Photovoltaics					0		
2.E.4 - Heat Transfer Fluid					0		
2.E.5 - Other (please specify)	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	2.838	0	0	0
2.F.1 - Refrigeration and Air Conditioning				2.838			
2.F.2 - Foam Blowing Agents				0			
2.F.3 - Fire Protection				0	0		
2.F.4 - Aerosols				0			
2.F.5 - Solvents				0	0		
2.F.6 - Other Applications (please specify)				0	0		
2.G.1 - Electrical Equipment					0	0	
2.G.2 - SF6 and PFCs from Other Product Uses					0	0	
2.G.3 - N2O from Product Uses			0				
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0					
2.H.2 - Food and Beverages Industry	0	0					
2.H.3 - Other (please specify)	0	0	0				
3 - Agriculture, Forestry, and Other Land Use	-319.51	0.98	0.297	0	0	0	0
3.A - Livestock	0	0.9283	0.024	0	0	0	0
3.A.1 - Enteric Fermentation		0.7806					
3.A.2 - Manure Management		0.1477	0.024				
3.B - Land	-319.4720879	0	0	0	0	0	0
3.B.1 - Forest land	-314.2357124						

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.B.2 - Cropland	-0.198						
3.B.3 - Grassland	0						
3.B.4 - Wetlands	0		0				
3.B.5 - Settlements	-5.038375467						
3.B.6 - Other Land	0						
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.0494	0.273	0	0	0	0
3.C.1 - Emissions from biomass burning		0.0494	0				
3.C.2 - Liming	0						
3.C.3 - Urea application	0						
3.C.4 - Direct N2O Emissions from managed soils			0.218				
3.C.5 - Indirect N2O Emissions from managed soils			0.055				
3.C.6 - Indirect N2O Emissions from manure management			0				
3.C.7 - Rice cultivations		0					
3.C.8 - Other (please specify)		0	0				
3.D.1 - Harvested Wood Products	-0.036619988						
3.D.2 - Other (please specify)	0	0	0				
4 - Waste	0	44.51	0.071	0	0	0	0
4.A - Solid Waste Disposal	0	42.829	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.6766	0.071	0	0	0	0
4.E - Other (please specify)	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	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0
Memo Items (5)							

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
International Bunkers	808.172365	0.0057	0.023	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	808.172365	0.0057	0.023				
1.A.3.d.i - International water-borne navigation (International bunkers)	0	0	0				

Table 85: Inventory Year: 2007 – NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO_2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.04147	0	2.837942	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.04147	0	2.837942	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							

5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							
7 - Other (please specify)							

Table 86: Inventory Year: 2008– NAI

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	3241.585159	50.032	0.484	3.794	0	0	0
1 - Energy	3537.23	0.79	0.134	0	0	0	0
1.A - Fuel Combustion Activities	3537.23	0.79	0.134	0	0	0	0
1.A.1 - Energy Industries	2028.06	0.40	0.076				
1.A.2 - Manufacturing Industries and Construction	443.75	0.11	0.015				
1.A.3 - Transport	850.61	0.19	0.041				
1.A.4 - Other Sectors	214.81	0.10	0.002				
1.A.5 - Non-Specified	0	0.0003	6E-05				
1.B - Fugitive emissions from fuels	0	0	0	0	0	0	0
1.B.1 - Solid Fuels	0	0	0				
1.B.3 - Other emissions from Energy Production	0	0	0				
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0						
1.C.2 - Injection and Storage	0						
1.C.3 - Other	0						
2 - Industrial Processes and Product Use	43.34	0	0	3.79	0	0	0
2.A - Mineral Industry	1.4927	0	0	0	0	0	0
2.A.1 - Cement production	0						
2.A.2 - Lime production	1.4927						
2.A.3 - Glass Production	0						
2.A.4 - Other Process Uses of Carbonates	0						
2.A.5 - Other (please specify)	0	0	0				

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B - Chemical Industry	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0						
2.B.2 - Nitric Acid Production			0				
2.B.3 - Adipic Acid Production			0				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0				
2.B.5 - Carbide Production	0	0					
2.B.6 - Titanium Dioxide Production	0						
2.B.7 - Soda Ash Production	0						
2.B.8 - Petrochemical and Carbon Black Production	0	0					
2.B.9 - Fluorochemical Production				0	0	0	0
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0
2.C - Metal Industry	41.85	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	41.85	0					
2.C.2 - Ferroalloys Production	0	0					
2.C.3 - Aluminium production	0				0		
2.C.4 - Magnesium production	0					0	
2.C.6 - Zinc Production	0						
2.C.7 - Other (please specify)	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.D.1 - Lubricant Use	0						
2.D.2 - Paraffin Wax Use	0						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	0	0	0				
2.E - Electronics Industry	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0
2.E.3 - Photovoltaics					0		

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.E.4 - Heat Transfer Fluid					0		
2.E.5 - Other (please specify)	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	3.794	0	0	0
2.F.1 - Refrigeration and Air Conditioning				3.794			
2.F.2 - Foam Blowing Agents				0			
2.F.3 - Fire Protection				0	0		
2.F.4 - Aerosols				0			
2.F.5 - Solvents				0	0		
2.F.6 - Other Applications (please specify)				0	0		
2.G.1 - Electrical Equipment					0	0	
2.G.2 - SF6 and PFCs from Other Product Uses					0	0	
2.G.3 - N2O from Product Uses			0				
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0					
2.H.2 - Food and Beverages Industry	0	0					
2.H.3 - Other (please specify)	0	0	0				
3 - Agriculture, Forestry, and Other Land Use	-338.99	0.99	0.282	0	0	0	0
3.A - Livestock	0	0.9393	0.023	0	0	0	0
3.A.1 - Enteric Fermentation		0.7969					
3.A.2 - Manure Management		0.1424	0.023				
3.B - Land	-338.9514591	0	0	0	0	0	0
3.B.1 - Forest land	-331.8499354						
3.B.2 - Cropland	-0.066						
3.B.3 - Grassland	0						
3.B.4 - Wetlands	0		0				

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.B.5 - Settlements	-7.035523733						
3.B.6 - Other Land	0						
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.0472	0.259	0	0	0	0
3.C.1 - Emissions from biomass burning		0.0472	0				
3.C.2 - Liming	0						
3.C.3 - Urea application	0						
3.C.4 - Direct N2O Emissions from managed soils			0.207				
3.C.5 - Indirect N2O Emissions from managed soils			0.052				
3.C.6 - Indirect N2O Emissions from manure management			0				
3.C.7 - Rice cultivations		0					
3.C.8 - Other (please specify)		0	0				
3.D - Other	-0.03812825	0	0	0	0	0	0
3.D.2 - Other (please specify)	0	0	0				
4 - Waste	0	48.25	0.069	0	0	0	0
4.A - Solid Waste Disposal	0	46.52	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.731	0.069	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
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0
Memo Items (5)							
International Bunkers	814.26059	0.0057	0.023	0	0	0	0

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
1.A.3.a.i - International Aviation (International Bunkers)	814.26059	0.0057	0.023				
1.A.3.d.i - International water-borne navigation (International bunkers)	0	0	0				
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0

Table 87: Inventory Year: 2008 – NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO_2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.04688	0	3.793623	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2 - Industrial Processes	0.04688	0	3.793623	0	0	0	0
2A - Mineral Products							
2B - Chemical Industry							
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.04688	0	3.793623	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							

5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							
7 - Other (please specify)							

Table 88: Inventory Year: 2009 – NAI

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	3210.471266	41.527	0.482	4.585	0	0	0
1 - Energy	3495.48	0.80	0.133	0	0	0	0
1.A - Fuel Combustion Activities	3495.484	0.80	0.133	0	0	0	0
1.A.1 - Energy Industries	2024.15	0.40	0.075				
1.A.2 - Manufacturing Industries and Construction	368.39	0.10	0.014				
1.A.3 - Transport	878.49	0.20	0.042				
1.A.4 - Other Sectors	224.46	0.10	0.002				
1.B - Fugitive emissions from fuels	0	0	0	0	0	0	0
1.B.1 - Solid Fuels	0	0	0				
1.B.2 - Oil and Natural Gas	0	0	0				
1.B.3 - Other emissions from Energy Production	0	0	0				
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0						
1.C.2 - Injection and Storage	0						
1.C.3 - Other	0						
2 - Industrial Processes and Product Use	44.69	0.00	0.00	4.58	0	0	0
2.A - Mineral Industry	1.4927	0	0	0	0	0	0
2.A.1 - Cement production	0						
2.A.2 - Lime production	1.4927						
2.A.3 - Glass Production	0						
2.A.4 - Other Process Uses of Carbonates	0						
2.A.5 - Other (please specify)	0	0	0				
2.B - Chemical Industry	0	0	0	0	0	0	0

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B.1 - Ammonia Production	0						
2.B.2 - Nitric Acid Production			0				
2.B.3 - Adipic Acid Production			0				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0				
2.B.5 - Carbide Production	0	0					
2.B.6 - Titanium Dioxide Production	0						
2.B.7 - Soda Ash Production	0						
2.B.8 - Petrochemical and Carbon Black Production	0	0					
2.B.9 - Fluorochemical Production				0	0	0	0
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0
2.C - Metal Industry	43.2	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	43.2	0					
2.C.2 - Ferroalloys Production	0	0					
2.C.3 - Aluminium production	0				0		
2.C.5 - Lead Production	0						
2.C.6 - Zinc Production	0						
2.C.7 - Other (please specify)	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.D.1 - Lubricant Use	0						
2.D.2 - Paraffin Wax Use	0						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	0	0	0				
2.E - Electronics Industry	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0
2.E.3 - Photovoltaics					0		

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.E.4 - Heat Transfer Fluid					0		
2.E.5 - Other (please specify)	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	4.585	0	0	0
2.F.1 - Refrigeration and Air Conditioning				4.585			
2.F.2 - Foam Blowing Agents				0			
2.F.3 - Fire Protection				0	0		
2.F.4 - Aerosols				0			
2.F.5 - Solvents				0	0		
2.F.6 - Other Applications (please specify)				0	0		
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment					0	0	
2.G.2 - SF6 and PFCs from Other Product Uses					0	0	
2.G.3 - N2O from Product Uses			0				
2.H - Other	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0					
2.H.2 - Food and Beverages Industry	0	0					
2.H.3 - Other (please specify)	0	0	0				
3 - Agriculture, Forestry, and Other Land Use	-329.71	0.99	0.276	0	0	0	0
3.A - Livestock	0	0.9455	0.024	0	0	0	0
3.A.1 - Enteric Fermentation		0.802					
3.A.2 - Manure Management		0.1435	0.024				
3.B - Land	-329.6666425	0	0	0	0	0	0
3.B.1 - Forest land	-323.4298185						
3.B.2 - Cropland	-0.099						
3.B.3 - Grassland	0						
3.B.4 - Wetlands	0		0				
3.B.5 - Settlements	-6.137824						

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.B.6 - Other Land	0						
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.0475	0.252	0	0	0	0
3.C.1 - Emissions from biomass burning		0.0475	0				
3.C.2 - Liming	0						
3.C.3 - Urea application	0						
3.C.4 - Direct N2O Emissions from managed soils			0.201				
3.C.5 - Indirect N2O Emissions from managed soils			0.051				
3.C.6 - Indirect N2O Emissions from manure management			0				
3.C.8 - Other (please specify)		0	0				
3.D - Other	-0.039205069	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	-0.039205069						
3.D.2 - Other (please specify)	0	0	0				
4 - Waste	0	39.73	0.073	0	0	0	0
4.A - Solid Waste Disposal	0	37.86	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.8745	0.073	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
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0
Memo Items (5)							
International Bunkers	671.67672	0.0047	0.019	0	0	0	0
1.A.3.d.i - International water-borne navigation (International bunkers)	0	0	0				
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0

Table 89: Inventory Year: 2009 – NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO_2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.05141	0	4.58459	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.05141	0	4.58459	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							

5 - Land-Use Change & Forestry							
5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							

Table 90: Inventory Year: 2010 – NAI

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	3447.45877	47.485	0.521	5.215	0	0	0
1 - Energy	3728.36	0.83	0.139	0	0	0	0
1.A - Fuel Combustion Activities	3728.36	0.83	0.139	0	0	0	0
1.A.2 - Manufacturing Industries and Construction	373.18	0.11	0.016				
1.A.3 - Transport	918.19	0.21	0.044				
1.A.5 - Non-Specified	0	0	0				
1.B - Fugitive emissions from fuels	0	0	0	0	0	0	0
1.B.1 - Solid Fuels	0	0	0				
1.B.2 - Oil and Natural Gas	0	0	0				
1.B.3 - Other emissions from Energy Production	0	0	0				
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0						
1.C.2 - Injection and Storage	0						
1.C.3 - Other	0						
2 - Industrial Processes and Product Use	44.69	0	0	5.21	0	0	0
2.A - Mineral Industry	1.4927	0	0	0	0	0	0
2.A.1 - Cement production	0						
2.A.2 - Lime production	1.4927						
2.A.3 - Glass Production	0						
2.A.4 - Other Process Uses of Carbonates	0						
2.A.5 - Other (please specify)	0	0	0				

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B - Chemical Industry	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0						
2.B.2 - Nitric Acid Production			0				
2.B.3 - Adipic Acid Production			0				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0				
2.B.5 - Carbide Production	0	0					
2.B.6 - Titanium Dioxide Production	0						
2.B.7 - Soda Ash Production	0						
2.B.9 - Fluorochemical Production				0	0	0	0
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0
2.C - Metal Industry	43.2	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	43.2	0					
2.C.2 - Ferroalloys Production	0	0					
2.C.3 - Aluminium production	0				0		
2.C.4 - Magnesium production	0					0	
2.C.5 - Lead Production	0						
2.C.6 - Zinc Production	0						
2.C.7 - Other (please specify)	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.D.1 - Lubricant Use	0						
2.D.2 - Paraffin Wax Use	0						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	0	0	0				
2.E - Electronics Industry	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.E.3 - Photovoltaics					0		
2.E.4 - Heat Transfer Fluid					0		
2.E.5 - Other (please specify)	0	0	0	0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	5.215	0	0	0
2.F.1 - Refrigeration and Air Conditioning				5.215			
2.F.2 - Foam Blowing Agents				0			
2.F.3 - Fire Protection				0	0		
2.F.5 - Solvents				0	0		
2.F.6 - Other Applications (please specify)				0	0		
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment					0	0	
2.G.2 - SF6 and PFCs from Other Product Uses					0	0	
2.G.3 - N2O from Product Uses			0				
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0					
2.H.2 - Food and Beverages Industry	0	0					
2.H.3 - Other (please specify)	0	0	0				
3 - Agriculture, Forestry, and Other Land Use	-325.59	1.04	0.308	0	0	0	0
3.A - Livestock	0	0.9947	0.027	0	0	0	0
3.A.1 - Enteric Fermentation		0.8296					
3.A.2 - Manure Management		0.1651	0.027				
3.B - Land	-325.5563386	0	0	0	0	0	0
3.B.1 - Forest land	-317.7585999						
3.B.2 - Cropland	0						
3.B.3 - Grassland	0						

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.B.4 - Wetlands	0		0				
3.B.5 - Settlements	-7.797738667						
3.B.6 - Other Land	0						
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.0462	0.282	0	0	0	0
3.C.1 - Emissions from biomass burning		0.0462	0				
3.C.2 - Liming	0						
3.C.3 - Urea application	0						
3.C.4 - Direct N2O Emissions from managed soils			0.227				
3.C.5 - Indirect N2O Emissions from managed soils			0.055				
3.C.6 - Indirect N2O Emissions from manure management			0				
3.C.7 - Rice cultivations		0					
3.C.8 - Other (please specify)		0	0				
3.D.1 - Harvested Wood Products	-0.03799526						
3.D.2 - Other (please specify)	0	0	0				
4 - Waste	0	45.61	0.073	0	0	0	0
4.A - Solid Waste Disposal	0	43.945	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.6694	0.073	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
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0
Memo Items (5)							
International Bunkers	738.67794	0.0052	0.021	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	738.67794	0.0052	0.021				

	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
1.A.3.d.i - International water-borne navigation (International bunkers)	0	0	0				

Table 91: Inventory Year: 2010 – NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO_2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.05506	0	5.214659	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.05506	0	5.214659	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							

4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							
5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							

Table 92: Inventory Year: 2011 – NAI

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	3409.225692	49.491	0.629	5.687	0	0	0
1 - Energy	3692.61	0.82	0.138	0	0	0	0
1.A - Fuel Combustion Activities	3692.61	0.82	0.138	0	0	0	0
1.A.1 - Energy Industries	2174.84	0.40	0.077				
1.A.2 - Manufacturing Industries and Construction	356.04	0.10	0.015				
1.A.3 - Transport	929.81	0.22	0.045				
1.A.4 - Other Sectors	231.91	0.10	0.002				
1.A.5 - Non-Specified	0	0	0				
1.B.1 - Solid Fuels	0	0	0				
1.B.2 - Oil and Natural Gas	0	0	0				
1.B.3 - Other emissions from Energy Production	0	0	0				
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0						
1.C.2 - Injection and Storage	0						
1.C.3 - Other	0						
2 - Industrial Processes and Product Use	48.74	0	0	5.69	0	0	0
2.A - Mineral Industry	1.4927	0	0	0	0	0	0
2.A.1 - Cement production	0						
2.A.2 - Lime production	1.4927						
2.A.3 - Glass Production	0						
2.A.4 - Other Process Uses of Carbonates	0						
2.A.5 - Other (please specify)	0	0	0				
2.B - Chemical Industry	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0						
2.B.2 - Nitric Acid Production			0				

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)
2.B.3 - Adipic Acid Production			0				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0				
2.B.5 - Carbide Production	0	0					
2.B.6 - Titanium Dioxide Production	0						
2.B.7 - Soda Ash Production	0						
2.B.8 - Petrochemical and Carbon Black Production	0	0					
2.B.9 - Fluorochemical Production				0	0	0	0
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0
2.C - Metal Industry	47.25	0	0	0	0	0	0
2.C.1 - Iron and Steel Production	47.25	0					
2.C.3 - Aluminium production	0				0		
2.C.4 - Magnesium production	0					0	
2.C.5 - Lead Production	0						
2.C.6 - Zinc Production	0						
2.C.7 - Other (please specify)	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.D.1 - Lubricant Use	0						
2.D.2 - Paraffin Wax Use	0						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	0	0	0				
2.E - Electronics Industry	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0
2.E.3 - Photovoltaics					0		
2.E.4 - Heat Transfer Fluid					0		
2.E.5 - Other (please specify)	0	0	0	0	0	0	0

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	5.687	0	0	0
2.F.1 - Refrigeration and Air Conditioning				5.687			
2.F.2 - Foam Blowing Agents				0			
2.F.3 - Fire Protection				0	0		
2.F.4 - Aerosols				0			
2.F.5 - Solvents				0	0		
2.F.6 - Other Applications (please specify)				0	0		
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment					0	0	
2.G.3 - N2O from Product Uses			0				
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0					
2.H.2 - Food and Beverages Industry	0	0					
2.H.3 - Other (please specify)	0	0	0				
3 - Agriculture, Forestry, and Other Land Use	-332.13	1.05	0.417	0	0	0	0
3.A - Livestock	0	0.9639	0.026	0	0	0	0
3.A.1 - Enteric Fermentation		0.7965					
3.A.2 - Manure Management		0.1673	0.026				
3.B - Land	-332.0915899	0	0	0	0	0	0
3.B.1 - Forest land	-322.9195963						
3.B.2 - Cropland	0						
3.B.3 - Grassland	0						
3.B.4 - Wetlands	0		0				
3.B.5 - Settlements	-9.1719936						
3.B.6 - Other Land	0						

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.0867	0.391	0	0	0	0
3.C.1 - Emissions from biomass burning		0.0867	0				
3.C.2 - Liming	0						
3.C.3 - Urea application	0						
3.C.5 - Indirect N2O Emissions from managed soils			0.057				
3.C.6 - Indirect N2O Emissions from manure management			0				
3.C.7 - Rice cultivations		0					
3.C.8 - Other (please specify)		0	0				
3.D - Other	-0.035554975	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	-0.035554975						
3.D.2 - Other (please specify)	0	0	0				
4 - Waste	0	47.62	0.074	0	0	0	0
4.A - Solid Waste Disposal	0	45.749	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0.0515	0	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.8158	0.074	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
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0
Memo Items (5)							
International Bunkers	783.948165	0.0055	0.022	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	783.948165	0.0055	0.022				
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0

Table 93: Inventory Year: 2011 – NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO_2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.05784	0	5.687045	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B2 - Oil and Natural Gas							
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.05784	0	5.687045	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							
5A - Changes in Forest and Other Woody Biomass Stocks							

5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6D - Other (please specify)							
7 - Other (please specify)							

Table 94: Inventory Year: 2012 – NAI

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	3522.568204	48.322	0.583	6.005	0	0	0
1 - Energy	3815.22	0.82	0.140	0	0	0	0
1.A.1 - Energy Industries	2270.19	0.40	0.078				
1.A.2 - Manufacturing Industries and Construction	350.46	0.09	0.013				
1.A.3 - Transport	967.88	0.23	0.047				
1.A.4 - Other Sectors	226.68	0.10	0.002				
1.A.5 - Non-Specified	0	0	0				
1.B - Fugitive emissions from fuels	0	0	0	0	0	0	0
1.B.1 - Solid Fuels	0	0	0				
1.B.2 - Oil and Natural Gas	0	0	0				
1.B.3 - Other emissions from Energy Production	0	0	0				
1.C - Carbon dioxide Transport and Storage	0	0	0	0	0	0	0
1.C.1 - Transport of CO2	0						
1.C.2 - Injection and Storage	0						
1.C.3 - Other	0						
2 - Industrial Processes and Product Use	44.96	0	0	6.01	0	0	0
2.A - Mineral Industry	1.4927	0	0	0	0	0	0
2.A.1 - Cement production	0						
2.A.2 - Lime production	1.4927						
2.A.3 - Glass Production	0						
2.A.4 - Other Process Uses of Carbonates	0						
2.A.5 - Other (please specify)	0	0	0				
2.B - Chemical Industry	0	0	0	0	0	0	0
2.B.1 - Ammonia Production	0						
2.B.2 - Nitric Acid Production			0				

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B.3 - Adipic Acid Production			0				
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0				
2.B.5 - Carbide Production	0	0					
2.B.6 - Titanium Dioxide Production	0						
2.B.7 - Soda Ash Production	0						
2.B.8 - Petrochemical and Carbon Black Production	0	0					
2.B.9 - Fluorochemical Production				0	0	0	0
2.B.10 - Other (Please specify)	0	0	0	0	0	0	0
2.C - Metal Industry	43.47	0	0	0	0	0	0
2.C.2 - Ferroalloys Production	0	0					
2.C.3 - Aluminium production	0				0		
2.C.4 - Magnesium production	0					0	
2.C.5 - Lead Production	0						
2.C.6 - Zinc Production	0						
2.C.7 - Other (please specify)	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.D.1 - Lubricant Use	0						
2.D.2 - Paraffin Wax Use	0						
2.D.3 - Solvent Use							
2.D.4 - Other (please specify)	0	0	0				
2.E - Electronics Industry	0	0	0	0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor				0	0	0	0
2.E.2 - TFT Flat Panel Display					0	0	0
2.E.3 - Photovoltaics					0		
2.E.4 - Heat Transfer Fluid					0		
2.E.5 - Other (please specify)	0	0	0	0	0	0	0

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	6.005	0	0	0
2.F.1 - Refrigeration and Air Conditioning				6.005			
2.F.2 - Foam Blowing Agents				0			
2.F.3 - Fire Protection				0	0		
2.F.4 - Aerosols				0			
2.F.6 - Other Applications (please specify)				0	0		
2.G - Other Product Manufacture and Use	0	0	0	0	0	0	0
2.G.1 - Electrical Equipment					0	0	
2.G.2 - SF6 and PFCs from Other Product Uses					0	0	
2.G.3 - N2O from Product Uses			0				
2.G.4 - Other (Please specify)	0	0	0	0	0	0	0
2.H - Other	0	0	0	0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0					
2.H.2 - Food and Beverages Industry	0	0					
2.H.3 - Other (please specify)	0	0	0				
3 - Agriculture, Forestry, and Other Land Use	-337.61	1.07	0.348	0	0	0	0
3.A - Livestock	0	0.9906	0.026	0	0	0	0
3.A.1 - Enteric Fermentation		0.8272					
3.A.2 - Manure Management		0.1634	0.026				
3.B - Land	-337.5704959	0	0	0	0	0	0
3.B.1 - Forest land	-327.6727721						
3.B.2 - Cropland	0						
3.B.3 - Grassland	0						
3.B.4 - Wetlands	0		0				
3.B.5 - Settlements	-9.897723733						

Categories	Emissions (Gg)			Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.0803	0.322	0	0	0	0
3.C.1 - Emissions from biomass burning		0.0803	0				
3.C.2 - Liming	0						
3.C.3 - Urea application	0						
3.C.4 - Direct N2O Emissions from managed soils			0.257				
3.C.5 - Indirect N2O Emissions from managed soils			0.066				
3.C.6 - Indirect N2O Emissions from manure management			0				
3.C.7 - Rice cultivations		0					
3.C.8 - Other (please specify)		0	0				
3.D - Other	-0.03939001	0	0	0	0	0	0
3.D.1 - Harvested Wood Products	-0.03939001						
3.D.2 - Other (please specify)	0	0	0				
4 - Waste	0	46.43	0.096	0	0	0	0
4.A - Solid Waste Disposal	0	44.263	0	0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0.3478	0.021	0	0	0	0
4.C - Incineration and Open Burning of Waste	0	6E-05	6E-05	0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.8181	0.075	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
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0	0	0	0	0
5.B - Other (please specify)	0	0	0	0	0	0	0
Memo Items (5)							
International Bunkers	793.11089	0.0055	0.022	0	0	0	0
1.A.3.a.i - International Aviation (International Bunkers)	793.11089	0.0055	0.022				
1.A.5.c - Multilateral Operations	0	0	0	0	0	0	0

Table 95: Inventory Year: 2012 – NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO_2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.05975	0	6.005424	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2 - Industrial Processes	0.05975	0	6.005424	0	0	0	0
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.05975	0	6.005424	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							

5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							
7 - Other (please specify)							

Table 96: Inventory Year: 2013 – NAI

Categories	Emissions (Gg)				Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O		HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
Total National Emissions and Removals	3606.192539	47.748	0.568		6.173	0	0	0
1 - Energy	3903.66	0.83	0.142		0	0	0	0
1.A - Fuel Combustion Activities	3903.66	0.83	0.142		0	0	0	0
1.A.1 - Energy Industries	2352.83	0.41	0.08					
1.A.2 - Manufacturing Industries and Construction	336.55	0.09	0.013					
1.A.3 - Transport	987.75	0.24	0.048					
1.A.4 - Other Sectors	226.53	0.10	0.002					
1.A.5 - Non-Specified	0	0	0					
1.B - Fugitive emissions from fuels	0	0	0		0	0	0	0
1.B.1 - Solid Fuels	0	0	0					
1.B.2 - Oil and Natural Gas	0	0	0					
1.B.3 - Other emissions from Energy Production	0	0	0					
1.C.1 - Transport of CO2	0							
1.C.2 - Injection and Storage	0							
1.C.3 - Other	0							
2 - Industrial Processes and Product Use	37.54	0.00	0.00		6.17	0	0	0
2.A - Mineral Industry	1.4927	0	0		0	0	0	0
2.A.1 - Cement production	0							
2.A.2 - Lime production	1.4927							
2.A.3 - Glass Production	0							
2.A.4 - Other Process Uses of Carbonates	0							
2.A.5 - Other (please specify)	0	0	0					
2.B - Chemical Industry	0	0	0		0	0	0	0
2.B.1 - Ammonia Production	0							
2.B.2 - Nitric Acid Production			0					
2.B.3 - Adipic Acid Production			0					

	Emissions (Gg)				Emissions CO2 Equivalents (Gg)			
Categories	Net CO2 (1)(2)	CH4	N2O		HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production			0					
2.B.5 - Carbide Production	0	0						
2.B.6 - Titanium Dioxide Production	0							
2.B.7 - Soda Ash Production	0							
2.B.8 - Petrochemical and Carbon Black Production	0	0						
2.B.9 - Fluorochemical Production					0	0	0	0
2.B.10 - Other (Please specify)	0	0	0		0	0	0	0
2.C - Metal Industry	36.045	0	0		0	0	0	0
2.C.1 - Iron and Steel Production	36.045	0						
2.C.2 - Ferroalloys Production	0	0						
2.C.3 - Aluminium production	0					0		
2.C.4 - Magnesium production	0						0	
2.C.6 - Zinc Production	0							
2.C.7 - Other (please specify)	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.D.1 - Lubricant Use	0							
2.D.2 - Paraffin Wax Use	0							
2.D.3 - Solvent Use								
2.D.4 - Other (please specify)	0	0	0					
2.E - Electronics Industry	0	0	0		0	0	0	0
2.E.1 - Integrated Circuit or Semiconductor					0	0	0	0
2.E.2 - TFT Flat Panel Display						0	0	0
2.E.3 - Photovoltaics						0		
2.E.4 - Heat Transfer Fluid						0		
2.E.5 - Other (please specify)	0	0	0		0	0	0	0
2.F - Product Uses as Substitutes for Ozone Depleting Substances	0	0	0		6.173	0	0	0

Categories	Emissions (Gg)				Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O		HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
2.F.1 - Refrigeration and Air Conditioning					6.173			
2.F.2 - Foam Blowing Agents					0			
2.F.3 - Fire Protection					0	0		
2.F.4 - Aerosols					0			
2.F.5 - Solvents					0	0		
2.F.6 - Other Applications (please specify)					0	0		
2.G.2 - SF6 and PFCs from Other Product Uses						0	0	
2.G.3 - N2O from Product Uses			0					
2.G.4 - Other (Please specify)	0	0	0		0	0	0	0
2.H - Other	0	0	0		0	0	0	0
2.H.1 - Pulp and Paper Industry	0	0						
2.H.2 - Food and Beverages Industry	0	0						
2.H.3 - Other (please specify)	0	0	0					
3 - Agriculture, Forestry, and Other Land Use	-335.00	1.06	0.351		0	0	0	0
3.A - Livestock	0	0.9785	0.024		0	0	0	0
3.A.1 - Enteric Fermentation		0.8159						
3.A.2 - Manure Management		0.1626	0.024					
3.B - Land	-334.9660424	0	0		0	0	0	0
3.B.1 - Forest land	-331.9974973							
3.B.2 - Cropland	0							
3.B.3 - Grassland	0							
3.B.4 - Wetlands	0		0					
3.B.5 - Settlements	-2.968545067							
3.B.6 - Other Land	0							
3.C - Aggregate sources and non-CO2 emissions sources on land	0	0.0793	0.326		0	0	0	0

Categories	Emissions (Gg)				Emissions CO2 Equivalents (Gg)			
	Net CO2 (1)(2)	CH4	N2O		HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)
3.C.2 - Liming	0							
3.C.3 - Urea application	0							
3.C.4 - Direct N2O Emissions from managed soils			0.259					
3.C.5 - Indirect N2O Emissions from managed soils			0.067					
3.C.6 - Indirect N2O Emissions from manure management			0					
3.C.7 - Rice cultivations		0						
3.C.8 - Other (please specify)		0	0					
3.D - Other	-0.038207193	0	0		0	0	0	0
3.D.1 - Harvested Wood Products	-0.038207193							
3.D.2 - Other (please specify)	0	0	0					
4 - Waste	0	45.86	0.076		0	0	0	0
4.A - Solid Waste Disposal	0	43.73	0		0	0	0	0
4.B - Biological Treatment of Solid Waste	0	0.3464	0		0	0	0	0
4.C - Incineration and Open Burning of Waste	0	0	0		0	0	0	0
4.D - Wastewater Treatment and Discharge	0	1.7875	0.076		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
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	0	0	0		0	0	0	0
5.B - Other (please specify)	0	0	0		0	0	0	0
Memo Items (5)								
1.A.3.a.i - International Aviation (International Bunkers)	732.62332	0.0051	0.02					
1.A.3.d.i - International water-borne navigation (International bunkers)	0	0	0					
1.A.5.c - Multilateral Operations	0	0	0		0	0	0	0

Table 97: Inventory Year: 2013- NAI

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO^2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO_2)	SF6 (Gg)
Total National Emissions and Removals	0.06082	0	6.173136	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2 - Industrial Processes	0.06082	0	6.173136	0	0	0	0
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.06082	0	6.173136	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							

5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO_2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							
7 - Other (please specify)							

APPENDIX 3: QC Category-specific Procedures

Key categories identified in Mauritius are:

- CO_2 emissions from Energy Industries - Solid Fuels
- CO_2 emissions from Manufacturing Industries and Construction - Liquid Fuels
- CO_2 emissions from Energy Industries - Liquid Fuels
- CO_2 removals from Forest land Remaining Forest land
- CO_2 emissions from Other Sectors - Liquid Fuels
- CH_4 emissions from Solid Waste Disposal
- CO_2 emissions from Road Transportation
- CO_2 emissions from Iron and Steel Production
- CH_4 emissions from Biological Treatment of Solid Waste

QC procedures are listed in Table below.

Table 98: QC Procedures

No	QC Activity	Procedures	Task Completed		Corrective Measure Taken	
			Name/ Initials	Date	Supporting Documents (List Document Name)	Date
1	Assess the applicability of IPCC default factors	• Evaluate whether national conditions are similar to those used to develop the IPCC default factors • Compare default factors to site or plant-level factors • Consider options for obtaining country-specific factors • Document results of this assessment				

No	QC Activity	Procedures	Task Completed		Corrective Measure Taken	
			Name/ Initials	Date	Supporting Documents (List Document Name)	Date
3	Review measurements	• Determine if national or international (e.g., ISO) standards were used in measurements • Ensure measurement equipment is calibrated and maintained properly • Compare direct measurements with estimates using a factor; document any significant discrepancies				
5	Check that parameters and units are correctly recorded and that appropriate conversion factors are used.	• Check that units are properly labelled in calculation sheets. • Check that units are correctly carried through from beginning to end of calculations. • Check that conversion factors are correct. • Check that temporal and spatial adjustment factors are used correctly.				

No	QC Activity	Procedures	Task Completed		Corrective Measure Taken	
			Name/ Initials	Date	Supporting Documents (List Document Name)	Date
6	Check the integrity of database files.	• Examine the included intrinsic documentation to: ✓ Confirm that the appropriate data processing steps are correctly represented in the database; ✓ Confirm that data relationships are correctly represented in the database; ✓ Ensure that data fields are properly labelled and have the correct design specifications; ✓ Ensure that adequate documentation of database and model structure and operation are archived.				
	Check for consistency in data between categories.	• Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emission/removal calculations.				

No	QC Activity	Procedures	Task Completed		Corrective Measure Taken	
			Name/ Initials	Date	Supporting Documents (List Document Name)	Date
10	Check that the movement of inventory data among processing steps is correct.	• Check that emissions and removals data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. • Check that emissions and removals data are correctly transcribed between different intermediate products.				
12	Check completeness.	• Confirm that estimates are reported for all categories and for all years from the appropriate base year to the period of the current inventory. • For subcategories, confirm that entire category is being covered. • Provide clear definition of ‘Other’ type categories. • Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate in relation to total emissions (e.g., subcategories classified as ‘not estimated’, see Chapter 8, Reporting Guidance and Tables).				

No	QC Activity	Procedures	Task Completed		Corrective Measure Taken	
			Name/ Initials	Date	Supporting Documents (List Document Name)	Date
13	QC uncertainty estimates	• Apply QC techniques to uncertainty estimates • Review uncertainty calculations • Document uncertainty assumptions and qualifications of any experts consulted				

APPENDIX 4: Quality Assurance Procedures

Following is the checklist used by the external experts to review the whole process of GHG inventory. These checklist can be used to develop the Terms of reference to hire the external consultant (s) to conduct QA procedures

Cross-Cutting Checks for Overall Inventory Quality

Table 99: Cross-Cutting Checks for Overall Inventory Quality

Activities	Task Completed		
	Findings	Date	Recommendation
1. Emission Calculations Across GHG Emission and Removal Categories			
Identify parameters that are common across categories (e.g. conversion factors, carbon content coefficients, etc.) and check for consistency			
Check that using same data inputs (e.g. animal population data) report comparable values (i.e., analogous in magnitude)			
Check across categories that same electronic data set is used for common data (e.g., linking animal population data to the enteric fermentation and manure management calculations)			
Check that the number of significant digits or decimal places for common parameters, conversion factors, emission factors, or activity data is consistent across categories			
Check that total emissions are reported consistently (in terms of significant digits or decimal places) across categories			
Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels			
Other (specify):			
2. Documentation			
Check if internal documentation practices are consistent across categories			
Other (specify):			
3. Completeness			
Check for completeness across categories and years			
Check that data gaps are identified and reported as required			
Compare current national inventory estimates with previous			

years'			
Other (specify):			
4. Maintaining Master Inventory File: Spreadsheets and Inventory Document			
• Have file control procedures been followed?			
• Other (specify):			

Detailed Checklist for Inventory Document

Table 100: Detailed Checklist for Inventory Document

	Name	Date	
1. Front Section			
Cover page has correct date, title, and contact address			
Tables of contents/tables/figures are accurate: titles match document, page #s match; numbers run consecutively and have correct punctuation			
The Executive Summary and Introduction are updated with appropriate years and discussion of trends			
Other (specify):			
2. Tables and Figures			
All numbers in tables match numbers in spreadsheets			
Check that all tables have correct number of significant digits			
Check alignment in columns and labels			
Check that table formatting is consistent			
Check that all figures are updated with new data and referenced in the text			
Check table and figure titles for accuracy and consistency with content			
Other (specify):			
3. Equations			
Check for consistency in equations			
Check that variables used in equations are defined following the equation			
Other (specify):			
4. **References**			
Check consistency of references, and that in text citations and references match			

Other (specify):			
5. **General Format**			
All fonts in text, headings, titles, and subheadings are consistent			
All highlighting, notes, and comments are removed from document			
Size, style, and indenting of bullets are consistent			
Spell check is complete			
Other (specify):			
6. Other Issues			
Check that each section is updated with current year (or most recent year that inventory report includes)			
Other (specify):			

APPENDIX 5: Comparison of results for 2006 using Revised 1996 and 2006 IPCC Methodologies

Table 101: Comparison of results for 2006 using Revised 1996 and 2006 IPCC Methodologies

	CO_2		CH_4		N_2O		Total TNC 2006 GL	Total SNC 1996 GL	Value Change from both methodologies	% Chang e
Sectors	2006 GL (TNC)	1996 GL (SNC)	2006 GL (TNC)	1996 GL (SNC)	2006 GL (TNC)	1996 GL (SNC)				
Energy	3,267.4	3,114.9	16.7	9.2	43.7	27.9	3,327.9	3,152.0	175.9	6
IPPU	42.0	1.9					42.0	1.9	N/A	N/A
Agriculture			37.3	73.8	75.1	132.4	112.39	206.19	N/A	N/A
FOLU	-361.4	-361.4					-361.42	-361.42	0.0	-
Total	**2948.0**	**2755.4**	**851.5**	**825.5**	**140.6**	**186.3**	**3940.2**	**3767.17**	**173.0**	**5**

Note:

(i) IPPU and Agriculture (part of AFOLU) were not considered because they are not Key categories;

(ii) Forest and Other Land Use (FOLU) which is almost former LULUCF was fully recalculated from 2000 to 2006 as main part of AFOLU and it is at the same time a key category; and

(iii) For Waste Water, only emissions calculated using 2006 IPCC Guidelines were considered because the methodology used during SNC were not accurate.

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