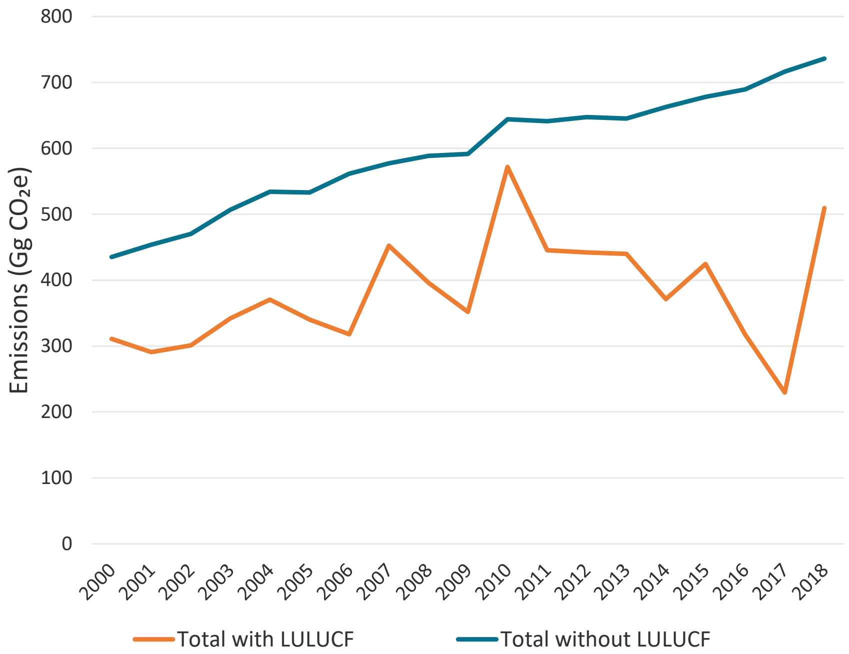
MINISTRY OF EDUCATION, INNOVATION, GENDER RELATIONS AND SUSTAINABLE DEVELOPMENT

Department of Sustainable Development

Saint Lucia National Inventory Report

August 2020



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Glossary

APP	Annual Average Population
AWMS	Animal Waste Management Systems
BOD	Biochemical Oxygen Demand
CfRN	Coalition for Rainforest Nations
CO_2eq	Carbon Dioxide Equivalent
COD	Chemical Oxygen Demand
DOM	Dead Organic Matter
DSA	Data Supply Agreements
F-gases	Fluorinated gases
FAO	Food and Agriculture Organisation
FOD	First Order Decay
GCF	Green Climate Fund
GDP	Gross Domestic Product
Gg	Gigagrams (1 Gg = 1 kt)
GHG	Greenhouse Gas
GWP	Global Warming Potential
HWP	Harvested Wood Products
IE	Included Elsewhere
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
LUCELEC	Saint Lucia Electricity Services Limited
LULUCF	Land use, land use change and forestry
MCF	Methane Correction Factor
MMR	Monitoring Mechanism Regulation
MRV	Monitoring, Reporting and Verification
MW	Megawatt
MS	Method Statement
NA	Not Applicable
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NE	Not Estimated
NEIS	National Environmental Information System
NIR	National Inventory Report

NO	Not Occurring
ODS	Ozone Depleting Substance
OLADE	Latin American Energy Organization
QA/QC	Quality Assurance and Quality Control
RAC	Refrigeration and air-conditioning
SAR	Second Assessment Report
SLASPA	Saint Lucia Air and Sea Ports Authority
SLSWMA	Saint Lucia Solid Waste Management Authority
SOC	Soil Organic Carbon
SWDS	Solid Waste Disposal Sites
UNFCCC	United Nations Framework Convention on Climate Change
WASCO	Water and Sewage Company

Executive Summary

Background information

The Government of Saint Lucia recognises the challenges that climate change poses to its population, the country's natural resources and economy, and has taken considerable measures to identify and address, to the extent possible, current and future climate risks both at the policy and operational levels. Saint Lucia became a party of the United Nations Framework Convention on Climate Change (UNFCCC) in 1993 and submitted its Third National Communication in 2017. Saint Lucia ratified the Paris Agreement in 2016 and has made significant progress in the integration of climate change into national policies, strategies and plans.

Greenhouse gas inventory

This is Saint Lucia's National Inventory Report (NIR) prepared in 2020. The inventory covers the entirety of on island emissions from Saint Lucia and national waters. It contains national greenhouse gas (GHG) emission and removal estimates for the period 2000 – 2018, and the descriptions of the methods used to produce the estimates. The report is prepared in accordance with the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines and for some sectors, the 2019 Refinement to the 2006 IPCC Guidelines. GHG emissions from all major sectors have been estimated for CO_2, CH_4, N_2O and HFCs. Emissions of NMVOCs, an indirect GHG, have also been estimated in the Industrial Process and Product Use (IPPU) sector. The inventory is managed and maintained by The Department of Sustainable Development on behalf of Saint Lucia. The GHG inventory has a number of specific uses including:

- Reporting to the UNFCCC (a key part of the countries Biennial Update Reports (Biennial Transparency Reports under Paris Agreement) and National Communications)
- Supporting decision makers with metrics, factors, historical data and analysis and monitoring tools for assessing and tracking mitigation actions and modelling future emissions/removal scenarios
- Prioritising certain sectors and activities to mobilise finance for action
- Tracking progress with Saint Lucia's Nationally Determined Contribution (NDC)

Where possible, national datasets have been used to compile the GHG estimates. All estimates have been compiled and reviewed in line with the QA/QC Plan which was developed in 2020. The inventory is part of a continuous improvement cycle, a number of improvements have been identified during this inventory cycle and have been compiled into an Improvement Plan. Key improvements include expanding the national inventory team to include at least two experts per sector, implementing a system for processing the energy balance, expanding data collection and developing country-specific factors e.g. electricity generation and forest land biomass stocks.

Overview of sources, sinks and trends

The total emissions in Saint Lucia with and without the land use, land use change and forestry (LULUCF) sector are presented in **Figure 1** and **Table 1**. GHG emissions and removals have fluctuated throughout the period between 2000 and 2018. Overall, total emissions have increased by over half since 2000, both with and without LULUCF. Emissions in Saint Lucia are dominated by the energy sector due to the contribution from the electricity generation and road transport sectors. The trend in increasing emissions is driven by a rising population with an increasing demand for electricity and transport. Overall, the LULUCF sector is a net sink of emissions, but the size of this sink fluctuates over the time series. This is in part due to the impact of hurricanes, on forest land in Saint Lucia which result in emissions. These events are countered with subsequent removals through reforesting projects. To determine which categories have the biggest impact on the overall emissions and emissions trend, an approach 1 and 2 key category analysis was performed. The top five key categories in Saint Lucia are energy industries, road transport, refrigeration and air conditioning, forest land remaining forest land and solid waste disposal.

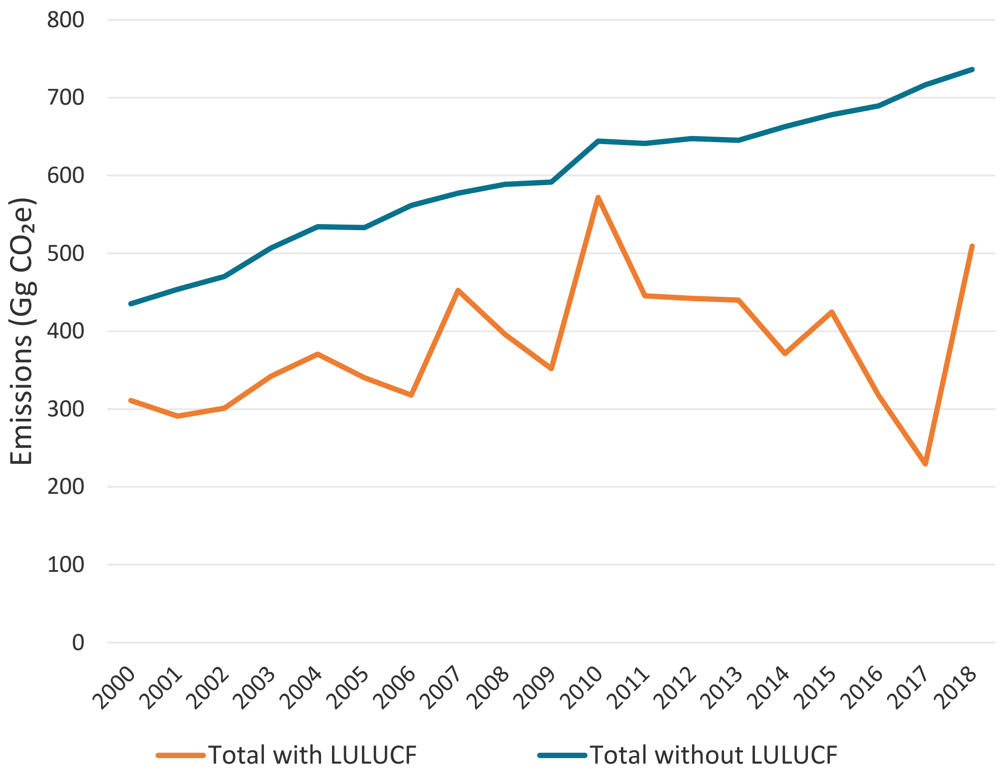


Figure 1: Total GHG emissions and removals with and without the Land Use, Land Use Change and Forestry (LULUCF) sector Table 1: Total GHG emissions with and without LULUCF

Year	Total with LULUCF		Total without LULUCF	
	Emissions (Gg CO_2e)	Change from 2000 (%)	Emissions (Gg CO_2e)	Change from 2000 (%)
2000	311	-	435	-
2005	340	9%	533	23%
2010	572	84%	644	48%
2014	371	19%	663	52%
2015	425	37%	678	56%
2016	318	2%	690	59%
2017	229	-26%	717	65%
2018	509	64%	736	69%

1 Introduction

This is Saint Lucia's 2020 National Inventory Report (NIR). It provides an overview of greenhouse gas (GHG) reporting, the current inventory and detailed methodological information. The GHG inventory has a number of specific uses including:

- Reporting to the UNFCCC (a key part of the countries Biennial Update Reports (Biennial Transparency Reports under Paris Agreement) and National Communications)
- Supporting decision makers with metrics, factors, historical data and analysis and monitoring tools for assessing and tracking mitigation actions and modelling future emissions/removal scenarios
- Prioritising certain sectors and activities to mobilise finance for action
- Tracking progress with Saint Lucia's Nationally Determined Contribution (NDC)

The GHG inventory presented in this NIR covers the period 1990 to 2018. This is an update (applied to the full time series) on the GHG inventory produced in 2015 which included GHG emissions estimates for 2000, 2005 and 2010. The recalculation based on a comparison with this inventory are presented in **Section 1.9.2**.

1.1 Background information

1.1.1 Climate Change

Saint Lucia is highly vulnerable to climate change due to three main conditions: (a) its small geographical area, which accounts for the fact that disasters take country-wide proportions; (b) its location in an area of cyclone, volcanic and seismic activity; and (c) its dependence on economic sectors that are directly affected by climate variability and change. While the country's contribution to global GHG emissions and thus to human-induced climate change are miniscule, this phenomenon could cost lives, livelihoods and well over 24.5 % of its gross domestic product (GDP) by 2050 and 49.1 % by 2100 (Bueno *et al.* 2008). Therefore, it is imperative that effective national and regional adaptation and global mitigation action is taken as soon as possible. In order to participate in global efforts Saint Lucia needs to track its own GHG emissions and report as well as be informed about how best to move to a low carbon economy.

The Government of Saint Lucia recognises the challenges that climate change poses to its population, the country's natural resources and economy, and has taken considerable measures to identify and address, to the extent possible, current and future climate risks both at the policy and operational levels. Saint Lucia became a party of the United Nations Framework Convention on Climate Change (UNFCCC) in 1993, submitted its Initial National Communication to the UNFCCC in 2001, its Second National Communication in 2012 and its Third National Communication in 2017. Saint Lucia also submitted its first NDC under the UNFCCC in 2015[1] and developed an NDC Partnership Plan in 2019, ratified the Paris Agreement in 2016 and has made significant progress in the integration of climate change into national policies, strategies and plans. Currently, the Saint Lucia Climate Change Adaptation Policy of 2015 embodies a key policy and guidance document on the matter and the country launched a comprehensive ten-year National Adaptation Plan (NAP) in 2018. Complementing the NAP are a series of adaptation strategies and action plans for priority sectors and thematic areas, project concept note portfolios, a communications strategy, monitoring and evaluation plan, climate financing strategy, private sector engagement strategy and other supplements. Saint Lucia has developed its multi-sectoral Country Programme and Project Pipeline

[1] The NDC has set as targets, the reduction of 16% and 23% of national greenhouse gas emissions by 2025 and 2030, respectively (relative to those in 2010)

under the Green Climate Fund (GCF), has submitted a water-focused project for consideration, accessed funding for its first GCF readiness project and is expecting to submit a number of project concepts within the four-year cycle of its Country Programme. Saint Lucia received approval from the Adaptation Fund in 2019 for a US$ 10 million project focused on the agricultural sector that aggregates a number of the initiatives proposed in its adaptation strategies and action plans. At the international climate change policy arena, Saint Lucia is actively seeking the rapid reduction of global GHG emissions (mitigation) and fair agreements, collaboration and support for adaptation, including limits to adaptation (loss and damage), to build resilience and address climate change, while facilitating sustainable socioeconomic development under a changing climate.

Climate change impacts result from complex interactions between climatic and non-climatic factors, which are also expected to change with time. Resilience building therefore implies that under considerable uncertainty, short to medium-term decisions and investments need to be made by governments, businesses and individuals to manage existing and emerging risks and to adequately adjust ongoing activities, operations, plans and policies to the changing conditions. These decisions should be based on the best information available.

1.1.2 GHG Inventory

Saint Lucia's GHG inventory provides a key evidence based on the trends and key sources of emissions and removals in the country. This resource can be used for reporting as well as informing different decision makers and stakeholders in the country. The GHG inventory is managed and maintained by The Department of Sustainable Development on behalf of Saint Lucia.

Geographical coverage

This inventory covers the entirety of on island emissions from Saint Lucia and national waters.

GHG’s reported

Direct GHGs have a radiative effect in the atmosphere. Indirect GHGs are gases that have indirect radiative effects through reacting/breaking down in the atmosphere and produce a direct GHG. NO_x, CO and NMVOC are indirect GHGs which can increase tropospheric ozone concentration and hence radiative forcing. SO_2 contributes to aerosol formation in the atmosphere which is believed to have a negative net radiative forcing effect, tending to cool the surface.

The direct GHG’s reported are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)

The following GHGs have not been included due to their low significance and complexities in collecting and compiling their data.

- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)
- Nitrogen trifluoride (NF_3)

The indirect GHG’s reported are:

- Non-Methane Volatile Organic Compounds (NMVOC)

The following other indirect GHG's have not been included in this inventory:

- Nitrogen oxides (NO_x, as NO_2)
- Carbon monoxide (CO)
- Sulphur dioxide (SO_2)

1.2 Global Warming Potentials

The direct GHGs have different effectiveness in radiative forcing. The global warming potential (GWP) provides a simple measure of the relative radiative effects of the emissions of the various gases. It is defined as the cumulative radiative forcing between the present and a future time horizon caused by a unit mass of gas emitted now, expressed relative to that of CO_2. It is necessary to define a time horizon because the gases have different lifetimes in the atmosphere. Emissions and removals from non-CO_2 pollutants have been converted to CO_2 equivalent (CO_2eq) using GWP values from the IPCC Second Assessment Report (SAR). The applied GWP values are presented in **Table 2**. By weighting the emissions using each gases GWP, it is possible to estimate the total GHG emissions of Saint Lucia.

Table 2: Global warming potential (GWP) values applied in the inventory, source: SAR

Gas		GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
HFC-32 *	CH_2F_2	650
HFC-143a *	CH_3CF_3	3,800
HFC -125 *	CHF_2CF_3	2,800
HFC 134a *	CH_2CHF_2	1,300

*Note: * An annual GWP value for the assumed blend of f-gases used in the Refrigeration and Stationary Air Conditioning has been calculated from these HFCs.*

1.3 Institutional Arrangements

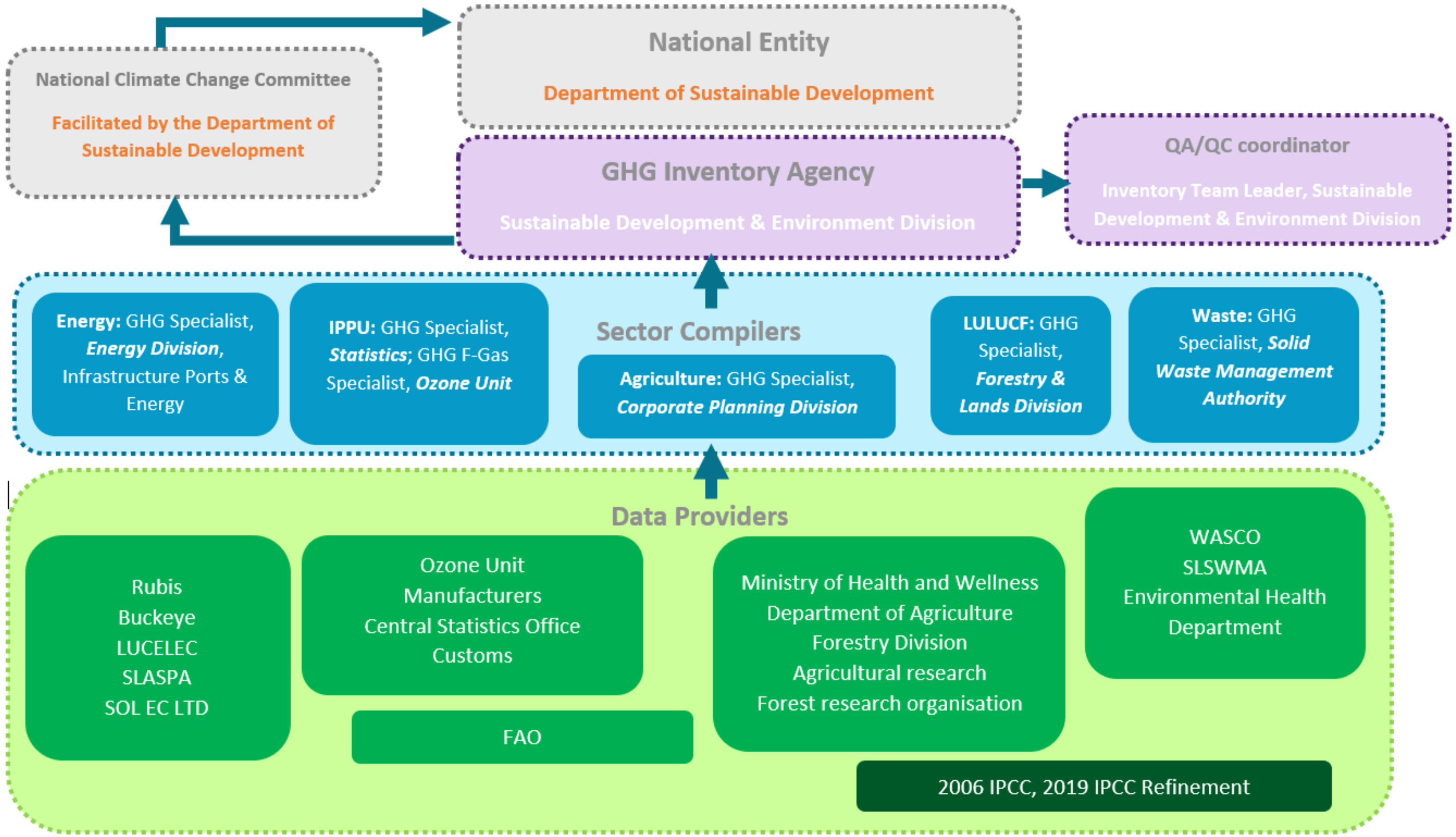
1.3.1 Institutional, Legal and Procedural Arrangements for compiling the inventory

The Department of Sustainable Development is the National Climate Change Focal Point as we as the National Entity responsible for reporting the GHG inventory to the UNFCCC. An overview of the current institutional arrangements for the GHG inventory in Saint Lucia is presented in **Figure 2**. Further information on the roles and capacities of each of the institutions and individuals is provided in **Table 3**. All key documents for the inventory process are archived by the Department of Sustainable Development and on Saint Lucia's National Environmental Information System (NEIS) at the end of the inventory cycle. The NEIS is hosted by the Government of Saint Lucia and provides a platform for archiving environmental information.

The Department of Sustainable Development is responsible for the planning, preparation and development of the GHG inventory. The Department of Sustainable Development set the timetable for the inventory updates and manage the completion of tasks by the GHG inventory team. The Department also coordinates the work, consolidates and reports the data and provides central quality assurance and quality control of the data. Individual sector experts (from a range of departments) are responsible for the compilation of their sectoral categories and quality assurance and quality control of the estimates.

Planned improvements to institutional arrangements are provided in the Improvement Plan (**Annex IV**). Key improvements include training inventory staff and developing a system for processing the energy balance.

Figure 2: Institutional arrangements structure



Notes: LUCELEC = Saint Lucia Electricity Services Limited, SLASPA = Saint Lucia Air and Sea Ports Authority, FAO = UN Food and Agriculture Organization, WASCO = Water and Sewage Company , SLSWMA = Saint Lucia Solid Waste Management Authority

Table 3: Roles and necessary capacities of institutions and individual team members

Stakeholder	General Roles	Necessary Capacities
Single National Entity The Department of Sustainable Development	Overall responsibility that MRV System produces expected outputs such as NCs, BURs.	Administrative skills, government authority
Steering Committee Chaired by The Department of Sustainable Development and including other data providers and sectoral experts	Provide overall planning, coordination, management and technical facilitators of inputs and outputs.	Technical and administrative expertise, government authority
Management team The Department of Sustainable Development	Responsible for overall planning, coordination and management of MRV System.	Technical and administrative expertise, government authority, capacity to coordinate and lead the process
Sector Experts The Department of Sustainable Development and other departments	Undertake data collection, calculations, drafting, quality control, archiving, and documentation.	Technical expertise including knowledge of the UNFCCC reporting requirements and IPCC methodologies
Data Providers A range of public and private organisations including national statistics.	Timely delivery of input data in appropriate format	Technical skills, legal authority to improve and enhance data collection

Notes: MRV = Monitoring, Reporting and Verification, NC = National Communication, BUR = Biennial Update Report

1.3.2 Overview of inventory preparation and management

The inventory cycle is presented in **Figure 3** below. This cycle ensures that there is continuous improvement in the inventory data each time it is updated. Planning and improvement phases enable new data and improvements to be implemented in an organised way.

Figure 3: The GHG inventory cycle [2]

1.4 Inventory Preparation

1.4.1 Data collection, compilation and storage

The data and information required for compiling national GHG inventories can include data from a range of different data collecting organisations. This data can be in the form of online datasets, data from hard copies of reports, and expert judgement information from discussions with experts. All this information and data must be collated, reviewed and analysed to ensure it is appropriately and accurately used within the inventory estimates.

Throughout the inventory compilation process, the sector experts applied the good practice guidance from the IPCC Guidelines to identify, select, collect, review and incorporate data gathered in a consistent and accurate manner. All datasets and information used have been transparently documented in the **Excel compilation spreadsheets** and through the **method statements**:

- **Excel compilation spreadsheets:** excel spreadsheets have been set up for all non-LULUCF sectors to calculate emission estimates. The structure of these compilation spreadsheets is presented in **Figure 4** and **Figure 5**. The LULUCF sector estimates have been taken from the Coalition for Rainforest Nations (CfRN) project, funded by the Norwegian Agency for Development Cooperation (Norad).
- **Method statements:** methodology description, including data sources. Methodology description, including data sources, quality assurance/ quality control (QA/QC), verification and improvements are provided within method statements. The method statements are provided in **Annex III**. The sector summary tables provided at the beginning of each sectoral chapter (**Chapters 3 - 7**) provides a mapping of each sector to its method statement. Where the same

[2] Institutional arrangements template. Developing a national inventory system template workbook. US EPA, December 2011.

methodology has been used for multiple sectors only one combined method statement has been prepared to reduce repetition.

Figure 4: Summary of the tabs within the compilation spreadsheets

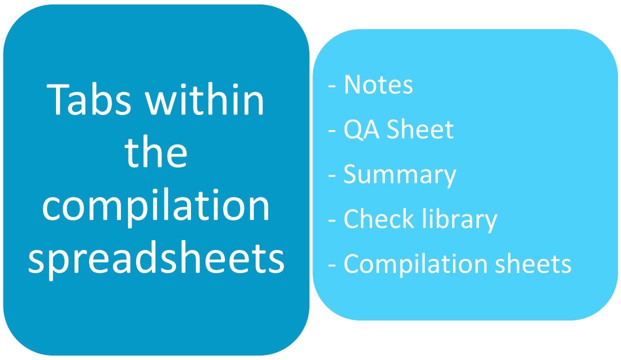
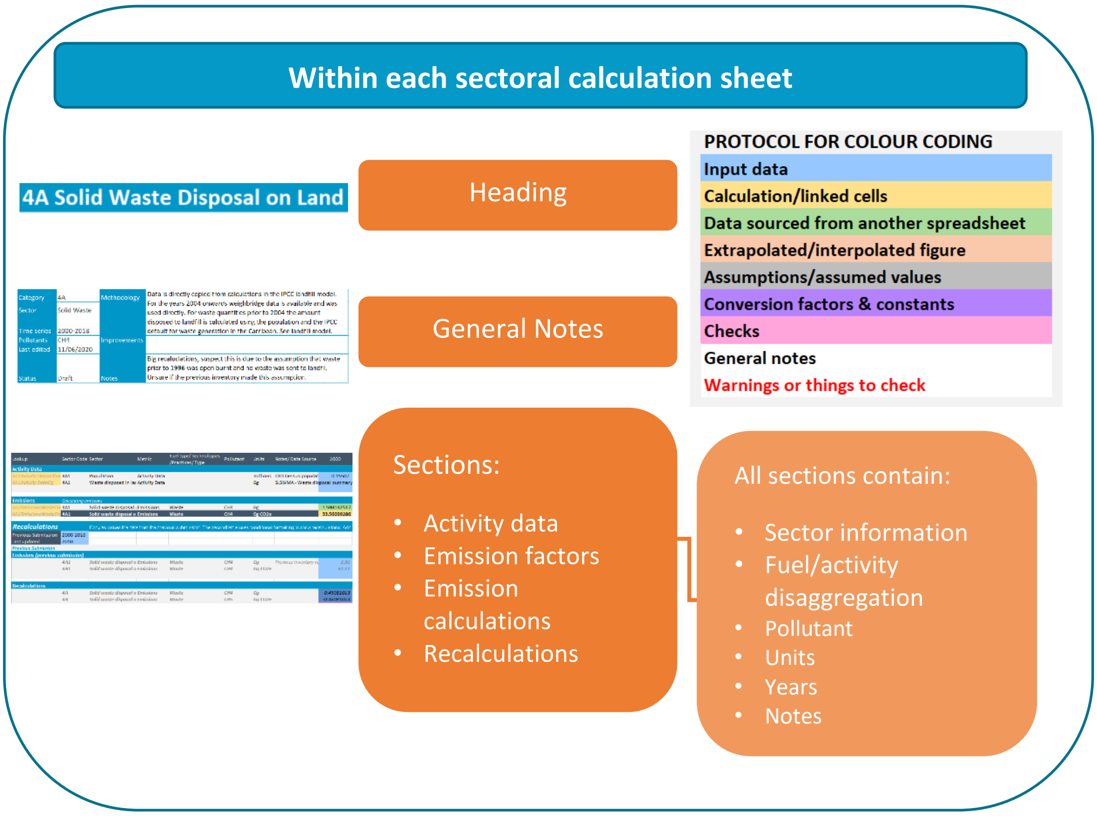


Figure 5: Summary of the format of each compilation sheet



As far as possible, national datasets have been used in the inventory. However, there are instances where the national datasets are not available, and information has been taken from international datasets e.g. livestock population trends.

1.4.2 Quality assurance/ quality control (QA/QC) procedures and GHG inventory review

A detailed description of the QA/QC system is provided within **Section 1.7**. Information on sector specific QA/QC undertaken is provided within the sectoral chapters (**Chapters 3 - 7**).

1.5 Key methods and data sources

As far as possible, national datasets and statistics are used in the inventory. However, there are instances where the national datasets are not available, and information has been taken from international datasets e.g. FAO data for livestock trends. Throughout the data collection process, the sector experts have been conscious of the prioritisation of categories. These are sectors which are likely to have a more significant contribution to total national emissions and therefore deemed a higher priority. The data gathering process has focussed on the key categories[3] by putting resources into the investigation and collection of data to support the estimates in the key categories. See the method statements (**Annex III**) for all activity data sources.

For energy, IPPU, agriculture and waste, the 2006 IPCC Guidelines (IPCC, 2006) and 2019 IPCC Refinement (IPCC, 2019) emission factors were used for the GHG estimates. The method statements (**Annex III**) provide details and justification for the use of different factors . In the LULUCF sector, country-specific emission factors have also been used in the calculations for above ground biomass in forest land. Other local sources of information have also been used, such as fraction of biomass loss due to disturbance, using expert judgement from Saint Lucia's Forest Division. Additional information is provided within the LULUCF chapter (**Chapter 6**).

1.6 Key Categories

The key category analysis as detailed in the 2006 IPCC Guidelines (V1, Chp4), provides a useful analysis of the inventory estimates by highlighting the more significant categories. By highlighting these categories, the inventory compilation team can better assess the prioritisation for improvement of data gathering and methodologies. Other users of the inventory can also clearly identify those categories that may be more applicable for mitigation to reduce national GHG emissions.

There are three ways of determining a key category:

- **Level assessment** – order the inventory categories from large to small in terms of emissions for a single year and highlight all categories that contribute to 95 % of the total emissions;
- **Trend assessment** – order the inventory categories from large to small in terms of their contribution to the total trend and highlight all categories that contribute to 95 % of the total trend;
- **Qualitative assessment** – inventory team identifies categories in addition to those flagged by the Level and Trend assessment that are deemed significant, and this could be due to expected growth or completeness of the inventory.

Table 4 below summarises the key categories in the inventory and indicates which assessment has flagged each as a key category. The top three sectors of 1A1 Energy Industries CO_2, 1A3b Road Transport CO_2 and 3B1a Forest Land Remaining Forest Land CO_2 make up the majority of emissions/removals in Saint Lucia. The rank of each category changes between the level and trend assessments using Approach 1 and

[3] 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 in terms of the absolute level, the trend or the uncertainty

Approach 2, with LULUCF. No additional key categories were identified when conducting the key category analysis without LULUCF.

The full results of the key category analysis are provided in **Annex I**.

The key category analysis helps the GHG inventory compilation team to prioritise the improvements for future inventory compilation cycles and is further discussed in the improvement plan in **Annex IV**.

Table 4 Summary of the identified key categories according to Level and Trend assessments with LULUCF using Approach 1 and Approach 2

L1 = level, approach 1, T1 = trend, approach 1, L2 = level approach 2, T2 = trend, approach 2, BY = base year, LY = latest year. Note, the most significant category is denoted by a rank of 1.

Category	L1 BY	L1 LY	T1	L2	T2	Overall Rank
1A1: Energy Industries - CO_2	1	1	2	1	2	1.4
1A3b: Road Transport - CO_2	2	2	3	4	N	2.8
2F1: Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning - HFCs	7	4	1	2	1	3.0
3B1a: Forest Land Remaining Forest Land - CO_2	3	3	7	3	N	4.0
4A: Solid Waste Disposal - CH_4	4	5	5	5	N	4.8
1B1: Fugitive emissions from fuels - Solid Fuels - CH_4	6	N	4	N	5	5.0
1A4: Fuel Combustion Activities - Other Sectors - CH_4	8	N	6	N	4	6.0
1A2: Manufacturing Industries and Construction - CO_2	N	7	N	N	N	7.0
3C4: Direct N_2O MS - N_2O	10	N	9	6	3	7.0
3B1bi: Land Converted to Forest Land - CO_2	N	8	N	7	N	7.5
1A4: Fuel Combustion Activities - Other Sectors - CO_2	5	6	15	N	N	8.7
1A3b: Road Transport - N_2O	N	9	N	N	N	9.0
3A1aii: Enteric Fermentation Non-Dairy Cattle CH_4	9	11	8	N	N	9.3
3A2i: Manure Management Poultry N_2O	N	N	10	N	N	10.0
3B1bii: Land Converted to Forest Land - CO_2	N	10	N	N	N	10.0
3A2h: Manure Management Swine N_2O	N	12	11	N	N	11.5
1A3d: National Navigation - CO_2	N	N	12	N	N	12.0
1A3a: Domestic Aviation - CO_2	N	N	13	N	N	13.0
3C5: Indirect N_2O MS - N_2O	N	N	14	N	N	14.0
2G: Other Product Manufacture and Use - N_2O	N	N	16	N	N	16.0
1A4: Fuel Combustion Activities - Other Sectors - N_2O	N	N	17	N	N	17.0

1.7 Quality assurance/ quality control (QA/QC)

The implementation of QA/QC is essential for ensuring that the national inventory reporting is credible and can be relied on by its users. QA/QC focuses on ensuring that the GHG inventory is transparent, complete, consistent, comparable and accurate in accordance with the 2006 IPCC Guidelines. QA/QC activities include:

- **Quality Control (QC):** Routine activities to maintain quality during compilation to ensure data integrity and correctness, identify and address problems and document and archive inventory material and QA/QC
- **Quality Assurance (QA):** Review procedures by those not directly involved in inventory compilation
- **Verification:** External cross comparison and review processes, this could include checking country specific data against online resources or comparing the reference and sectoral approach

1.7.1 Overview of the QA/QC System

This section presents the QA/QC system that has been put in place for the Saint Lucian GHG inventory (see **Figure 6**). The QA/QC system is focused around three linked elements:

1) The QA/QC plan which provides centralised documentation of the inventory teams QA/QC activities. The QA/QC plan sets out the objectives, roles and responsibilities and activities for ensuring the GHG inventory is of the best possible quality. It provides a working framework and enhances the transparency of inventory compilation and reporting by defining structured QA/QC activities and documentation as well as wider documentation. The roles and key responsibilities of those involved with preparing the inventory documented in the plan include:

    a. **QA/QC coordinator:** overall responsibility for the annual design of QA/QC and improvements activities.

    b. **Sectoral lead:** the sectoral lead is the main knowledge holder on individual inventory sectors. They are responsible for completion of day-to-day QC activities.

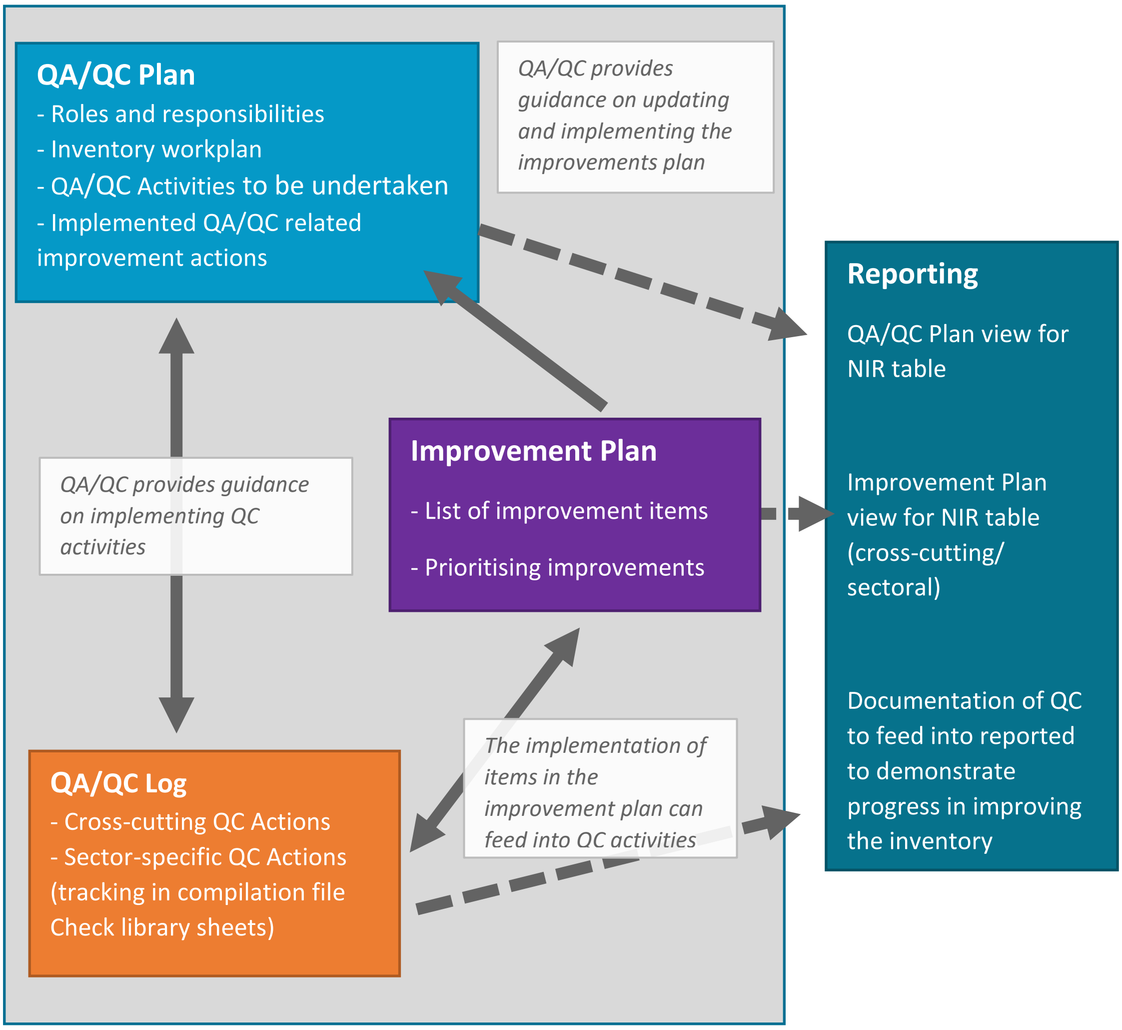
    c. **Sectoral support:** each inventory sector has an identified 'second'. The role of the second is to provide support to the sectoral lead and to protect institutional memory. The second has specific QC activities assigned to them at key milestones in the annual inventory cycle.

2) An Improvement Plan. This plan is used for tracking possible and agreed improvement work which is presented in **Annex IV**. An overview of the Improvement Plan is provided in **Section 1.9.3**.

3) The QA/QC log provides documented evidence of QA/QC activities. Logging of QA/QC is done at different levels and is often embedded in the compilation files using specialised tools. QA/QC activities are also documented within the check library sheet (see **Figure 5**) and are maintained by sectoral leads. The QA/QC coordinator is responsible for ensuring that all compilation files show complete QA/QC documentation as defined in the QA/QC Plan and for summarising the QA/QC activities undertaken for the QAQC log.

The QA/QC Plan acts as a centralised library for relevant training material (to identify and track the engagement of key experts and stakeholders with the inventory team); and for the storage of internal document templates and specific QA/QC guidance for e.g. data collection, review and analysis. The QA/QC coordinator is responsible for ensuring that the QA/QC Plan is kept up to date, and is reviewed at least annually.

Figure 6: Schematic of the QA/QC System



The following summarises the QA/QC applied to the GHG inventory estimates:

1) Cross-cutting QC: performed for all categories
    - Recalculations: where available emissions/removal estimates have been compared to available estimates in the previous inventory and reasons for any changes have been explained. A summary of the recalculations is provided in **Section 1.9.2**.
    - Trend checks: sense checks on the time series to identify outliers.
2) Cross-cutting QA: performed for all categories
    - QA review: all compilation files were reviewed by someone not directly involved in the compilation of the emission/removal estimates
3) Sector-specific QA/QC: performed during the data collection and emission/ removal compilation. These checks are documented in the sectoral method chapters (**Chapters 3 - 7**) and category-specific method statements (**Annex III**).
4) Peer review and consultation: the inventory as a whole and sector-specific estimates have undergone peer review during a Validation Workshop which took place between the 29th June – 8th July 2020.

1.8 Uncertainty Analysis

An uncertainty analysis was undertaken using the Approach 1 (error propagation) method described by the 2006 IPCC Guidelines (V1, Chp3). Approach 1 provides estimates of uncertainty by GHG according to IPCC sector. Trend uncertainty between the base year and 2018 and a combined uncertainty of activity data and emission factor uncertainty was undertaken. The total uncertainty for the inventory was determined to be ± 24 %, with a trend uncertainty of ± 41 %.

A full description of the uncertainty analysis is presented in **Annex II**.

1.9 Overview of Completeness, Recalculations & Improvements

1.9.1 Completeness

The following tables provide an overview of the categories in the current inventory which have been estimates, are not estimated, and do not occur.

Table 5: Summary of the categories estimates and the tiers used in the inventory

IPCC Category Description	Method
1A1ai: Electricity generation	T1
1A1ci: Manufacture of Solid Fuels	T1
1A2: Manufacturing Industries and Construction	T1
1A3b: Road Transport	T1
1A3aii: Domestic Aviation	T1
1A3dii: National Navigation	T1
1A4a: Commercial/Institutional	T1
1A4b: Residential	T1
1A4ci: Agriculture / Forestry - stationary combustion	T1
z_1A3ai: International aviation (memo item)	T1
z_1A3di: International marine bunkers (memo item)	T1
1B1ci: Charcoal and biochar production	T1
2D1: Non-Energy Products from Fuels and Solvent Use - Lubricant Use	T1
2D3a: Non-Energy Products from Fuels and Solvent Use - Solvent use	T1
2D3b: Non-Energy Products from Fuels and Solvent Use - Road paving with asphalt	T1
2D3d: Non-Energy Products from Fuels and Solvent Use - Coating applications	T2
2F1: Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	T2
2G3a: Medical Applications	T1
2H2: Food and Beverages Industry	T2
3A1aii: Enteric Fermentation Non-Dairy Cattle	T1
3A1c: Enteric Fermentation Sheep	T1
3A1d: Enteric Fermentation Goats	T1
3A1h: Enteric Fermentation Swine	T1
3A2aii: Manure Management Non-Dairy Cattle	T1

IPCC Category Description	Method
3A2c: Manure Management Sheep	T1
3A2d: Manure Management Goats	T1
3A2h: Manure Management Swine	T1
3A2i: Manure Management Laying Hens	T1
3A2i: Manure Management Broilers	T1
3B1a: Forest Land Remaining Forest Land	T1
3B1b: Land Converted to Forest Land	T2
3B2a: Cropland Remaining Cropland	T1
3B2bi: Land Converted to Cropland	T1
3B3b: Land Converted to Grassland	T1
3B5b: Land Converted to Settlements	T1
3B6b: Land Converted to Other Land	T1
3C2: Liming	T1
3C4: Direct N_2O Emissions from Managed	T1
3C5: Indirect N_2O Emissions from Managed soils	T1
3C6: Indirect N_2O Emissions from Manure Management	T1
4A: Solid waste disposal on land	T1
4D: Wastewater handling	T1

Table 6: List of all categories that are Not Estimated (NE) for all years

IPCC Category Description	Notation Key
1B2bv: Distribution of Gas Products	NE
2A4: Other Process Uses of Carbonates	NE
2D2: Non-Energy Products from Fuels and Solvent Use - Paraffin Wax Use	NE
2D3f: Non-Energy Products from Fuels and Solvent Use - Dry cleaning	NE
2D3g: Non-Energy Products from Fuels and Solvent Use - Chemical Products	NE
2G1b: Use of Electrical Equipment	NE
3C3: Urea application	NE
3D1: Harvested Wood Products	NE

Table 7: List of all categories that are Not Occurring (NO) for all years

IPCC Category Description	Not Occurring
1A1b: Refineries	NO
1A3c: Railways	NO
1A5a: Other, stationary	NO
1B1a: Coal Mining and Handling	NO
1B2c: Venting and Flaring	NO
2A1: Cement production	NO
2A2: Lime production	NO
2A3: Glass Production	NO
2A5: Other (please specify)	NO

IPCC Category Description	Not Occurring
2B: Chemical Industry	NO
2C: Metal Industry	NO
2D3e: Non-Energy Products from Fuels and Solvent Use - Degreasing	NO
2D3h: Non-Energy Products from Fuels and Solvent Use - Printing	NO
2E: Electronics Industry	NO
2F2: Product Uses as Substitutes for Ozone Depleting Substances - Foam Blowing Agents	NO
2F3: Product Uses as Substitutes for Ozone Depleting Substances - Fire Protection	NO
2F4: Product Uses as Substitutes for Ozone Depleting Substances - Aerosols	NO
2F5: Product Uses as Substitutes for Ozone Depleting Substances - Solvents	NO
2F6: Other Applications (please specify)	NO
2G1a: Manufacture of Electrical Equipment	NO
2G1c: Disposal of Electrical Equipment	NO
2G2: SF6 and PFCs from Other Product Uses	NO
2G3b: Propellant for pressure and aerosol products	NO
3A1ai: Enteric Fermentation Dairy Cattle	NO
3A1f: Enteric Fermentation Horses	NO
3A1g: Enteric Fermentation Mules	NO
3A2ai: Manure Management Dairy Cattle	NO
3A2e: Manure Management Horses	NO
3A2f: Manure Management Mules	NO
3A2aii: Manure Management Non-Dairy Cattle	NO
3B3a: Grassland Remaining Grassland	NO
3B4a: Wetlands Remaining Wetlands	NO
3B4b: Land Converted to Wetlands	NO
3B5a: Settlements Remaining Settlements	NO
3B6a: Other Land Remaining Other Land	NO
3C1: Emissions from Biomass Burning	NO
4B: Biological Treatment of Solid Waste	NO
4C: Incineration and Open Burning of Waste	NO

1.9.2 Recalculations

The previous inventory was prepared in 2015 and prepared emission/removal estimates for 2000, 2005 and 2010 from all major sectors. **Table 8** below provides the total emissions in the current and previous inventory for the overlapping years and the recalculations.

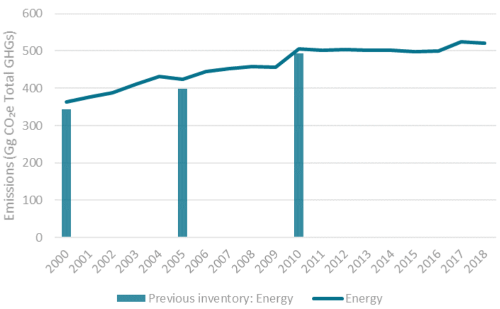
Table 8: Recalculations between the current and previous inventory for 2000, 2005 and 2010

Year	Total with LULUCF (Gg CO_2e)		

	Current inventory	Previous inventory	Recalculation (Gg CO_2e)	Recalculation (%)
2000	310.8	347.9	-37.1	-11%
2005	340.2	409.3	-69.1	-17%
2010	571.7	442.6	129.1	29%

The recalculations on a sector level are presented in **Figure 7**, the primary causes for recalculations in each sector are as follows:

- **Energy:** only small recalculations. Primary reason for recalculations are the adjustments to improve time-series consistency of activity data in a few cases (impacting CO_2 emissions mainly), particularly in the early part of the time-series, and the use of CH_4 and N_2O emission factors from the 2006 IPCC Guidelines rather than the Revised 1996 IPCC Guidelines.
- **IPPU:** HFC emissions from Refrigeration and Stationary Air Conditioning and Mobile Air Conditioning have been recalculated using a Tier 2 methodology which has resulted in much higher emission estimates as a result of assumptions on the number of equipment and amount of refrigerant in use (and hence leaking). Previous estimates assumed that the bulk imported amounts were emitted and did not accurately account for emissions from refrigerant imported in equipment.
- **Agriculture:** the reduction in emissions in the current inventory compared to the previous inventory is driven by lower emission estimates from fertiliser application. Similar estimates from enteric fermentation, slightly higher emissions in the current inventory due to emission factors from Latin America from the IPCC being applied, the previous inventory used emission factors from North America.
- **LULUCF:** new land use data from the use of Collect Earth tool for the entire period resulted in new activity data values, along with a change in the source of information of biomass loss.
- **Waste:** estimated CH_4 emissions from solid waste are much lower in the current inventory. This is driven by recalculations in solid waste disposal on land. There have been recalculations in the amount of waste disposed to landfill between 2004 and 2010, however this alone does not explain the large differences seen. It is unclear from the information available what assumptions were made about the percentage of waste sent to solid waste disposal sited before 1996 in the previous inventory. In this inventory, it was assumed no waste was disposed of in solid waste disposal sites before 1996. A different assumption for this could explain the recalculations.



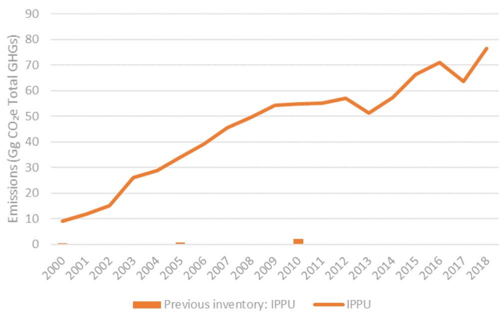


Figure 7: Emissions by sector for the current (line) and previous (bar) inventory, starting from the top left: energy, IPPU, agriculture, LULUCF and waste

1.9.3 Improvements

The Improvement Plan is a list of the identified actions required for improvements for the GHG inventory. For each action, a description of the improvement is provided, and the specific weakness is identified e.g. institutional arrangements. The actions are then prioritised and allocated to a responsible organisation. The progress in implementing the actions is tracked through the Improvement Plan. The Improvement Plan is maintained by the QA/QC coordinator with input from the sector leads. The Improvement Plan is reviewed and updated at the start and end of each inventory cycle.

The key cross-cutting improvements include ensuring that there are at least two (senior and junior) experts for each inventory sector, developing a system to process the energy balance and implementing a QA/QC log. The key sectoral improvements are outlined in the sectoral chapter (**Chapters 3 - 7**).

The Improvement Plan is provided in **Annex IV**.

2 Trends

2.1 Overview of sectors

GHG emissions and removals are presented in five main sectors. These sectors are defined as:

- **Energy**: emissions from fuel combustion dominated by carbon dioxide (CO_2) released from the conversion of carbon in fuel to CO_2 and generation of heat. Energy also includes emissions of methane (CH_4) and other carbon rich volatile organic compounds associated with fugitive emissions from fuel production and storage. Typically, this sector is dominated by the big fossil fuel users including electricity generation and road transport.

- Industrial Processes and Product Use (**IPPU**): non-fuel related emissions from industrial processes and use of products with global warming impacts. This is often dominated by CO_2 and sometimes nitrous oxide (N2O) emissions from large industrial process biproducts (such as converting limestone and dolomite to cement (CO_2) or hydrocarbons to base chemicals (CO_2, CH_4 and N_2O). In Saint Lucia (which does not have this sort of industry), the main IPPU contributors are the users of refrigerants for air conditioning and refrigeration and associated emissions of the high global warming potential "F-gases" which are substitutes for Ozone Depleting Substances (ODS).
- **Agriculture**: non-energy use emissions only from livestock and crop production. This category can be broadly split into emissions from livestock and emissions from agricultural soils. The main sources of emissions from livestock is from gases released from animals (enteric fermentation), a digestive process in herbivores which emits CH_4, and manure management (from the management of animal manure) which contains and emits CH_4 and N_2O. The methods of storage and treatment of manure (the animal waste management systems (AWMS)) impacts the quantity of CH_4 and N_2O emitted. The application or organic manure and synthetic fertiliser to land results in both direct and indirect N_2O from soils. Additional products which can be added to soils include liming and urea, which react with the soils composition to release CO_2. Finally, the process of burning crop residues left on agricultural soils is typically a small source of CH_4 and N_2O from the combustion as well as biogenic CO_2 (which is not counted in national totals).
- Land use, land use change and forestry (**LULUCF**): emissions and removals from land, this sector focuses on the different carbon pools (areas where carbon is stored). These include living biomass (growing vegetation within an agreed definition), dead organic matter, soil organic matter and harvested wood products. Removals occur through carbon sequestration (absorption of carbon from the atmosphere by growing vegetation), emissions are dominated by wood removals (harvesting and fuelwood), natural disturbances (fires, natural disasters e.g. hurricanes, pests and disease) and land management practices (e.g. ploughing cropland and disturbing the land for settlements etc.).
- **Waste**: non-energy use emissions associated with the management of solid and liquid waste . Emissions from waste are split into four main categories – solid waste disposal, biological treatment of solid waste, incineration/open burning, and wastewater. The main gases emitted are CH_4 through the anaerobic (absence of oxygen) decomposition of solid or liquid waste, N_2O from the oxygenation of protein rich compounds (e.g. foods) in the waste streams and CO_2 from incineration of fossil-based waste materials (e.g. plastic). CH_4 is emitted in solid waste disposal sites where organic matter decays over a period of many years, at a declining rate. Anaerobic conditions in wastewater treatment also produce CH_4. The biological treatment of waste, such as composting, also results in CH_4 emissions (from anaerobic decomposition) and N_2O emissions from oxidation of nitrogen rich materials (e.g. protein). Incineration and open burning of fossil-based wastes (e.g. increasingly plastics) are the most important sources of CO_2 emissions from waste incineration activities.

- **Memo**: emissions which are not included in the national totals in accordance with international reporting agreements, include international navigation, international aviation and CO_2 from biomass (bio-CO_2).

2.2 Key trends

GHG emissions and removals in Saint Lucia have fluctuated throughout the period between 2000 and 2018, as seen in **Figure 8** and **Table 9**. Total emissions have increased by over half since 2000, both with and without LULUCF. The categories that have experienced the most significant changes include Energy and LULUCF. The energy sector is by far the largest contributor to emissions in Saint Lucia, this is due to the contribution from the electricity generation and road transport sectors. The trend in increasing emissions is driven by a rising population with an increasing demand for electricity. The number of road vehicles in Saint Lucia doubled between 2000 and 2018. Whilst emissions from energy and other sectors have risen gradually over time, the LULUCF sector has experienced the largest changes year to year and has contributed most to the total trend. Projects to reforest areas of degraded land contribute to increase carbon stocks, but natural disturbances, particularly from hurricanes cause large spikes in emissions such as Hurricane Tomas in 2010.

The IPPU sector has seen the largest percentage change over the time series due to a sharp increase F-gas emissions from air conditioning and refrigeration (**Figure 9**). Emissions from the waste sector have doubled over the time series, as with energy this is linked to an increasing population. In contrast, emissions from agriculture have remained fairly stable over the time series but fluctuate according to livestock populations.

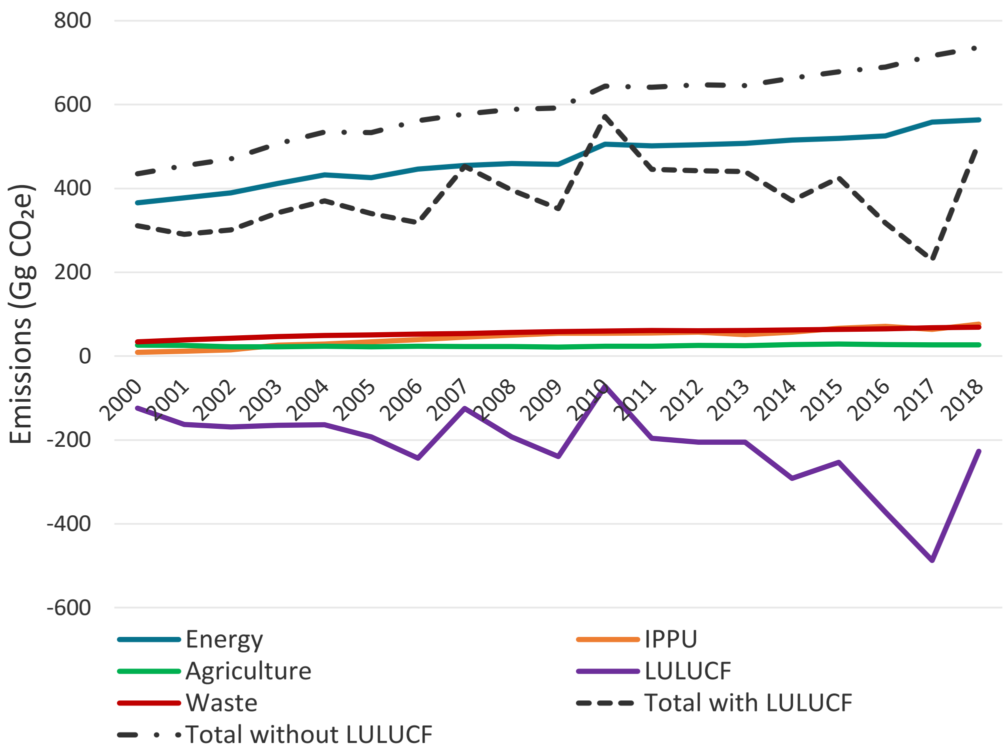


Figure 8: Total GHG emissions and removals by sector and total emissions with and without the LULUCF sector

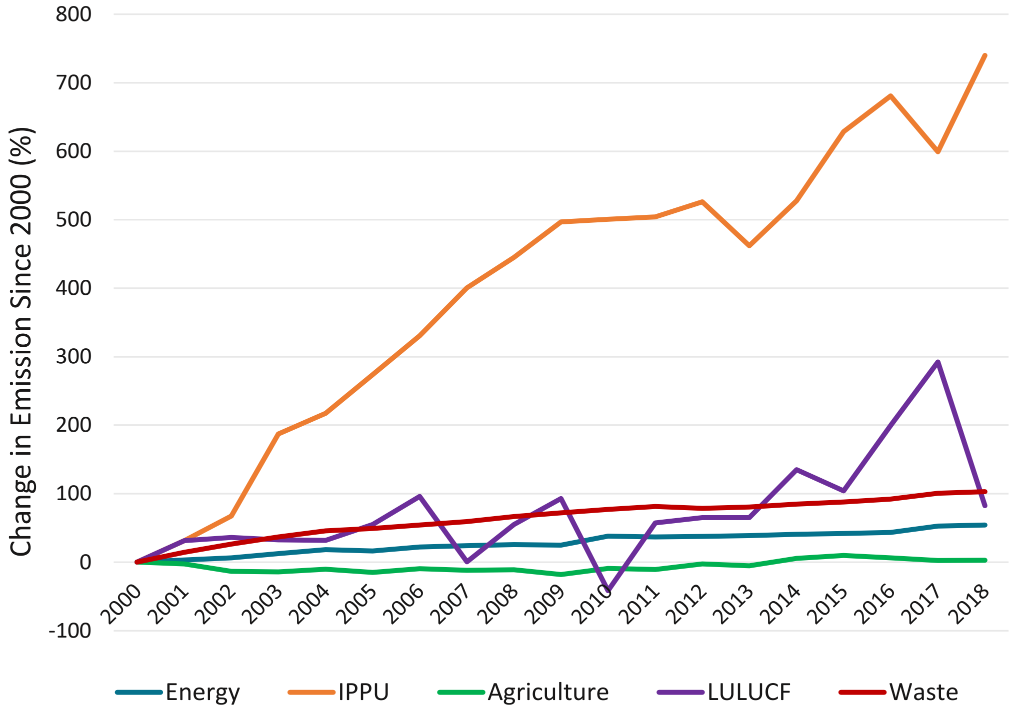


Figure 9: Percentage change in emissions and removals by sector compared to 2000

Table 9: Total GHG emissions and removals by sector

Year	Emissions (Gg CO_2e)					Total with LULUCF	Total % change from 2000
	Energy	IPPU	Agriculture	LULUCF	Waste		
2000	366	9	26	-124	34	**311**	-
2005	426	34	22	-193	51	**340**	**9%**
2010	505	55	24	-72	60	**572**	**84%**
2014	515	57	28	-292	63	**371**	**19%**
2015	519	66	29	-253	64	**425**	**37%**
2016	525	71	28	-372	65	**318**	**2%**
2017	558	64	27	-487	68	**229**	**-26%**
2018	564	77	27	-227	69	**509**	**64%**

2.3 Energy

The energy sector GHG emissions are primarily from CO_2 from fossil fuel combustion in the electricity generation and road transportation sectors (**Figure 10**). Emissions from these sectors have been increasing since 2010 and this drives the sector-wide trends across the time series.

Electricity is generated by a single operator in Saint Lucia at a centralised station that has used a consistent fuel mix (diesel combustion with supplementary firewood use) across the time series. The principal driver behind emissions increases from this sector is the increase in use of electricity with the expansion of the electricity network in Saint Lucia: since 2000 there has been an increase of over 45 % in the number of electricity customers[4] and in 2018 the vast majority of the population has access to the electricity grid. Much of this expansion took place between 2000-2010. Since this point, emission increases from the sector have tapered off. This may also be due to other factors such as the uptake of more energy efficient equipment on the island. Renewable projects, such as the installation of a 3 MW solar farm in La Tourney will reduce the carbon intensity of the electricity generated in country.

Increases in road transportation emissions are reflective of the marked increase in the number of vehicles on Saint Lucia's road network: there were over twice as many vehicles in 2018 as there were in 2000[5]. It is unclear whether the increase in emissions between 2009 and 2010 in the fuel used in road transportation is due to changes in data collection methodologies or genuine trends reflecting an increase in vehicle use. No formal energy balance data is available to inform trends since 2012.

The contribution of other sectors, such as residential combustion, is less important to the overall energy sector emissions context, but are key categories to the overall inventory. Emissions from these other sectors are characterised by the use of various fuels, importantly firewood and charcoal.

Figure 10 also presents the emission from international aviation and navigation which are memo items and therefore not included in the sector or inventory totals. Emissions from these sectors have remained fairly stable over the time series.

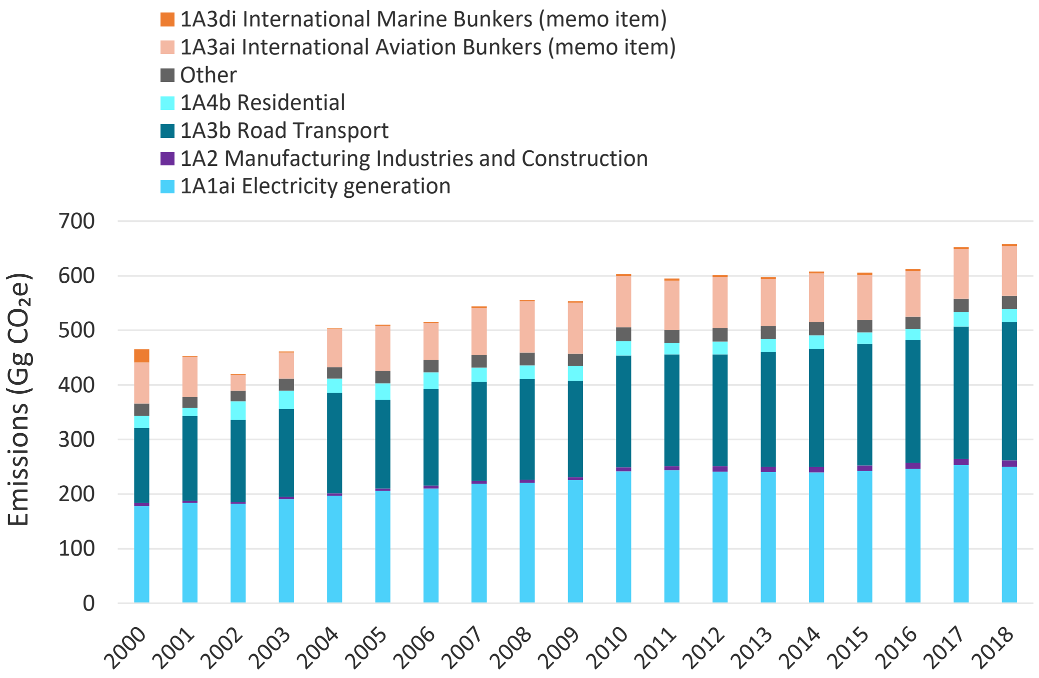


Figure 10: Total GHG emissions from the energy sector

[4] St Lucia Electricity Services Ltd - Annual Reports (https://www.lucelec.com/content/annual-reports)
[5] Data provided by the Ministry of Transport

2.4 Industrial Processes & Product Use (IPPU)

Emission estimates from IPPU show a significant increases across the time series driven predominantly by an increased use of high global warming potential refrigerants in refrigeration and air conditioning **Figure 11**.

The significant increase in emissions from F-gases can be attributed to the obligatory phase-out of ODS under the Montreal Protocol which Saint Lucia is party to. This phase-out has resulted in an increase in consumption of ODS substitutes (also known as "F-gases") in the refrigeration and air conditioning sector. In line with reduced ODS imports and the subsequent mainstreaming of use substitutes, emissions from refrigeration and stationary air conditioning increased 10 fold. Emissions in the mobile air conditioning sector increased by a factor of 7 over the time series. This is supported by a general increase in vehicle stock throughout the period with an increasing number of vehicles using mobile air-conditioning (90 % of vehicles using mobile air-conditioning in 2018 as opposed to 30 % in 2000).

Notable reduction in emissions were observed in 2013 and 2017 for the refrigeration and stationary air conditioning sector and can be attributed to lower imports in those years as a result of stockpiles in the previous year. The assumption is that unused stock from the previous year was sufficient to meet demand, as the data is largely based on imports rather than actual consumption data.

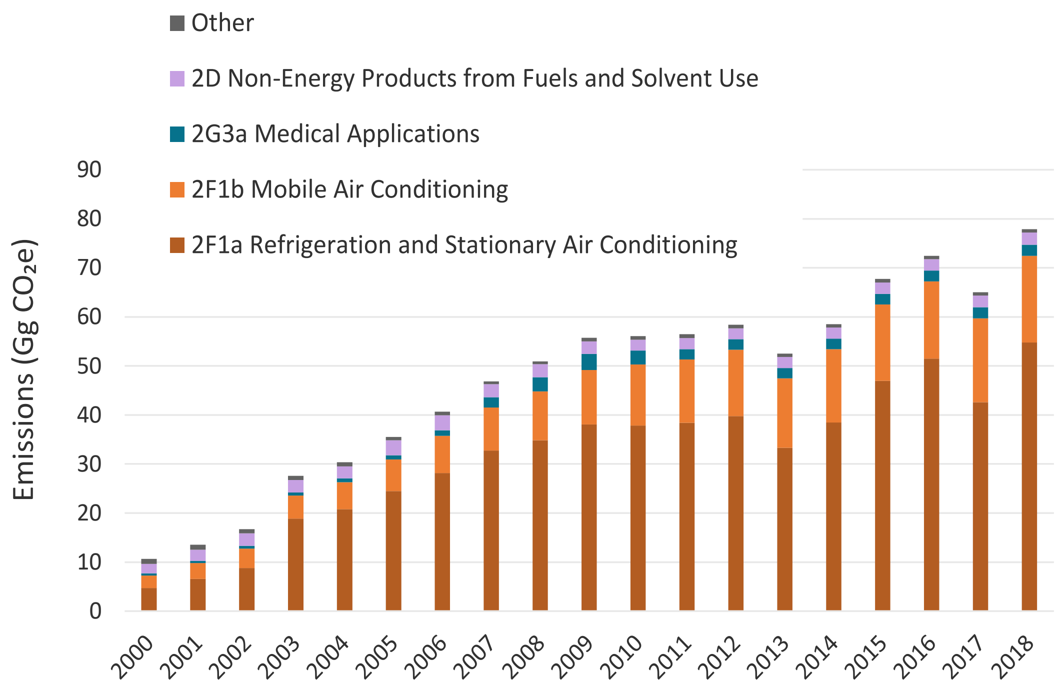


Figure 11: Total GHG emissions from the Industrial Processes and Product Use (IPPU) sector

It is noteworthy to mention four non F-gas sub-categories of emissions with significant trends (**Figure 12**). Emissions peak in 2009 mainly due to N_2O medical uses. This could be as a result of the preparation for the commissioning of the new hospital namely the OK-EU and the bulk importation of N_2O for use over a number of years rather than a single year. However, this trend may also be a function of imports driven by non-medical domestic demand.

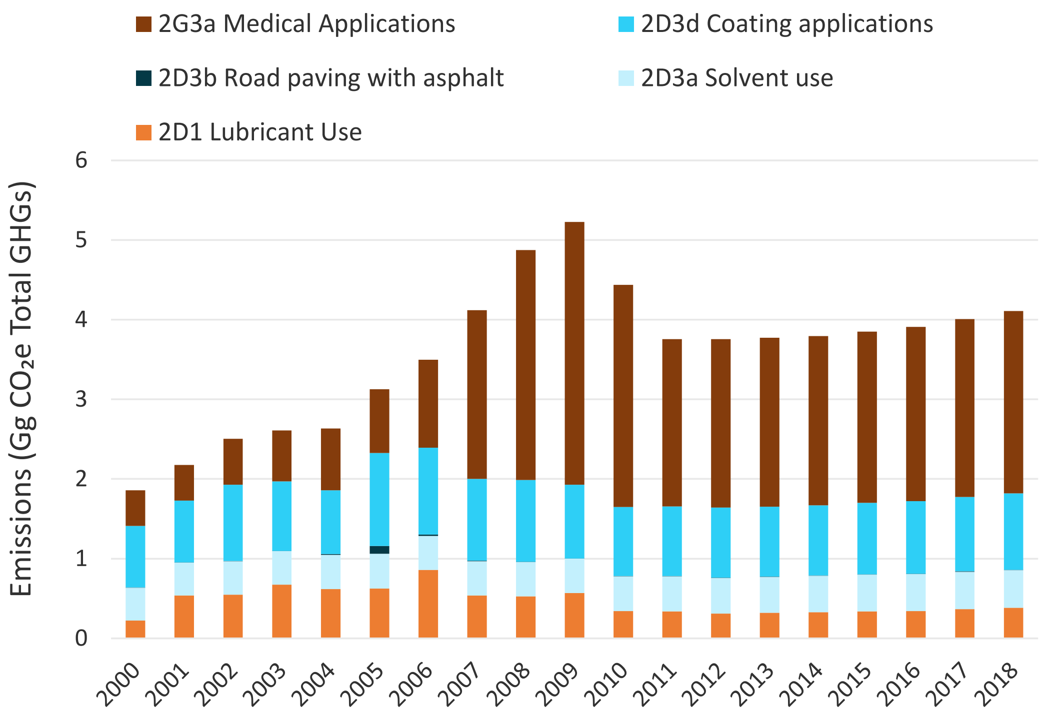


Figure 12: Non f-gas emissions from the Industrial Processes and Product Use (IPPU) sector

2.5 Agriculture

The majority of emissions come from livestock, enteric fermentation and manure management which are both key categories. Cattle is the biggest contributor of CH_4 through enteric fermentation, whilst swine is the greatest contributor in manure management. The third largest category in the agriculture sector is N_2O direct emissions from managed soils, which includes emissions from applying synthetic fertiliser and manure directly to the soils.

As seen in **Figure 13**, there is a fluctuating trend over the time series, which is primarily due to fluctuating livestock populations in Saint Lucia. Emissions from the agricultural sector peaked in 2015. The trend is primarily dominated by changes in livestock emissions from enteric fermentation (which sees a steep dip in 2008 and 2009 due to a dip in cattle numbers), and manure management (which has steadily increased across the time series due to increasing swine numbers). Both of these categories are driven by the total population of livestock in Saint Lucia. Total livestock population numbers are expected to fluctuate throughout the time series due to factors such as demand for livestock goods, success of animal breeding and the average length of time an animal survives. Other parameters such as annual average temperature and weather conditions in Saint Lucia, are likely to be driving some of the fluctuating trends observed. The amount of emissions from manure management systems will be heavily influenced by the conditions of the area, with warmer and wetter conditions typically resulting in increased emissions of CH_4.

Other parameters which could contribute to the fluctuating trend observed in Saint Lucia's agricultural emissions include the amount of synthetic fertiliser imported into the country based off of human population and demand by farmers. Import statistics for synthetic fertiliser is some of the activity data used for calculating N_2O emissions from managed soils, meaning the changes across the time series of emissions from direct N_2O from managed soils, could be driven by demand in fertilisers.

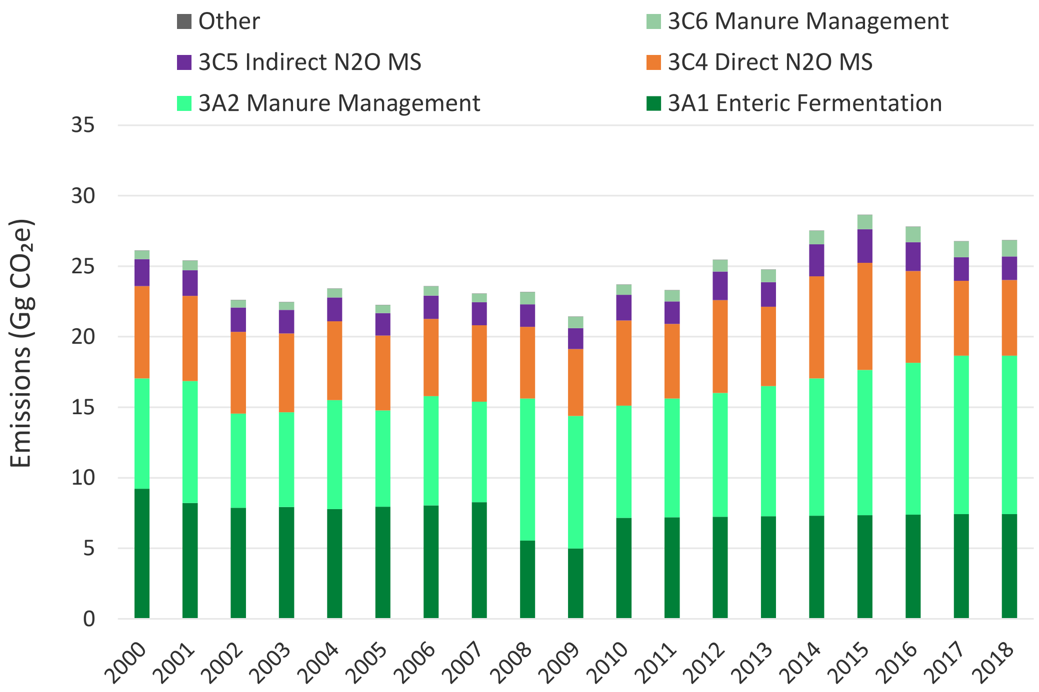


Figure 13: Total GHG emissions from the agriculture sector, note MS = managed soils

2.6 Land Use, Land Use Change and Forestry (LULUCF)

The LULUCF sector shows an increase in removals (sequestration) over the time series. The sector includes six land use classes and biomass burning, further information on the land use classes is provided in **Chapter 6**.

Forestland remaining forestland contributes the most to overall trends removing emissions as forests and vegetation are left to grow. Land converted to forestland also contributes to sequestration as more land area is committed to growing forest and act as additional carbon sinks. A small proportion of the emissions/removals are from croplands, grasslands and land converted to settlements notated by 'Other' in **Figure 14**. The overall tendency is of an increase in removals CO_2 over the time series.

The increase in removals over the time series reflect the increase in forest area. The spike in emissions in 2010 was due to Hurricane Tomas resulting in forest loss and removal/decay of the forest biomass. The following two years 2011 and 2012 show a responding regrowth with an increasing sink for the disturbed forest land remaining forest land category. Saint Lucia had implemented a series of projects which focuses on reforestation of degraded areas in private and public lands. Due to the decrease in banana production (cropland area) in recent years, Saint Lucia has experienced the conversion of farms to forestlands (secondary forest). This resulted in an increase in removals in land converted to forestland category.

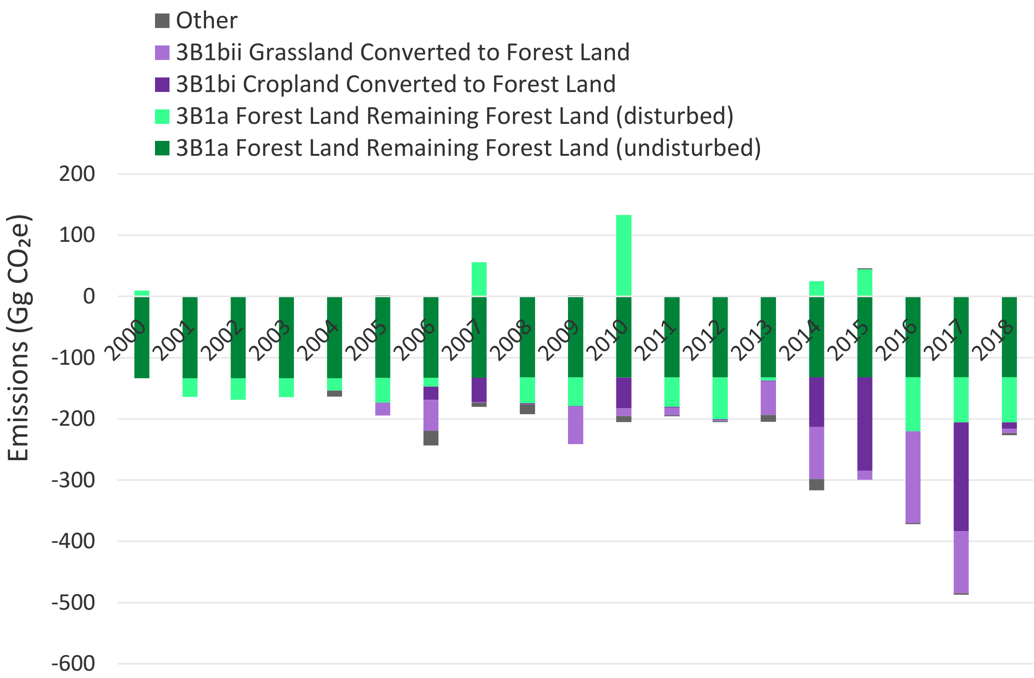


Figure 14: Total GHG emissions and removals from the Land Use, Land Use Change and Forestry sector

2.7 Waste

Emissions from waste are dominated by CH_4 emissions from solid waste disposal on land (**Figure 15**).

Solid Waste Disposal: Emissions from solid waste disposal on land generally are increasing year on year due to the increasing annual quantity of waste disposed in solid waste disposal site. The fluctuations are in line with the fluctuations in annual tonnes of waste disposed. In 1996 the Solid Waste Management Act was brought into force establishing managed Landfills within Saint Lucia and making waste collection for the whole Island the responsibility of one body. Two disposal sites were established: the Vieux Fort and Ciceron disposal sites. In 2003/4 the Ciceron site was closed and the Deglos Sanitary Landfill site was opened. While all disposal sites, including the now closed Ciceron site, had daily cover the Deglos Sanitary Landfill also has linings and leachate collection and treatment. Weighbridges were also included in this new site and in the same year the Vieux Fort site was updated to include weighbridges. Prior to 1996 there were no managed waste disposal sites and waste collection was managed by the local council. Waste was disposed of in open dump sites and usually burnt. From 1997, it has been assumed that all solid waste in Saint Lucia is disposed of in solid waste disposal sites: municipal solid waste, sanitised clinical waste and industrial waste (mostly construction waste). All waste types have been calculated together. Waste burnt or disposed of in unauthorised small dumps is considered negligible.

Composting at solid waste disposal sites (biological treatment of solid waste) began in 2004 however prior to 2015 waste was composted on a very small scale and no data is available on the amount of waste composted. Larger scale composting started in 2015 at the Vieux-fort disposal site, with 4 tonnes of green waste composted that year and an estimated 2 tonnes in subsequent years. There is some additional small scale composting taking place at schools, farms and households but there is no data on waste quantities for these activities so emissions have not been estimated from these activities. Emissions from this sector are too small to be shown in **Figure 15**.

Domestic wastewater: The water and sewerage company Inc. (WASCO) was first started in 1965, under a different name, and has responsibility over water supply and treatment. They manage one wastewater treatment facility: the Beausejour Stabilisation Ponds. This site is made up of two aerated ponds and a fermentation pit. Domestic wastewater is predominantly treated through pit latrines (23 % in 2010) and septic systems (63 % in 2010) with the latter increasing in use and the former decreasing. Approximately 7% of households were connected to the sewer system in 2010, covering wastewater both discharged to the sea and treated at the Beausejour Stabilisation ponds. There are additional aerobic treatment plants which treat wastewater from hotels. Hotel wastewater is also treated at the Beausejour Stabilisation Ponds.

Industrial wastewater is only applicable to alcohol production in Saint Lucia, namely brewing and distilling of rum. Wastewater from brewing is treated in aerobic treatment plants while wastewater from distilling is discharged to the sea.

Emissions was wastewater are presented in **Figure 16**.

Figure 15: Total GHG emissions from the waste sector

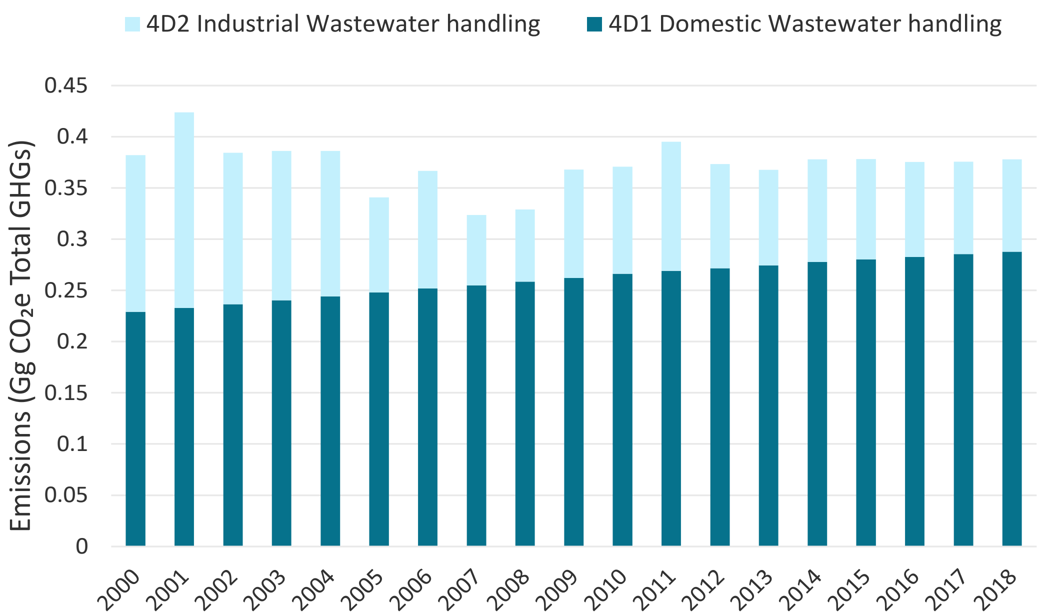


Figure 16: Total GHG emissions from wastewater

2.8 Indirect GHG Emissions

The only indirect GHG emissions that have been estimated in this inventory are NMVOC emissions from the IPPU sector. **Figure 17** illustrates these emissions of NMVOC which occur in non F-gas subcategories**.** Asphalt production, coating application and lubricant use all shows increases between 2005 and 2006. One possible explanation of this trends is increased activity under these sectors due to policy directives to strengthen and increase infrastructure in preparation for the nation's shared hosting with the West Indies of the ICC Cricket World Cup in 2007. This significant increase may also be attributed to preparation for national elections which were constitutional due by 2007 but took place in 2006. Solvent use remains relatively static as emissions levels are assumed by population which was remained stable over the time period.

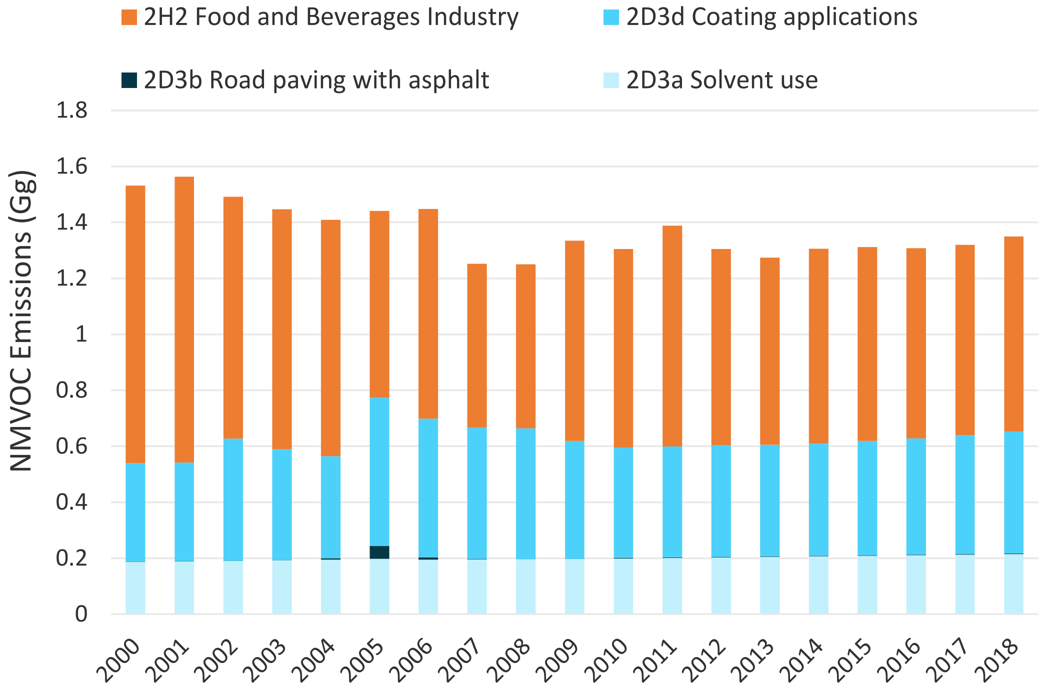


Figure 17: NMVOC emissions from the Industrial Processes and Product Use (IPPU) sector

3 Energy

3.1 Sector overview

Saint Lucia's energy sector is the dominant source of GHG emissions across the time-series. Discussion of the trends can be found in **Chapter 2**. General methods are described in this chapter.

A summary of the emission estimates in the energy sector is provided in the table below.

Table 10 Method summary - energy

1 Energy Greenhouse Gas Source and Sink Categories	Gases Included	% Total Emissions*	Key Categories	Uncertainty %**	Tier/ NK	MS reference	Notes
A. Fuel Combustion Activities							
1. Energy Industries							
a. Main Activity Electricity and Heat Production	CO_2, CH_4, N_2O	34	Y	4.2	T1	E1	
b. Petroleum Refining	-	-	-	-	NO	-	
c. Manufacture of Solid Fuels and Other Energy Industries	CH_4, N_2O	0.1	N	0.1	T1	E2	No fossil-CO_2 emissions as only fuel used is biomass.
2. Manufacturing Industries and Construction							
a. Iron and Steel	CO_2, CH_4, N_2O	1.6	Y	0.5	T1	E3	1A2 activity data not available in a disaggregated form.
b. Non-Ferrous Metals	-	-	-	-	NO	-	
c. Chemicals	-	-	-	-	NO	-	
d. Pulp, Paper and Print	-	-	-	-	NO	-	
e. Food Processing, Beverages and Tobacco	-	-	-	-	NO	-	
f. Non-Metallic Minerals	-	-	-	-	IE	-	
g. Transport Equipment	-	-	-	-	NO	-	
h. Machinery	-	-	-	-	NO	-	
i. Mining	-	-	-	-	NO	-	
j. Wood and wood products	-	-	-	-	NO	-	
k. Construction	-	-	-	-	IE	-	
l. Textile and Leather	-	-	-	-	IE	-	
m. Non-specified Industry	-	-	-	-	IE	-	
3. Transport							
a. Domestic Aviation	CO_2, N_2O, CH_4	0.7	Y	0.8	T1	E4	

b. Road Transportation	CO_2, N_2O, CH_4	34.5	Y	10.0	T1	E5	
c. Railways	-	-	-		NO	-	
d. Water-borne Navigation	CO_2, N_2O, CH_4	0.5	Y	0.0	T1	E6	
e. Other Transportation	-	-	-		NO	-	
4. Other Sectors							
a. Commercial/Institutional	CO_2, N_2O, CH_4	0.7	Y	0.1	T1	E7	
b. Residential	CO_2, N_2O, CH_4	3.3	Y	0.9	T1	E8	
c. Agriculture/Forestry/ Fishing/Fish farms	CO_2, N_2O, CH_4	0.9	Y	0.1	T1	E6, E9	Fishing vessels fuel use included within 1A3d
5. Non-Specified							
a. Stationary	-	-	-	-	NO	-	
b. Mobile	-	-	-	-	IE	-	Included within 1A3
c. Multilateral Operations	-	-	-	-	NO	-	
B. Fugitive emissions from fuels							
1. Solid Fuels							
a. Coal mining and handling	-	-	-	-	NO	-	
b. Uncontrolled combustion and burning coal dumps	-	-	-	-	NO	-	
c. Fuel transformation	CH_4, N_2O	0.4	Y	0.8	T1	E2	Charcoal production using biomass feedstock means there are no fossil-CO_2 emissions
2. Oil and Natural Gas							
a. Oil	-	-	-	-	NE	-	No domestic oil production, but some unrefined oil is stored before being re-exported
b. Natural Gas Systems	-	-	-	-	NE	-	Minor on-site biogas production, assumed no longer practiced
3. Other emissions from Energy Production							
Other emissions from Energy Production	-	-	-	-	NO	-	
C. Carbon dioxide Transport and Storage							
1. Transport of CO_2	-	-	-	-	NO	-	
2. Injection and Storage	-	-	-	-	NO	-	
3. Other	-	-	-	-	NO	-	
Memo items:							
International bunkers							
International aviation	CO_2, CH_4, N_2O	-	-	-	T1	E4	Not included in key category or uncertainty analysis

Navigation	CO_2, CH_4, N_2O	-	-	-	T1	E6	Not included in key category or uncertainty analysis
Multilateral operations	-	-	-	-	NO	-	
CO_2 emissions from biomass	CO_2	-	-	-	T1	E2, E8	Total bio-CO_2 emissions in 2018 were 105 Gg, excluded from national totals
CO_2 captured	-	-	-	-	NO	-	

*Note: NK = notation key, MS = method statement, T = tier, * percentage of total emissions without LULUCF in the most recent inventory year, ** Square root of the sum of the contribution to variance by category in the latest year*

3.2 Methods, data sources and assumptions

All methods in the energy sector use Tier 1 approaches outlined in either the 2006 IPCC Guidelines, or in the case of charcoal production, the 2019 Refinement to the 2006 IPCC Guidelines. Default emission factors are used in all cases for CO_2, CH_4, and N_2O in the absence of country-specific information.

In most cases, activity data is derived from the historic balances for the period 2000 to 2012. From 2000 – 2009, these were compiled by Saint Lucia Government, whilst from 2010 – 2012 they were instead compiled by the Latin American Energy Organization (OLADE). Since 2012, however, information on fuel used and type of fuel used is absent across all sectors apart from 1A1a Public Electricity and Heat Production. Extrapolations are instead applied to the latest available energy balance data, assuming that fuel use can be approximated by the trend in a number of proxies. The proxy used in each case is summarised below in **Table 11**.

Table 11: Proxies used to develop activity data time-series from 2013, split by subcategory.

Subcategory	Proxy used	Source
1A1a Public Electricity and Heat Production (firewood only)	Electricity generated	LUCELEC
1A1c Manufacture of Solid Fuels	Population	World Bank
1A2 Manufacturing Industries and Construction	GDP	World Bank
1A3a Domestic Aviation	Number of flights	Central Statistical Office
1A3b Road Transportation	Number of vehicles	Central Statistical Office
1A3d National Navigation	Flat – no proxy applied	-
1A4a Commercial / Institutional	GDP	World Bank
1A4b Residential Combustion	Population	World Bank
1A4c Agriculture, Forestry, Fishing	GDP	World Bank
1B1 Charcoal Production	Population	World Bank

Detailed methodology information is provided within the Method Statements in **Annex III** (refer to **Table 10** above).

3.3 Quality assurance/ quality control

Cross-cutting QA/QC checks are outlined within **Section 1.7**. When available, activity data from the energy balances has been compared to alternative data sources. For example, diesel consumption at the power station is also provided by LUCELEC and checks have been made to ensure their consistency. In most cases, however, such verification checks have not been undertaken due to a lack of data. Validation checks against neighbouring countries have also been made, to compare emissions and energy demand per capita on a sector-specific basis.

Further information on QA/QC undertaken for this sector is provided within the relevant method statements in **Annex III**.

3.4 Description of uncertainties

Percentage of uncertainty for each emission estimate under the energy sector is provided in **Annex II**. The primary uncertainties associated with the energy sector emissions estimates are those associated with the activity data time-series, in particular from 2013 to the latest year. There is no current available dataset which can either replace or validate the assumptions currently made to extrapolate activity data from the latest available energy balance. Therefore, the CO_2 emissions estimates, which dominate the emission profile of the sector, carry large uncertainties that are a priority to improve in future submissions of the inventory.

3.5 Time series consistency issues

The primary time series consistency issue is the lack of available activity data after 2012 across the majority of the energy sector. It is a priority to address the data gap in future submissions of the inventory. Sector-specific time series consistency issues are outlined in the method statements in **Annex III**.

3.6 Improvements

The priority improvement for the energy sector is to attain better data for the energy balance. Other high priority improvements include developing country-specific factors to enable a Tier 2 method for electricity generation to be applied and improving estimates for fuel use in the road transport sector. There are also some sectors for which only aggregated data is available and improvement items have been defined to provide better data, this includes:

- Splitting the fuel used for domestic and international aviation
- Establishing the split of fuel between the subcategories of Manufacturing Industries and Construction
- Splitting the fuel used between domestic and commercial uses

See **Section 1.9.3** for an introduction to improvement plan and **Annex IV** for the full Improvement Plan list.

4 Industrial Processes & Product Use (IPPU)

4.1 Sector overview

This category covers GHG emissions occurring from industrial processes, from the use of GHGs in products, and from non-energy uses of fossil fuel carbon. Whilst the 2006 IPCC Guidelines states that the main emission sources from IPPU are releases from industrial processes that chemically or physically transform materials (for example, the blast furnace in the iron and steel industry, other chemical products manufactured from fossil fuels and the cement industry), in Saint Lucia there is minimal industrial production. As such, many categories under IPPU are reported as 'Not Occurring' within Saint Lucia. Instead emissions reported within IPPU in Saint Lucia are dominated by emissions from substitutes for ODS, otherwise referred to as F-gases. These in used in products such as refrigerators, foams or aerosol cans.

A summary of the emission estimates in the IPPU sector is provided in the table below.

Table 12 Method summary - IPPU

2 Industrial Processes and Product Use Greenhouse Gas Source and Sink Categories	Gases Included	% Total Emissions*	Key Categories	Uncertainty %**	Tier/ NK	MS reference	Notes
A. Mineral Industry							
1. Cement production	-	-	-	-	NO	-	The only mineral industry reportedly occurring within Saint Lucia is ceramics production which is NE due to a lack of data availability.
2. Lime production	-	-	-	-	NO	-	
3. Glass Production	-	-	-	-	NO	-	
4. Other Process Uses of Carbonates	-	-	-	-	NE	-	
5. Other	-	-	-	-	NO	-	
B. Chemical Industry							
1. Ammonia Production	-	-	-	-	NO	-	There is no chemical industry in Saint Lucia over the time series.
2. Nitric Acid Production	-	-	-	-	NO	-	
3. Adipic Acid Production	-	-	-	-	NO	-	
4. Caprolactam, Glyoxal and Glyoxylic Acid Production	-	-	-	-	NO	-	
5. Carbide Production	-	-	-	-	NO	-	
6. Titanium Dioxide Production	-	-	-	-	NO	-	
7. Soda Ash Production	-	-	-	-	NO	-	
8. Petrochemical and Carbon Black Production	-	-	-	-	NO	-	
9. Fluorochemical Production	-	-	-	-	NO	-	
10. Other	-	-	-	-	NO	-	
C. Metal Industry							
1. Iron and Steel Production	-	-	-	-	NO	-	

2. Ferroalloys Production	-	-	-	-	NO	-	There is no metal industry in Saint Lucia over the time series.
3. Aluminium Production	-	-	-	-	NO	-	
4. Magnesium Production	-	-	-	-	NO	-	
5. Lead Production	-	-	-	-	NO	-	
6. Zinc Production	-	-	-	-	NO	-	
7. Other	-	-	-	-	NO	-	
D. Non-Energy Products from Fuels and Solvent Use							
1. Lubricant Use	CO_2	0.05	N	0.0	T1	IP1	
2. Paraffin Wax Use	-	-	-	-	NO		
3. Solvent Use	CO_2, NMVOC	0.20	N	0.0	T1/ T2	IP1	Tier 1 methodology was used for domestic solvent use, however, estimates from coating applications were derived from a Tier 2 methodology.
4. Other	-	-	-	-	NO	-	
E. Electronics Industry							
1. Integrated Circuit or Semiconductor	-	-	-	-	NO	-	There is no electronics manufacture in Saint Lucia over the time series.
2. TFT Flat Panel Display	-	-	-	-	NO	-	
3. Photovoltaics	-	-	-	-	NO	-	
4. Heat Transfer Fluid	-	-	-	-	NO	-	
5. Other	-	-	-	-	NO	-	
F. Product Uses as Substitutes for Ozone Depleting Substances							
1. Refrigeration and Air Conditioning	HFC-143a, HFC -125, HFC 134a, HFC-32	9.84	Y	83.8	T2	IP3, IP4	
2. Foam Blowing Agents	-	-	-	-	NO	-	-
3. Fire Protection	-	-	-	-	NO	-	-
4. Aerosols	-	-	-	-	NO	-	-
5. Solvents	-	-	-	-	NO	-	-
6. Other Applications	-	-	-	-	NO	-	-
G. Other Product Manufacture and Use							
1. Electrical Equipment	-	-	-	-	NO, NE	-	2G1b Use of Electrical equipment is NE, other subcategories are NO.
2. SF6 and PFCs from Other Product Uses	-	-	-	-	NO	-	
3. N_2O from Product Uses	N_2O	0.31	Y	0.0	T1	IP2	
4. Other	-	-	-	-	NO	-	

H. Other							
1. Pulp and Paper Industry	-	-	-	-	NO	-	
2. Food and Beverages Industry	NMVOC	-	-	-	T2	IP1	No direct GHGs
3. Other	-	-	-	-	NO	-	

*Note: NK = notation key, MS = method statement, T = tier, * percentage of total emissions without LULUCF in the most recent inventory year, **Contribution to variance by category in the latest year*

4.2 Methods, data sources and assumptions

Methodologies for estimating emissions from N_2O from Product Use (2G) and Stationary and Mobile Air conditioning and Refrigeration (2F), are sourced from the 2006 IPPC Guidelines. Emission estimates are derived from assumptions applied to import data and emission factors taken from the 2006 IPCC Guidebook.

Emissions of NO_x, NMVOC, CO, SO_2 and NH_3 are described as precursor emissions as these have an indirect GWP. Methodologies to estimate emissions of these gases is not included within the 2006 IPPC Guidelines, and therefore the EMEP/CORINAIR Emission Inventory Guidebook (EEA, 2005) has been utilised to generate emission estimates in accordance with Table 7.1 in Volume 1 (IPPC, 2006) which provides a link between the IPCC source categories and the corresponding methodology chapters in the EMEP/CORINAIR Emission Inventory Guidebook. For Saint Lucia, this is relevant for emissions of NMVOC from categories Solvent Use (2D) and Other Industrial Production (2H). Activity data is sourced predominantly from import and customs data on mass of product entering Saint Lucia (e.g. coating applications) applied to default emission factors taken from the EMEP guidebook. National production data has been collected from manufacturers of food and beverages within Saint Lucia.

Detailed methodology information is provided within the Method Statements in **Annex III** (refer to **Table 12** above).

4.3 Quality assurance/ quality control

Cross-cutting QA/QC checks are outlined within **Section 1.7**. Data compilation spreadsheets and the data collection templates were reviewed by two members of the IPPU team at Aether in collaboration with Saint Lucian national experts. All sources of data, emission factors, other factors and constants were consistently referenced. All formulas were checked to ensure the correct calculation was taking place, and comments made when compiling and checking were left directly in the compilation file with an initial of who left the comment and a date. All the data was compared to the previous inventory and sense checked through comparisons with typical inventory values. All assumptions on proxy data for extrapolation and for sources not occurring were decided with consultation with Saint Lucia inventory experts. Further information on QA/QC undertaken for this sector is provided within the relevant method statements in **Annex III**.

4.4 Description of uncertainties

Percentage of uncertainty for each emission estimate under the IPPU sector is provided in **Annex II**. The most significant sources of uncertainty are in the 2D Domestic Solvent use sector, where emission estimates are compiled using a Tier 1 default emission factor applied to population data. Reducing uncertainty in this sector would require import data on domestic solvents and a national survey to categorise solvent use in households. The other Tier 1 estimate is emissions from lubricant use, however reducing uncertainty in this sector relies on improvements made to the energy balance (see **Section 3.6**).

As emissions from F-gases are the most significant within the sector, addressing uncertainty in both the activity data and assumptions used to choose emission factors is important. Uncertainty arises in import data used to determine the stock of f-gas containing equipment within Saint Lucia and choosing parameters which impact the emission factor e.g. total charge, lifetime. Uncertainty is further documented in the relevant method statements.

4.5 Time series consistency issues

Issues with data availability impacts time series consistency. Due to the unavailability of production data and some import data, activity data has been extrapolated using GDP values for Saint Lucia. Whilst this produces a consistent trend it may not reflect the true fluctuation of production and import behaviour.

Trends of emissions in the IPPU sector are further described and justified in the trends chapter.

4.6 Improvements

A survey of suppliers of air conditioning and refrigeration units and servicing facilities of mobile air conditioning units would also help to capture information on recovery, re-use and charge required to improve estimates of the F-gases.

Where import data has been utilised, there is a need to reflect the relationship more accurately between consumption behaviour and import for all IPPU estimates involving product use. For example, to stratify the road paving in the country to model the different product and process types occurring in the national road paving industry, as opposed to assuming that all asphalt imported is consumed within the import year.

A national survey would be beneficial to categorise use of household products that contain NMVOCs. It has been suggested that required information could be integrated with national census surveys.

To ensure consistent supply of data from manufacturers and production facilities Data Supply Agreements (DSA) would be beneficial. This ensures clarity of the request and allows both parties to understand the requirements including data format, timescale, and granularity. This will also help to maintain good relationships with data providers.

Finally, collecting data for missing categories: 2A4 Ceramics production and 2G1 Electrical Equipment is required to improve completeness of reporting within the IPPU sector.

See **Section 1.9.3** for an introduction to improvement plan and **Annex IV** for the full Improvement Plan list.

5 Agriculture

5.1 Sector overview

Emissions from the agriculture sector have been calculated for the full time series. As there was difficulty obtaining updated national data for the compilation, the previous inventory data for 2000-2010 was used. After 2010, data was extrapolated based on a trend analysis of FAO statistics.

A summary of the emission estimates in the agriculture sector is provided in the table below.

Table 13 Method summary – agriculture

3 Agriculture Greenhouse Gas Source and Sink Categories	Gases Included	% Total Emissions*	Key Categories	Uncertainty %**	Tier/ NK	MS reference	Notes
A. Livestock							
1. Enteric Fermentation							
a.i. Dairy cattle	-	-	-	-	IE	A1	Included in “Other cattle” based on national definition.
a.ii. Other cattle	CH_4	0.8	Y	0.1	T1		
b. Buffalo	-	-	-	-	NO		
c. Sheep	CH_4	0.1	Y	0.0	T1		
d. Goats	CH_4	0.1	N	0.0	T1		
e. Camels	-	-	-	-	NO		
f. Horses	-	-	-	-	NO		
g. Mules and Asses							
h. Swine breeding	-	-	-	-	NO		
h. Market swine	CH_4	0.1	N	0.0	T1		
Poultry	CH_4	0.0	N	0.0	T1		
j. Other	-	-	-	-	NO		
2. Manure Management							
a.i. Dairy cattle	-	-	-	-	IE	A2	Included in “Other cattle” based on national definition.
a.ii. Other cattle	N_2O CH_4	0.0	N	0.0	T1		
b. Buffalo	-	-	-	-	NO		
c. Sheep	N_2O CH_4	0.1	N	0.0	T1		
d. Goats	N_2O CH_4	0.1	N	0.1	T1		
e. Camels	-	-	-	-	NO		
f. Horses	-	-	-	-	NO		

g. Mules and Asses	-	-	-	-	NO		
h. Swine breeding	N_2O CH_4	0.9	Y	3.3	T1		
Market	N_2O CH_4	0.5	Y	9.0	T1		
Poultry	-	-	-	-	NO		
j. Other	N_2O CH_4	0.0	N	0.0	T1		
C. Aggregate sources and non-CO_2 emissions sources on land							
1. GHG emissions from biomass burning	*See LULUCF (**Chapter 6**)*						
2. Liming	CO_2	0.0	N	0.0	T1	A6	
3. Urea application	CO_2	-	-	-	NE	-	
4. Direct N_2O emissions from managed soils	N_2O	0.8	Y	56.2	T1	A3	
5. Indirect N_2O emissions from managed soils	N_2O	0.2	Y	4.8	T1	A4	
6. Indirect N_2O emissions from manure management	N_2O	0.2	N	0.2	T1	A5	
7. Rice Cultivations	CH_4	-	-	-	NO	-	
8. Other		-	-	-	NO	-	

*Note: NK = notation key, MS = method statement, T = tier, * percentage of total emissions without LULUCF in the most recent inventory year, **Contribution to variance by category in the latest year*

5.2 Methods, data sources and assumptions

A Tier 1 methodology approach was taken in the agriculture sector as outlined in the 2006 IPCC Guidelines. Default emission factors were used in all cases for CO_2, CH_4, and N_2O as there was no country-specific information available.

In most cases, the activity data used was taken from the previous inventory, which covered the period 2000-2010. The majority of this data was compiled by the Ministry of Agriculture. Due to a lack of later data available after 2010, the time series was extrapolated based off a trend analysis carried out on international FAO statistics. For the fraction of AWMS, this was taken from a report by Dr George Joseph the Chief Veterinary Officer in 2000, and these fractions were assumed to be the same across the time series. In the case of liming and composting, this data was applied from local expert judgement. In the case of crop yields, where there were no IPCC default assumptions for percentage of dry matter, the Jamaican GHG inventory was used.

Assumptions for region and average temperature were made following the Tier 1 methodology. Saint Lucia was assumed to be 'Latin America' where possible, if not 'Developing Country'. The climate was assumed to be 'warm'. As there are no cattle bred strictly for dairy on the island, all cattle are categorised as 'non-dairy' according to the definitions set in the 2006 IPCC Guidelines.

Detailed methodology information is provided within the Method Statements in **Annex III** (refer to **Table 13** above).

5.3 Quality assurance/ quality control

Cross-cutting QA/QC checks are outlined within **Section 1.7**. Data compilation spreadsheets and the data collection templates were reviewed by two members of the agricultural expert team at Aether. All sources of data, emission factors, other factors and constants were consistently referenced. All formulas were checked to ensure the correct calculation was taking place, and comments made when compiling and checking were left directly in the compilation file with an initial of who left the comment and a date. All the data was compared to the previous inventory in addition to the FAO statistics. The Jamaican agricultural inventory was additionally used to provide a comparison, where data was not available (such as for calculating crop residues).

Further information on QA/QC undertaken for this sector is provided within the relevant method statements in **Annex III**.

5.4 Description of uncertainties

Percentage of uncertainty for each emission estimate under the IPPU sector is provided in **Annex II**. Most uncertainty factors for the activity data and emission factors have been taken from the 2006 IPCC Guidelines as default emission factors were being used, and no country-specific studies of uncertainty have been carried out in Saint Lucia.

The overall average uncertainty was calculated to be ±46 % which is high, according to the 2006 IPCC Guideline definitions. Indirect N_2O emissions were particularly uncertain ranging from a ±92 % uncertainty for indirect N_2O emissions from manure management, and ±180 % uncertainty for indirect N_2O emissions from volatilisation[6]. There is however relatively low uncertainty for CH_4 emissions from enteric fermentation and manure management, which have an uncertainty of around ±20 %, considerably lower than other sectors and gases.

5.5 Time series consistency issues

Consistency issues in the time series for enteric fermentation and manure management are linked to a lack of data on livestock populations. The overall trend of emissions from the agriculture sector fluctuates from year to year, primarily driven by changing livestock populations and other external parameters which are likely to impact emission levels such as average temperature in Saint Lucia. There is a small dip in emissions in 2009, whilst emissions peaked in 2015. These changes can be attributed to changing livestock values.

5.6 Improvements

A large improvement for the following inventory would be to obtain up-to-date, robust, and good quality activity data for the whole time series, including livestock populations, synthetic fertiliser data, crop production data, urea and liming application data, and updated data on manure management systems.

Further improvements would be to include the number of national agriculture experts in order to increase the in-country capacity and make the next compilation process even quicker and smoother. There is additionally a need for more monitoring on agricultural

[6] In the uncertainty analysis uncertainty factors were set to a maximum of 100 % as the propagation of errors method does not allow for asymmetric uncertainty. This is in line with the 2006 IPCC Guidelines, see V1, Chp 3, Section 3.2.3.1.

practices on the island, as some data is difficult to obtain. More frequent discussions with farmers to better understand their practices would be beneficial to obtaining a more holistic overview of agriculture in Saint Lucia. Surveys and census' could be carried out which captures data on areas such as amount of fertiliser applied, areas of crop residues burnt, fraction of AWMS.

See **Section 1.9.3** for an introduction to improvement plan and **Annex IV** for the full Improvement Plan list.

6 Land Use, Land Use Change & Forestry (LULUCF)

6.1 Sector overview

The LULUCF sector´s GHG emissions and removals have been estimated under the Reporting for Results-based REDD+ program of the Coalition for Rainforest Nations (CfRN) project, funded by the Norwegian Agency for Development Cooperation (Norad). Despite not having a formal cooperation agreement, the consultancy “Saint Lucia 2018 National Greenhouse Gas Inventory to the United Nations Framework Convention on Climate Change” have reviewed the estimates and supported with the estimation of the sector´s uncertainty. Activity data and emission factor sources of information have been assessed and results have been verified with another LULUCF Inventory compiled separately. The final estimates are still under verification control with external UNFCCC´s experts.

The carbon pools considered are aboveground, belowground biomass and dead organic matter (DOM, deadwood and litter). Soil organic carbon (SOC) and harvested wood products (HWP) could not be estimated with the current information available, the inclusion of these carbon pools in future reports is a priority improvement (see **Section 6.6**).

A summary of the emission and removal estimates in the LULUCF sector is provided in the table below.

Table 14 Method summary - LULUCF

3 Land Use and Land Use Change Greenhouse Gas Source and Sink Categories	Gases Included	% Total Emissions*	Key Categories	Uncertainty %**	Tier/ NK	MS reference	Notes
B. Land							
1. Forest Land							
a. Forest land Remaining Forest land	CO_2	79.8	Y	4.9	T1	LU1, LU2	
b. Land Converted to Forest land	CO_2	10.7	Y	0.2	T2		CL and GL converted to FL are key categories
2. Cropland							
a. Cropland Remaining Cropland land	CO_2	1.3	N	0.0	T1	LU1, LU2	
b. Land Converted to Cropland	CO_2	6.3	-	-	T1		
3. Grassland							
a. Grassland Remaining Grassland	CO_2	-	-	-	T1	LU1, LU2	
b. Land Converted to Grassland	CO_2	1.2	-	-	T1		
4. Wetlands							
a. Wetlands Remaining Wetlands	CO_2	-	-	-	T1	LU1, LU2	
b. Land Converted to Wetlands	CO_2	-	-	-	NO		

5. Settlements							
a. Settlements Remaining Settlements	CO_2	-	-	-	T1	LU1, LU2	
b. Land Converted to Settlements	CO_2	0.7	N	0.0	T1		
2. Other land							
a. Other land Remaining Other land	CO_2	-	-	-	T1	LU1, LU2	
b. Land Converted to Other land	CO_2	-	-	-	T1		
C. Aggregate sources and non-CO_2 emission sources on land							
1. Biomass burning							
a. Biomass burning – forest land	CH_4, N_2O	-	N	-	T1	LU3	Emissions 2015 only
b. Biomass burning – cropland	-	-	-	-	NO	-	
c. Biomass burning – grassland	-	-	-	-	NO	-	
d. Biomass burning – all other land	-	-	-	-	NO	-	
D. Harvested Wood Products							
1. Harvested Wood Products	CO_2	-	-	-	NE	-	No data available

*Note: NK = notation key, MS = method statement, T = tier, * percentage of absolute emissions/removals compared to total emissions without LULUCF in the most recent inventory year, **Contribution to variance by category in the latest year*

6.2 Methods, data sources and assumptions

The land use and land-use change matrix for time series is obtained with the use of Collect Earth tool developed under the CfRN project. The land use data is categorised into 16 different land uses; 2,501 land area parcels (24.63 ha each) were analysed over the period. Disturbances and the year they occurred are recorded and accounted for.

Emission factors are obtained mainly from the 2006 IPCC Guidelines and 2019 Refinement to the 2006 IPCC Guidelines, with high level of uncertainties. Country-specific emission factors are used for biomass stock in forestland from data arising from the National Forest Inventory (2009). Chave *et al.* (2014) pantropical biomass allometric equation was selected to estimate biomass in Saint Lucia.

Detailed methodology information is provided within the method statements in **Annex III** (refer to **Table 14** above) and *"GREENHOUSE GAS INVENTORY REPORT FOR THE FOREST AND LAND USE SECTOR (FOLU) OF SAINT LUCIA 2000 –2018"[7].*

6.3 Quality assurance/ quality control

Cross-cutting QA/QC checks are outlined within **Section 1.7**. The national expert team is planning to implement validation cross-checks with technicians from neighbouring countries, along with independent reviewers' verification controls.

The emissions and removals estimations done in Excel sheet were checked using formula spot checks. Quality control is currently being undertaken through the CfRN project; however, this is not expected to have a large impact on the estimates.

[7] This document is currently under review and is pending publication

Further information on QA/QC undertaken for this sector is provided within the relevant method statements in **Annex III**.

6.4 Description of uncertainties

Percentage of uncertainty for each emission estimate under the LULUCF sector is provided in **Annex II**. LULUCF uncertainty results from the combination of different uncertainty sources (activity data sampling process, emission factors accuracy, among others).

The land uses and land-use changes that have a minor representation in Saint Lucia´s total area have fewer sample plots in Collect Earth analysis, consequently with a higher uncertainty. Forest land remaining forest land has the lowest uncertainty of all land use areas with an activity data uncertainty of ±3 %. In contrast, croplands, grasslands and settlements converted to forest lands have activity data uncertainty values of ±38, 37 and 100 % respectively.

Emission factors from the 2006 IPCC Guidelines and 2019 Refinement to the 2006 IPCC Guidelines have high level of uncertainties. Uncertainty of the country-specific emission factors used for biomass stock in forestland from the National Forest Inventory is unknown.

6.5 Time series consistency issues

The time series does not have any major time series consistency issues.

6.6 Improvements

The priority improvements for the LULUCF sector are as follows:

- Emission factors (in other land differently from forestland) could be improved by moving from IPCC defaults values to country-specific values using local or regional studies. Emissions factors in forestland could be improved by local data about biomass losses.
- Activity data analysis (with Collect Earth tool) could be improved with the estimation of the level of uncertainty. More sampling plots could be included in the activity data analysis to reduce the level of uncertainty in land use and land-use changes that have a minor representation in Saint Lucia´s total area
- Biomass burning activity data and emission factors collection could be improved by using local data and other sources of information (e.g. MODIS) with its necessary processing for being applicable.
- Data on HWPs could be collected in the future, to estimate emissions and removals in this pool.
- SOC pool is not considered in the current Inventory and shall be accounted in future inventories (at least with Tier 1 approach).

See **Section 1.9.3** for an introduction to improvement plan and **Annex IV** for the full Improvement Plan list.

7 Waste

7.1 Sector overview

Emissions from waste in Saint Lucia are dominated by two categories: solid waste disposal in managed landfill and wastewater treatment and discharge. A summary of the emission estimates in the waste sector is provided in the table below.

Table 15 Method summary - waste

4 Waste Greenhouse Gas Source and Sink Categories	Gases Included	% Total Emissions*	Key Categories	Uncertainty %**	Tier/ NK	MS reference	Notes
A. Solid Waste Disposal							
1. Managed Waste Disposal Sites	CH_4	9.8	Y	32.7	T1	W1	
2. Unmanaged Waste Disposal Sites	-	-	-	-	NO		
3. Uncategorised Waste Disposal Sites	-	-	-	-	NO		
B. Biological Treatment of Solid Waste							
Biological Treatment of Solid Waste	CH_4, N_2O	-	N	-	T1	W2	
C. Incineration and Open Burning of Waste							
1. Waste Incineration	-	-	-	-	NO	-	
2. Open Burning of Waste	-	-	-	-	NO		Assumed to be negligible
D. Wastewater Treatment and Discharge							
1. Domestic Wastewater Treatment and Discharge	CH_4, N_2O	0.50	Y	1.3	T1	W3	
2. Industrial Wastewater Treatment and Discharge	CH_4	0.01	N	0.0	T1		
E. Other							
Other	-	-	-	-	NO	-	

*Note: NK = notation key, MS = method statement, T = tier, * percentage of total emissions without LULUCF in the most recent inventory year, **Contribution to variance by category in the latest year*

7.2 Methods, data sources and assumptions

Calculation of CH_4 emissions from Solid Waste Disposal Sites (SWDS) used the Tier 1 First Order Decay (FOD) Model from the 2006 IPCC Guidelines. The IPCC have developed a spreadsheet model which was used. Data on amount of waste disposed of in the SWDS has been used where available. However, this data is only available from when weighbridges came into operation. For the years prior the amount of waste disposed in landfill was calculated using population and the IPCC regional default for waste generation. The weighbridge data was used to calculate an average waste generation value for the years available and this confirmed that the IPCC regional default is applicable. Saint Lucia specific waste composition data was used.

CH_4 and N_2O emissions from composting was calculated using the 2006 IPCC Tier 1 methodology. Data on the amount of waste composted at the Vieux-fort disposal site was used, however this was only available for 2015 and 2019. It was estimated by the Saint Lucia Solid Waste Management Authority that half the amount of waste composted in 2015 was composted in 2016-2018. IPCC default emission factors for CH_4 and N_2O from composting were used.

CH_4 emissions from domestic wastewater was calculated using 2006 IPCC Tier 1 methodology. The Saint Lucia specific activity data used was population and the fraction of utilisation of the different wastewater treatment types. Population was adjusted to include tourism to give a more accurate estimation of emissions.

CH_4 emissions from industrial wastewater was also calculated using a Tier 1 methodology. The volumes of industrial wastewater produced was calculated using production and the IPCC default for wastewater production.

N_2O emissions from wastewater were calculated using protein consumption of the population, adjusted to include tourists. A correction factor for co-discharge of industrial wastewater was also used.

Detailed methodology information is provided within the Method Statements in **Annex III** (refer to **Table 15** above).

7.3 Quality assurance/ quality control

Cross-cutting QA/QC checks are outlined within **Section 1.7**. Sector specific checks performed on the calculations were:

- Ensuring that the total degree of utilisation of wastewater treatment types equals 100 %.
- Ensuring total waste composition equals 100 %.
- Ensuring all solid waste is accounted for and the amount of waste generated equals the amount of waste treated.
- Comparison of the IPCC default value for waste generation per capita with the average waste generation per capita value calculated using the available weighbridge data.

Further information on QA/QC undertaken for this sector is provided within the relevant method statements in **Annex III**.

7.4 Description of uncertainties

Percentage of uncertainty for each emission estimate under the waste sector is provided in **Annex II**. Solid waste disposal on land had a high uncertainty of ±72 %. The largest contribution to this estimate was the uncertainty in the amount of waste disposed to the SWDS as while weighbridge data is available for the later years it is not available across the time series.

The use of IPCC default emission factors in estimating emissions from composting and N_2O from domestic wastewater was the highest contribution to their respective uncertainties. The uncertainty in N_2O emissions from domestic wastewater was the highest from the waste sector, along with CH_4 emissions from industrial wastewater, at ±106 %.

CH_4 emissions from industrial wastewater treatment the largest contributing factor to this uncertainty is the use of IPCC defaults for the volume of wastewater produced per unit of production and Chemical Oxygen Demand (COD) which may not be reflective of Saint Lucia.

7.5 Time series consistency issues

Majority of the activity data in the waste sector did not cover the complete time series. The below list outlines the data and technique used to create a complete time series:

- Population data and information on the split of population using different wastewater treatment types use census data which is collected periodically. Data on waste composition is also only collected periodically. Extrapolation was used to complete the time series for data collected periodically.
- Data on waste disposed to landfill only covered 2004-2018 as weighbridges were only installed on the disposal sites in 2004, for waste quantities disposed in landfill prior to 2004 the population and regional IPCC default for waste generation was used.
- Data on amount of waste composted was only available for 2015, expert judgement was used to estimate that half the amount composted in 2015 was composted in 2016-2018.
- Data on overnight stay tourists and average overnight stay did not cover the years 2000-2001. 2002 values were used for these years.
- Rum production volumes were unavailable for 2018, 2017 values were used.
- Brewery production volumes were unavailable for 2011-2018. The time series was completed with 2010 values.

7.6 Improvements

The key improvements for the waste sector are focused on collecting data where currently no activity data is available and therefore emissions have not been estimates. This includes:

- the amount of waste composted at waste disposal sites, farms, households and schools,
- the amount of open burning, and
- the volume of wastewater from breweries and distilleries.

In addition, a priority improvement is to develop a better understanding of the Beausejour wastewater treatment to improve the accuracy of the methane correction factor (MCF). See **Section 1.9.3** for an introduction to improvement plan and **Annex IV** for the full Improvement Plan list.

8 Reference list

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Annex I Key Category Analysis

A key category analysis has been undertaken in accordance with approach 1 and 2 in the 2006 IPCC Guidelines. **Table 16** presents the key categories identified under approach 1 without LULUCF, **Table 17** presents the key categories identified under approach 1 with LULUCF and **Table 18** presents the key categories identified under approach 2. An overall rank has been calculated to combine the results of the key category analysis.

Table 16: Key category analysis approach 1, without LULUCF – identified key categories

Sector code	Sector description	Fuel Type/ AD Split	Pollutant	2000 Emissions (Gg CO_2e)	2018 Emissions (Gg CO_2e)	Base year level	Latest year level	Trend	Overall rank
1A1	Energy Industries	-	CO_2	177.16	249.35	40.72%	33.88%	11.58%	1
1A3b	Road Transport	-	CO_2	131.86	245.09	30.31%	33.30%	5.06%	2
1A4	Fuel Combustion Activities - Other Sectors	-	CO_2	19.15	31.41	4.40%	4.27%	0.23%	3
3A2i	Manure Management	Poultry	N_2O	3.37	3.23	0.77%	0.44%	0.57%	3
1B1	Fugitive emissions from fuels - Solid Fuels	-	CH_4	8.63	3.03	1.98%	0.41%	2.66%	5
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	-	HFCs	7.25	72.43	1.67%	9.84%	13.83%	5
4A	Solid Waste Disposal	-	CH_4	33.56	68.54	7.71%	9.31%	2.70%	7
3C5	Indirect N_2O MS	-	N_2O	1.90	1.68	0.44%	0.23%	0.35%	8
1A4	Fuel Combustion Activities - Other Sectors	-	CH_4	7.15	3.92	1.64%	0.53%	1.88%	9
2G	Other Product Manufacture and Use	-	N_2O	0.45	2.29	0.10%	0.31%	0.35%	9
1A4	Fuel Combustion Activities - Other Sectors	-	N_2O	1.26	0.74	0.29%	0.10%	0.32%	11
1A3b	Road Transport	-	N_2O	4.32	7.20	0.99%	0.98%	0.02%	12
3A2h	Manure Management	Swine	N_2O	1.84	5.48	0.42%	0.74%	0.55%	13

3A1aii	Enteric Fermentation	Non-Dairy Cattle	CH_4	7.01	5.70	1.61%	0.77%	1.42%	14
1A3d	National Navigation	-	CO_2	3.41	3.62	0.78%	0.49%	0.49%	15
1A3a	Domestic Aviation	-	CO_2	3.89	5.06	0.89%	0.69%	0.35%	16
3C4	Direct N_2O MS	-	N_2O	6.55	5.36	1.51%	0.73%	1.31%	17
1A2	Manufacturing Industries and Construction	-	CO_2	6.00	11.49				
1A1	Energy Industries	-	CO_2	177.16	249.35				
1A3b	Road Transport	-	CO_2	131.86	245.09				
1A4	Fuel Combustion Activities - Other Sectors	-	CO_2	19.15	31.41				

Table 17: Key category analysis approach 1, with LULUCF – identified key categories

Sector code	Sector description	Fuel Type/ AD Split	Pollutant	2000 Emissions (Gg CO_2e)	2018 Emissions (Gg CO_2e)	Base year level	Latest year level	Trend	Overall rank
1A1	Energy Industries	-	CO_2	177.16	249.35	31.7%	25.9%	10.0%	1
1A3b	Road Transport	-	CO_2	131.86	245.09	23.6%	25.4%	3.2%	2
1A2	Manufacturing Industries and Construction	-	CO_2	6.00	11.49	1.1%	1.2%	0.2%	2
3B1bi	Land Converted to Forest Land	-	CO_2	0.00	-10.50	0.0%	1.1%	0.0%	4
1A3b	Road Transport	-	N_2O	4.32	7.20	0.8%	0.7%	0.0%	5
3A2i	Manure Management	Poultry	N_2O	3.37	3.23	0.6%	0.3%	0.5%	6
1B1	Fugitive emissions from fuels - Solid Fuels	-	CH_4	8.63	3.03	1.5%	0.3%	2.1%	6
3B1bii	Land Converted to Forest Land	-	CO_2	0.00	-6.77	0.0%	0.7%	0.0%	6
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	-	HFCs	7.25	72.43	1.3%	7.5%	10.7%	9

1A3d	National Navigation	-	CO_2	3.41	3.62	0.6%	0.4%	0.4%	9
1A3a	Domestic Aviation	-	CO_2	3.89	5.06	0.7%	0.5%	0.3%	11
3B1a	Forest Land Remaining Forest Land	-	CO_2	-124.21	-205.88	22.2%	21.4%	1.5%	11
4A	Solid Waste Disposal	-	CH_4	33.56	68.54	6.0%	7.1%	1.9%	13
3C5	Indirect N_2O MS	-	N_2O	1.90	1.68	0.3%	0.2%	0.3%	13
1A4	Fuel Combustion Activities - Other Sectors	-	CH_4	7.15	3.92	1.3%	0.4%	1.5%	13
2G	Other Product Manufacture and Use	-	N_2O	0.45	2.29	0.1%	0.2%	0.3%	16
1A4	Fuel Combustion Activities - Other Sectors	-	N_2O	1.26	0.74	0.2%	0.1%	0.3%	17
3C4	Direct N_2O MS	-	N_2O	6.55	5.36	1.2%	0.6%	1.1%	18
3A2h	Manure Management	Swine	N_2O	1.84	5.48	0.3%	0.6%	0.4%	19
1A4	Fuel Combustion Activities - Other Sectors	-	CO_2	19.15	31.41	3.4%	3.3%	0.3%	20
3A1aii	Enteric Fermentation	Non-Dairy Cattle	CH_4	7.01	5.70	1.3%	0.6%	1.1%	21

Table 18: Key category analysis approach 2, with LULUCF – identified key categories

Sector code	Sector description	Fuel Type/ AD Split	Pollutant	2000 Emissions (Gg CO_2e)	2018 Emissions (Gg CO_2e)	Uncertainty	Latest year level	Trend	Overall rank
1A1	Energy Industries	-	CO_2	177.16	249.35	100.4%	33.9%	10.0%	1
2F1	Product Uses as Substitutes for Ozone Depleting Substances - Refrigeration and Air Conditioning	-	HFCs	7.25	72.43	210.9%	20.7%	22.6%	1
3B1a	Forest Land Remaining Forest Land	-	CO_2	-124.21	-205.88	57.8%	16.1%	0.8%	1
1A3b	Road Transport	-	CO_2	131.86	245.09	20.6%	6.8%	0.7%	4
1A4	Fuel Combustion Activities - Other Sectors	-	CH_4	7.15	3.92	201.0%	1.1%	3.0%	4

Sector code	Sector description	Fuel Type/ AD Split	Pollutant	2000 Emissions (Gg CO_2e)	2018 Emissions (Gg CO_2e)	Uncertainty	Latest year level	Trend	Overall rank
1B1	Fugitive emissions from fuels - Solid Fuels	-	CH_4	8.63	3.03	141.4%	0.6%	3.0%	6
4A	Solid Waste Disposal	-	CH_4	33.56	68.54	71.8%	6.7%	1.4%	6
3B1bi	Land Converted to Forest Land	-	CO_2	0.00	-10.50	107.0%	1.5%	0.0%	8
3C4	Direct N_2O MS	-	N_2O	6.55	5.36	434.4%	3.2%	4.6%	9

Annex II Uncertainty Analysis

The methodology of the uncertainty assessment is discussed in **Section 1.8**. **Table 19** below provides the complete uncertainty assessment for all sectors.

Table 19 Uncertainty Assessment

Sector Code	Sector	Pollutant	Base Year Emissions (Gg CO_2e)	Latest Year Emissions (Gg CO_2e)	Activity Data Uncertainty (%)	Emission Factor Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in latest year	Uncertainty in Trend in Total Emissions due to EF (%)	Uncertainty in Trend in Total Emissions due to AD (%)	Combined Uncertainty in Trend in Total Emissions (%)
1A1ai	Electricity generation	CO_2	177.156	249.345	0.05	0.07	8.60%	0.177%	0.918%	5.672%	0.330%
1A1ci	Manufacture of Solid Fuels	CO_2	0.000	0.000	1.00	0.00	100.00%	0.000%	0.000%	0.000%	0.000%
1A2	Manufacturing Industries and Construction	CO_2	6.003	11.493	0.20	0.07	21.19%	0.002%	0.037%	1.046%	0.011%
1A3aii	Domestic Aviation	CO_2	3.893	5.063	0.75	0.05	75.17%	0.006%	0.021%	1.728%	0.030%
1A3b	Road Transport	CO_2	131.861	245.089	0.20	0.05	20.62%	0.984%	0.464%	22.301%	4.976%
1A3dii	National Navigation	CO_2	3.411	3.621	0.05	0.02	5.22%	0.000%	0.009%	0.082%	0.000%
1A4a	Commercial/Institutional	CO_2	4.676	5.293	0.10	0.05	11.18%	0.000%	0.038%	0.241%	0.001%
1A4b	Residential	CO_2	14.403	19.505	0.10	0.05	11.18%	0.002%	0.066%	0.887%	0.008%
1A4ci	Agriculture / Forestry - stationary combustion	CO_2	0.068	6.609	0.10	0.05	11.18%	0.000%	0.105%	0.301%	0.001%
1A4cii	Agriculture / Forestry - mobile combustion	CO_2	0.000	0.000	0.10	0.05	11.18%	0.000%	0.000%	0.000%	0.000%
1B2av	Distribution of Oil Products	CO_2	0.000	0.000	1.00	0.00	100.00%	0.000%	0.000%	0.000%	0.000%

2A1	Cement production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2A2	Lime production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2A3	Glass Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2A4	Other Process Uses of Carbonates	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2A5	Other (please specify)	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2B1	Ammonia Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2B5	Carbide Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2B6	Titanium Dioxide Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2B7	Soda Ash Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2B8	Petrochemical and Carbon Black Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2C1	Iron and Steel Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2C2	Ferroalloys Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2C3	Aluminium production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2C4	Magnesium production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2C5	Lead Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2C6	Zinc Production	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2C7	Other (please specify)	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2D1	Lubricant Use	CO_2	0.224	0.383	0.20	0.50	53.85%	0.000%	0.003%	0.035%	0.000%
2D2	Paraffin Wax Use	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2D3a	Solvent use	CO_2	0.412	0.472	0.02	0.50	50.04%	0.000%	0.033%	0.004%	0.000%
2D3b	Road paving with asphalt	CO_2	0.001	0.005	0.05	3.03	303.17%	0.000%	0.003%	0.000%	0.000%

2D3d	Coating applications	CO_2	0.774	0.959	0.05	0.76	75.98%	0.000%	0.075%	0.022%	0.000%
2D3e	Degreasing	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2D3f	Dry cleaning	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2D3g	Chemical Products	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2D3h	Printing	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2D3i	2G Other Solvent and product use	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2D4	Other (please specify)	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3B1a	Forest Land Remaining Forest Land (disturbed)	CO_2	9.535	-74.114	0.03	0.41	40.85%	0.353%	11.758%	1.012%	1.393%
3B1a	Forest Land Remaining Forest Land (undisturbed)	CO_2	-133.742	-131.763	0.03	0.41	40.85%	1.116%	11.508%	1.798%	1.357%
3B1bi	Land Converted to Forest Land	CO_2	0.000	-10.505	0.38	1.00	106.98%	0.049%	3.379%	1.816%	0.147%
3B1bii	Land Converted to Forest Land	CO_2	0.000	-6.767	0.37	1.00	106.63%	0.020%	2.177%	1.139%	0.060%
3B1biii	Land Converted to Forest Land	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3B1biv	Land Converted to Forest Land	CO_2	0.000	-0.228	1.00	1.00	141.42%	0.000%	0.073%	0.104%	0.000%
3B2a	Cropland Remaining Cropland	CO_2	0.000	-2.435	0.11	0.75	75.80%	0.001%	0.588%	0.122%	0.004%
3B2bi	Land Converted to Cropland	CO_2	0.000	0.430	0.65	1.00	119.27%	0.000%	0.138%	0.127%	0.000%
3B2bii	Land Converted to Cropland	CO_2	0.000	0.000	0.65	1.00	119.27%	0.000%	0.000%	0.000%	0.000%

3B2biii	Land Converted to Cropland	CO_2	0.000	0.000	0.65	1.00	119.27%	0.000%	0.000%	0.000%	0.000%
3B2biv	Land Converted to Cropland	CO_2	0.000	0.000	0.65	1.00	119.27%	0.000%	0.000%	0.000%	0.000%
3B2bv	Land Converted to Cropland	CO_2	0.000	0.000	0.65	1.00	119.27%	0.000%	0.000%	0.000%	0.000%
3B3a	Grassland Remaining Grassland	CO_2	0.000	0.000	0.12	0.00	12.00%	0.000%	0.000%	0.000%	0.000%
3B3bi	Land Converted to Grassland	CO_2	0.000	0.000	0.52	0.75	91.26%	0.000%	0.000%	0.000%	0.000%
3B3bii	Land Converted to Grassland	CO_2	0.000	0.000	0.52	0.75	91.26%	0.000%	0.000%	0.000%	0.000%
3B3biii	Land Converted to Grassland	CO_2	0.000	0.000	0.52	0.75	91.26%	0.000%	0.000%	0.000%	0.000%
3B3biv	Land Converted to Grassland	CO_2	0.000	0.000	0.52	0.75	91.26%	0.000%	0.000%	0.000%	0.000%
3B3bv	Land Converted to Grassland	CO_2	0.000	0.000	0.52	0.75	91.26%	0.000%	0.000%	0.000%	0.000%
3B4ai	Wetlands Remaining Wetlands	CO_2	0.000	0.000	0.59	0.00	59.00%	0.000%	0.000%	0.000%	0.000%
3B4aii	Wetlands Remaining Wetlands	CO_2	0.000	0.000	0.59	0.00	59.00%	0.000%	0.000%	0.000%	0.000%
3B4bi	Land Converted to Wetlands	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3B4bii	Land Converted to Wetlands	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%

3B4biii	Land Converted to Wetlands	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3B5a	Settlements Remaining Settlements	CO_2	0.000	0.000	0.11	0.00	11.00%	0.000%	0.000%	0.000%	0.000%
3B5bi	Land Converted to Settlements	CO_2	0.000	-0.857	0.88	0.75	115.62%	0.000%	0.207%	0.343%	0.002%
3B5bii	Land Converted to Settlements	CO_2	0.000	-0.078	0.88	0.75	115.62%	0.000%	0.019%	0.031%	0.000%
3B5biii	Land Converted to Settlements	CO_2	0.000	-0.312	0.88	0.75	115.62%	0.000%	0.075%	0.125%	0.000%
3B5biv	Land Converted to Settlements	CO_2	0.000	0.000	0.88	0.75	115.62%	0.000%	0.000%	0.000%	0.000%
3B5bv	Land Converted to Settlements	CO_2	0.000	0.000	0.88	0.75	115.62%	0.000%	0.000%	0.000%	0.000%
3B6a	Other Land Remaining Other Land	CO_2	0.000	0.000	0.50	0.00	50.00%	0.000%	0.000%	0.000%	0.000%
3B6bi	Land Converted to Other Land	CO_2	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
3B6bii	Land Converted to Other Land	CO_2	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
3B6biii	Land Converted to Other Land	CO_2	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
3B6biv	Land Converted to Other Land	CO_2	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
3B6bv	Land Converted to Other Land	CO_2	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
3C2	Liming	CO_2	0.004	0.004	0.30	0.00	30.00%	0.000%	0.000%	0.001%	0.000%

3C3	Urea application	CO_2	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
CO_2 Total			218.679	321.214				16.467%			
1A1ai	Electricity generation	CH_4	0.167	0.223	0.05	1.00	100.12%	0.000%	0.016%	0.005%	0.000%
1A1ci	Manufacture of Solid Fuels	CH_4	0.395	0.139	1.00	1.00	141.42%	0.000%	0.163%	0.063%	0.000%
1A2	Manufacturing Industries and Construction	CH_4	0.014	0.019	0.20	1.00	101.98%	0.000%	0.001%	0.002%	0.000%
1A3aii	Domestic Aviation	CH_4	0.001	0.001	0.75	1.00	125.00%	0.000%	0.000%	0.000%	0.000%
1A3b	Road Transport	CH_4	0.866	1.335	0.20	1.00	101.98%	0.001%	0.027%	0.121%	0.000%
1A3dii	National Navigation	CH_4	0.007	0.007	0.05	0.50	50.25%	0.000%	0.001%	0.000%	0.000%
1A4a	Commercial/Institutional	CH_4	0.008	0.009	0.10	1.00	100.50%	0.000%	0.001%	0.000%	0.000%
1A4b	Residential	CH_4	7.144	3.904	0.10	1.00	100.50%	0.006%	2.510%	0.178%	0.063%
1A4ci	Agriculture / Forestry - stationary combustion	CH_4	0.000	0.006	0.10	1.00	100.50%	0.000%	0.002%	0.000%	0.000%
1A4cii	Agriculture / Forestry - mobile combustion	CH_4	0.000	0.000	0.10	1.00	100.50%	0.000%	0.000%	0.000%	0.000%
1B1ci	Charcoal and biochar production	CH_4	8.632	3.033	1.00	1.00	141.42%	0.007%	3.574%	1.380%	0.147%
1B2av	Distribution of Oil Products	CH_4	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
1B2bv	Distribution of Gas Products	CH_4	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
3A1ai	Enteric Fermentation	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3A1aii	Enteric Fermentation	CH_4	7.014	5.701	0.20	0.40	44.72%	0.003%	0.745%	0.519%	0.008%
3A1c	Enteric Fermentation	CH_4	1.058	0.457	0.20	0.40	44.72%	0.000%	0.164%	0.042%	0.000%
3A1d	Enteric Fermentation	CH_4	0.967	0.729	0.20	0.40	44.72%	0.000%	0.110%	0.066%	0.000%

3A1f	Enteric Fermentation	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3A1g	Enteric Fermentation	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3A1h	Enteric Fermentation	CH_4	0.177	0.529	0.20	0.40	44.72%	0.000%	0.031%	0.048%	0.000%
3A1i	Enteric Fermentation	CH_4	0.000	0.000	0.40	0.80	89.44%	0.000%	0.000%	0.000%	0.000%
3A2ai	Manure Management	CH_4	0.000	0.000	0.25	0.30	39.05%	0.000%	0.000%	0.000%	0.000%
3A2aii	Manure Management	CH_4	0.125	0.102	0.25	0.30	39.05%	0.000%	0.010%	0.012%	0.000%
3A2c	Manure Management	CH_4	0.042	0.018	0.22	0.30	37.42%	0.000%	0.005%	0.002%	0.000%
3A2d	Manure Management	CH_4	0.043	0.032	0.22	0.30	37.42%	0.000%	0.004%	0.003%	0.000%
3A2e	Manure Management	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3A2f	Manure Management	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3A2h	Manure Management	CH_4	0.354	1.057	0.22	0.30	37.42%	0.000%	0.046%	0.108%	0.000%
3A2i	Manure Management	CH_4	0.176	0.170	0.41	0.60	72.80%	0.000%	0.023%	0.032%	0.000%
3C1a	Emissions from Biomass Burning	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3C1b	Emissions from Biomass Burning	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3C1c	Emissions from Biomass Burning	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3C1d	Emissions from Biomass Burning	CH_4	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
4A	Solid waste disposal on land	CH_4	33.561	68.536	0.66	0.29	71.76%	0.932%	1.268%	20.447%	4.197%
4D1	Domestic Wastewater handling	CH_4	0.229	0.288	0.47	0.30	55.90%	0.000%	0.008%	0.062%	0.000%

4D2	Industrial Wastewater handling	CH_4	0.153	0.090	1.00	0.30	104.40%	0.000%	0.015%	0.041%	0.000%
CH_4 Total			61.133	86.384				9.739%			
1A1ai	Electricity generation	N_2O	0.477	0.648	0.05	1.00	100.12%	0.000%	0.043%	0.015%	0.000%
1A1ci	Manufacture of Solid Fuels	N_2O	0.777	0.273	1.00	1.00	141.42%	0.000%	0.322%	0.124%	0.001%
1A2	Manufacturing Industries and Construction	N_2O	0.032	0.047	0.20	1.00	101.98%	0.000%	0.002%	0.004%	0.000%
1A3aii	Domestic Aviation	N_2O	0.034	0.044	0.75	1.00	125.00%	0.000%	0.004%	0.015%	0.000%
1A3b	Road Transport	N_2O	4.320	7.201	0.20	1.00	101.98%	0.021%	0.039%	0.655%	0.004%
1A3dii	National Navigation	N_2O	0.029	0.030	0.05	1.00	100.12%	0.000%	0.005%	0.001%	0.000%
1A4a	Commercial/Institutional	N_2O	0.002	0.003	0.10	1.00	100.50%	0.000%	0.000%	0.000%	0.000%
1A4b	Residential	N_2O	1.254	0.717	0.10	1.00	100.50%	0.000%	0.431%	0.033%	0.002%
1A4ci	Agriculture / Forestry - stationary combustion	N_2O	0.000	0.017	0.10	1.00	100.50%	0.000%	0.005%	0.001%	0.000%
1A4cii	Agriculture / Forestry - mobile combustion	N_2O	0.000	0.000	0.10	1.00	100.50%	0.000%	0.000%	0.000%	0.000%
1B1ci	Charcoal and biochar production	N_2O	0.253	0.089	1.00	1.00	141.42%	0.000%	0.105%	0.040%	0.000%
1B2av	Distribution of Oil Products	N_2O	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
1B2bv	Distribution of Gas Products	N_2O	0.000	0.000	1.00	1.00	141.42%	0.000%	0.000%	0.000%	0.000%
2B2	Nitric Acid Production	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2B3	Adipic Acid Production	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%

2B4	Caprolactam, Glyoxal and Glyoxylic Acid Production	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2G3a	Medical Applications	N_2O	0.449	2.290	0.05	0.02	5.39%	0.000%	0.010%	0.052%	0.000%
3A2ai	Manure Management	N_2O	0.000	0.000	0.25	1.00	103.08%	0.000%	0.000%	0.000%	0.000%
3A2aii	Manure Management	N_2O	0.000	0.000	0.25	1.00	103.08%	0.000%	0.000%	0.000%	0.000%
3A2c	Manure Management	N_2O	0.880	0.380	0.22	1.00	102.47%	0.000%	0.342%	0.039%	0.001%
3A2d	Manure Management	N_2O	1.010	0.761	0.22	1.00	102.47%	0.000%	0.288%	0.077%	0.001%
3A2e	Manure Management	N_2O	0.000	0.000	0.00	1.00	100.00%	0.000%	0.000%	0.000%	0.000%
3A2f	Manure Management	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3A2h	Manure Management	N_2O	1.836	5.480	0.22	1.00	102.47%	0.012%	0.795%	0.558%	0.009%
3A2i	Manure Management	N_2O	3.370	3.233	0.41	2.00	204.21%	0.017%	1.473%	0.606%	0.025%
3C1a	Emissions from Biomass Burning	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3C1b	Emissions from Biomass Burning	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3C1c	Emissions from Biomass Burning	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3C1d	Emissions from Biomass Burning	N_2O	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
3C6	Manure Management	N_2O	0.601	1.140	0.92	1.00	135.82%	0.001%	0.050%	0.477%	0.002%
3C4	Direct N_2O MS	N_2O	6.549	5.365	1.69	4.00	434.42%	0.209%	6.907%	4.136%	0.648%
3C5	Indirect N_2O MS	N_2O	1.901	1.676	3.53	2.00	405.79%	0.018%	0.926%	2.693%	0.081%
4B1	Composting	N_2O		0.000	0.50	1.00	111.80%	0.000%	0.000%	0.000%	0.000%
N_2O Total			23.774	29.394				5.277%			
2B9	Fluorochemical Production	HFC	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%

2F2	Foam Blowing Agents	HFC	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2F3	Fire Protection	HFC	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2F4	Aerosols	HFC	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2F5	Solvents	HFC	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2F6	Other Applications (please specify)	HFC	0.000	0.000	0.00	0.00	0.00%	0.000%	0.000%	0.000%	0.000%
2F1a	Refrigeration and Stationary Air Conditioning	HFC	4.709	54.752	0.30	1.01	105.79%	1.293%	15.349%	7.473%	2.914%
2F1b	Mobile Air Conditioning	HFC	2.545	17.681	0.30	1.80	182.43%	0.401%	7.820%	2.413%	0.670%
HFC Total			7.254	72.433				13.015%			
Total GHGs			310.840	509.425	% Uncertainty in total inventory:			23.73%	% Trend Uncertainty:		41.35%

Annex III Method Statements

This section provides the method statements for all sectors. These method statements provide detailed information on the methodology applied, data sources used, QA/QC, recalculations, improvements, uncertainties and verification undertaken in the 2020 GHG inventory. The method summary tables, provided at the start of each sectoral chapter (**Chapters 3 - 7**), provide a mapping between the IPCC codes and the method statements, each method statement also lists the relevant categories.

Method Statements E1 Electricity Generation

E1: Electricity Generation

Relevant Categories

1A1ai Electricity generation

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

Diesel, Firewood

Background

The electricity generation market in Saint Lucia is operated by a single electricity provider, from a centralised generation station. Activity data is readily available on the diesel consumed at the generator. Default Tier 1 emission factors are used in the absence of better information on the typical emission profile for the fuel consumed.

Data sources

Activity data:
2000 – 2018 (diesel): Saint Lucia Electricity Services (LUCELEC) annual reports
2000 – 2009 (firewood): Saint Lucia Energy Balances
2010 – 2012 (firewood): Saint Lucia Energy Balances compiled by OLADE
2013 – 2018 (firewood): Extrapolated activity data, using changes in electricity generation over this period as a proxy for the change in firewood activity data

Method approach

1A1ai: Tier 1, 2006 IPCC Guidelines approach

Method Changes

N

Assumptions & observations

Only data on the diesel consumed by the generation station was provided, and so it is assumed that the trend in firewood use as a supplementary fuel is proportional to the trends in diesel consumption in years where no energy balance is available. In other words, it is assumed the fuel mix remains constant between 2010 and 2018.

Recalculation

Y

Recalculation justification & summary of change

Overall CO_2e emissions have not been recalculated significantly, but larger changes exist in 2010. This is due to updates to the time-series of activity data since 2000 which was provided by LUCELEC for this inventory, which was used in preference to historic energy balances. Changes are more significant for 2010 where CO_2 has recalculated by around 4%. CH_4 and N_2O

emissions have been recalculated more significantly due to using emission factors from the 2006 IPCC Guidelines rather than the Revised 1996 Guidelines.

Improvements

The priority planned improvement is to attain better data for the energy balance and to develop country-specific factors to enable a Tier 2 method for electricity generation to be applied.

QA/QC processes

Comparison of fuel consumption data as provided by LUCELEC and the estimates from the historic 2000-2012 energy balances illustrates good agreement between the datasets for 2000 and 2009. For 2010 – 2012 (coinciding with the publication by OLADE), estimates of diesel consumption are consistently 5% higher in the energy balances. The reason for this remains unclear. LUCELEC data has been preferred in this instance as it shows more consistency with the remainder with 2000 – 2009: the OLADE energy balance 2010 implies a 13% increase in diesel consumption between 2009 and 2010 that has not been validated.

Time series consistency issues

Activity data for firewood use in LUCELEC's electricity generation boilers is not available for 2012 onwards. In this case, it is assumed that the trends in use of firewood are proportional to those of diesel use.

Uncertainties

The key uncertainties associated with the emissions calculated under 1A1ai are the carbon content of the fuel used at LUCELEC is unknown and so country-specific estimates are not available for the inventory. In addition, without clear energy balance information from 2012 onwards it is not possible to verify and validate activity data reported by the power station.

Verification

Activity data as provided by LUCELEC is compared against activity data from the historic energy balances (2000 – 2012) when available. No such verification step is possible for firewood blending at the power station, or for later years of the inventory where published energy balance exists for St. Lucia.

Method Statements E2 Charcoal Production

E2: Charcoal Production

Relevant Categories

1A1ci Manufacture of Solid Fuels

1B1ci Charcoal and Biochar Production

Relevant Gases

CH_4, N_2O

Relevant fuels, activities

Firewood

Background

Charcoal production on Saint Lucia transforms firewood into charcoal fuel which is used in various sectors in Saint Lucia (most notably the domestic combustion sector in 1A4bi). Emissions of CH_4 and N_2O are estimated. CO_2 emissions are excluded as they are biogenic in origin.

Data sources

2000 – 2009: Saint Lucia Energy Balances

2010 – 2012: Saint Lucia Energy Balances compiled by OLADE

2012 – 2018: Activity is extrapolated on the basis of proxies in a derived energy balance. Activity for charcoal production is more specifically extrapolated on the trends in population in Saint Lucia (World Bank data)

Method approach

1A1ci: Tier 1, 2006 IPCC Guidelines approach

1B1ci: Tier 1, 2019 refinements to the 2006 IPCC Guidelines

Method Changes

Y – Estimates for charcoal production are made for the first time in this inventory submission.

Assumptions & observations

The primary assumption in the estimate of emissions from charcoal production is that the growth in activity since 2012 (the most recent year for which energy balance data is available) can be approximated by changes in population. In addition, it is not known whether lignite briquettes are added to the output charcoal. The production of lignite briquettes does not occur on Saint Lucia so it is assumed that this does not occur.

Recalculation

N

Recalculation justification & summary of change

Estimates of emissions from charcoal production are not specifically estimated in previous inventories so recalculation comparison not available for either 1A1ci or 1B1b.

Improvements

Estimates of emissions from charcoal production are made for the first time in this submission. Combustion emissions follows a 2006 IPCC Guidelines Tier 1 method, whilst fugitive emissions (1B1b) are produced using the Tier 1 methods from the 2019 refinement to the 2006 IPCC Guidelines.

QA/QC processes

No sector-specific QA/QC processes were utilised due to a lack of alternative datasets.

Time series consistency issues

No activity data exists for the amount of charcoal produced, or the amount of firewood used in its production since 2012. In the absence of better information, it has been assumed that activity growth since 2012 is proportional by changes in population.

Uncertainties

No activity data is available since 2012. In addition, as the process uses biogenic material only, output emissions are strongly influenced by the uncertainties associated with the use of Tier 1 emission factors from IPCC guidance.

Verification

No verification steps have been possible due to the paucity of data (activity- or emission factor-based) in this sector.

Method Statements E3 Industry and Manufacturing

E3: Industry and Manufacturing

Relevant Categories

1A2e Food Processing, Beverages and Tobacco

1A2m Non-specified industry

Note that in the absence of information which would allow for the disaggregation of emissions into individual 1A2 subcategories, all emissions are reported under 1A2.

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

Diesel, gasoline, kerosene, charcoal, LPG, waste oils

Background

This method statement includes emissions from the industry and manufacturing sector in the use of diesel, gasoline, kerosene, charcoal, LPG and waste oils. There is generally a lack of data collection in this category and therefore most of the data was extrapolated based on GDP trends. Note charcoal emissions are excluded for CO_2 as they are biogenic in origin.

Data sources

Activity data:

2000-2010: Saint Lucia Energy Balances

2010-2012: Saint Lucia Energy Balance completed by OLADE

2013-2018: Activity data is extrapolated based on proxy information in a derived energy balance. Activity in this sector is based on the trends in GDP for Saint Lucia

2010-2019: Activity data from Saint Lucia Distillery on waste oil use is available.

Emission factor:

Tier 1 defaults from the 2006 IPCC Guidelines

Method approach

Tier 1, 2006 IPCC Guidelines

Method Changes

N

Assumptions & observations

It is assumed that GDP trends in Saint Lucia is a suitable proxy for the extrapolation data for this sector from 2012 (the most recent year for which energy balance data is available).

Recalculation

Y

Recalculation justification & summary of change

Recalculations are done due to the use of 2006 IPCC Guidelines when compared to the revised 1996 IPCC guidelines for the last inventory.

The recalculations for CO_2 are 7% for National Communication Inventory for 2000, 1% for 2005 and 4% for 2010. The 2000 recalculation is due to the assumption that the lubricant use in this year of the energy balance is reallocated to 2D1 in this submission of the inventory. The 2010 recalculation is due to the inclusion of waste oil combustion at Saint Lucia Distillery and the associated CO_2 emissions.

There are larger recalculations for CH_4 and N_2O emissions due to the use of emission factors from the 2006 IPCC Guidelines rather than the Revised 1996 IPCC Guidelines.

Improvements

The emissions are now reported as a time-series from 2000 – 2018. Waste oil emissions estimates are included in the inventory for the first time.

QA/QC processes

Standard QA/QC procedures have been undertaken on emissions calculations as outlined in the QA/QC plan. Limitations on data availability for this sector precludes many additional QA/QC processes that would be beneficial.

Time series consistency issues

Limited activity data from 2013-2018 for the manufacture and industry sector. Extrapolation using GDP trends in Saint Lucia to estimate activity across the years. In addition, waste oil activity data is not available from Saint Lucia Distillery prior to 2010 but this is a priority for improvement in future years.

Uncertainties

The key uncertainty with the time-series is whether the methods used to extrapolate activity data from 2013-2018 are representative of the actual change in emissions from the sector. There is normally uncertainty associated with the extrapolations themselves, and uncertainty in whether the methodologies used for the extrapolation are time-series consistent.

Verification

No category-specific verification is possible due to lack of data against which to compare emissions outputs against.

Method Statements E4 Aviation

E4: Aviation

Relevant Categories

1A3ai International Aviation

1A3aii Domestic Aviation

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

Aviation Gasoline, Jet Kerosene

Background

This method statement covers the methodology of emissions from all air transport in Saint Lucia, including both domestic and international flights. Emissions are calculated on the basis of sector-wide fuel consumption.

Data sources

2000 – 2009: Saint Lucia Energy Balances

2010 – 2012: Saint Lucia Energy Balances compiled by OLADE

2013 – 2018: No activity data exists for this time-period. Instead, activity data is extrapolated using the trends in the number of flights since 2012 per year, data published by the Central Statistical Office of Saint Lucia.

Method approach

Tier 1, 2006 IPCC Guidelines. The methodology uses a simple fuel consumption x emission factor approach.

Method Changes

N

Assumptions & observations

It is assumed that the number of flights (domestic + international) in total is a suitable proxy for changes in both domestic and international aviation activity. No data is available which indicates the number of domestic flights or the number of international flights separately to further refine this assumption. This assumption therefore implies that the proportion of fuel consumption which is used for domestic air transport does not change between 2012 and 2018.

One additional assumption is the applicability of the default emission factors of CH_4 and N_2O for domestic aviation. Transfers between Saint Lucia's international airports are often serviced by helicopters. Turboprop engines might be expected to have significantly different emission factors to those in the 2006 IPCC Guidelines which are more relevant to conventional aircraft jet engines. Without more information on the aircraft type and the number of LTO cycles and flights for each, it is not possible to verify these emissions estimates with an alternative approach.

Recalculation

Y

Recalculation justification & summary of change

As emissions are now disaggregated by domestic and international components, there are recalculations to 1A3aii Domestic Aviation in particular, whilst international aviation emissions have been reduced to offset. The domestic aviation emissions are estimated in this inventory to represent the direct transfers (typically by helicopter) between the two international airports in Saint Lucia.

Improvements

No sector-specific improvements are currently planned.

QA/QC processes

Standard QA/QC procedures have been undertaken on emissions calculations as outlined in the QA/QC plan and Table 6.1 of Vol 1 Ch 6 2006 IPCC Guidelines. In addition, comparisons are made against other national inventories to ensure the fuel use per capita are in the same order of magnitude and so comparable.

Time series consistency issues

No activity data is available from 2013-18. Extrapolations using the growth in the number of flights in Saint Lucia is used to estimate activity across these years.

Uncertainties

The key uncertainty with the time-series is whether the methods used to extrapolate activity data from 2013-2018 are representative of the actual change in emissions from the sector. Indeed, the 2000 – 2012 energy balance is believed to have been calculated with similar extrapolations / interpolations for many years. There is therefore uncertainty associated with the extrapolations themselves, and uncertainty in whether the methodologies used for the extrapolation are time-series consistent.

Verification

No category-specific validation is possible due to lack of data against which to compare emissions outputs against. Fuel use per capita is compared against the activity data from Dominica for domestic travel to verify the order of magnitude of activity data, and therefore emissions as both using IPCC default emission factors.

Method Statements E5 Road Transport

E5: Road Transport

Relevant Categories

1A3b Road Transportation

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

Gasoline, Diesel

Background

This method statement includes emissions from all modes of road transportation (motorcycles, cars, LGVs, and HGVs). Emissions cannot be disaggregated into mode-specific estimates due to a lack of data on fleet composition and dynamics. Emissions from 1A3e – Other Transport are included within the estimates for 1A3b as there is no way to disaggregate further.

Data sources

Activity data:

2000 – 2009: Saint Lucia Energy Balances

2010 – 2012: Saint Lucia Energy Balances compiled by OLADE

2013 – 2018: Activity data is extrapolated on the basis of proxy information. More specifically, it is based on growth in the number of vehicles on Saint Lucia

Emission factors:

Tier 1 defaults from the 2006 IPCC Guidelines

Method approach

Tier 1, 2006 IPCC Guidelines. Fuel consumption not available on a vehicle type-specific basis.

Method Changes

N

Assumptions & observations

It is assumed that the number of road vehicles in Saint Lucia is a suitable proxy for extrapolating the growth in activity from this sector. This is equivalent to assuming that the average fuel consumed per vehicle has not changed between 2012 and 2018. It is understood that this may not be the case as imports of more fuel-efficient vehicles from Japanese manufacturers in recent years, but a lack of additional data precludes further analysis.

Recalculation

Y

Recalculation justification & summary of change

While fuel consumption has not changed, and so CO_2 emissions estimates are similar, different emission factors have been used for CH_4 and N_2O emissions. In the 3rd National Communication, default emission factors from the Revised 1996 IPCC Guidelines were used, whilst in this submission, these factors have been updated to 2006 IPCC Guidelines.

Improvements

No improvements are currently planned for this sector.

QA/QC processes

Comparisons Standard QA/QC procedures have been undertaken on emissions calculations. In addition, comparisons are made against other national inventories to ensure the emissions per capita are in the same order of magnitude and so comparable.

Time series consistency issues

No activity data is available from 2013-18. Extrapolations using the growth in the number of vehicles in Saint Lucia is used to estimate activity across these years

Uncertainties

The key uncertainty with the time-series is whether the methods used to extrapolate activity data from 2013-2018 are representative of the actual change in emissions from the sector. Indeed, the 2000 – 2012 energy balance is believed to have been calculated with similar extrapolations / interpolations for many years. There is therefore uncertainty associated with the extrapolations themselves, and uncertainty in whether the methodologies used for the extrapolation are time-series consistent.

Without additional information on fleet composition to verify the use of default emission factors, the uncertainty associated with the use of default CH_4 and N_2O emission factors has a not insignificant impact on the overall uncertainty from the transport sector.

Verification

No category-specific validation is possible due to lack of data against which to compare emissions outputs against. Emissions per capita against other national inventories from Caribbean islands where information is available in National Communications or Biennial Update Reporting (Dominica, Jamaica) indicate that the inventories are comparable

Method Statements E6 Shipping

E6: Shipping

Relevant Categories

1A3di International Water-borne Navigation (International Bunkers)

1A3dii Domestic Water-borne Navigation

1A4ciii Fishing (mobile combustion)

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

Diesel

Background

Emissions estimates from shipping categories is based on fuel consumption data and the application of default emission factors. Activity data is not available at a more disaggregated level, meaning that emissions from fishing vessel activity is included within the estimates for domestic water-borne navigation ('IE').

Data sources

Activity data:

2000 – 2009: Saint Lucia Energy Balances

2010 – 2012: Saint Lucia Energy Balances compiled by OLADE

2013 – 2018: No activity data is available for vessel movements. Without additional information, or the identification of a suitable proxy, it is assumed that the activity consumed remains constant for 1A3di and 1A3dii from 2012 – 2018.

Emissions factors:

Tier 1 defaults from 2006 IPCC Guidelines

Method approach

Tier 1, 2006 IPCC Guidelines. The methodology uses a simple fuel consumption x emission factor approach.

Method Changes

N

Assumptions & observations

2000 – 2001: It is noted that in the international bunkers time-series there is a major drop in activity data between 2000 and 2001. It is known that this marks the end of a rapid decline in the banana industry in Saint Lucia. It is unclear, however, how much of the reduction in activity between these years can be attributed to this decline, and how much is attributable to changes in data collection methodology.

2013 – 2018: Without additional information, or the identification of a suitable proxy, it is assumed that the activity consumed remains constant for 1A3di and 1A3dii.

Recalculation

Y

Recalculation justification & summary of change

Whilst recalculations to CO_2 are more limited, there are larger recalculations to CH_4 and N_2O emissions when compared to the 3rd National Communication inventories for 2000, 2005, and 2010. This is the result of the use of 2006 IPCC Guidelines Tier 1 default emission factors in this inventory, whilst the previous versions of the inventory used default factors from the Revised 1996 IPCC Guidelines.

Improvements

No sector-specific improvements are currently planned.

QA/QC processes

Standard QA/QC procedures have been undertaken on emissions calculations as outlined in the QA/QC plan and Table 6.1 of Vol 1 Ch 6 2006 IPCC Guidelines. Limitations on data availability for this sector precludes many additional QA/QC processes that would be beneficial for shipping estimates.

Time series consistency issues

2000 – 2001: It is noted that in the international bunkers time-series there is a major drop in activity data between 2000 and 2001. It is known that this marks the end of a rapid decline in the banana industry in Saint Lucia. It is unclear, however, how much of the reduction in activity between these years can be attributed to this decline, and how much is attributable to changes in data collection methodology.

2013 – 2018: No data is available for activity between the years 2013 and 2018 so energy demand is assumed constant between years.

Uncertainties

Major uncertainties exist with the time-series of activity data. A full time-series of fuel used in the whole shipping sector is not available meaning extrapolations have been required in order to estimate a full time-series of emissions, as outlined elsewhere in this method statement. Additionally, the split of fuel use between international and domestic fuel use is unknown for many years.

Verification

Comparison of emissions estimates against other island states in the Caribbean is not possible on most occasions as published National Communications or Biennial Update Reports tend not to disclose emission data for 1A3d specifically, grouping emissions into "domestic transport" for which road transport would be expected to form the predominant portion. Emissions from 1A3di and 1A3dii therefore have not been compared to other national inventories with similar expected levels of vessel activity and purpose.

Method Statements E7 Commercial/Institutional

E7: Commercial/Institutional

Relevant Categories

1A4a Commercial/Institutional

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

LPG

Background

This method statement includes emissions from the commercial sector in the use of LPG. There is generally a lack of data collection in this category and therefore most of the data was extrapolated based on GDP. The major use of fuel in the commercial sector in Saint Lucia is LPG.

Data sources

Activity data:

2000-2010: Saint Lucia Energy Balances

2010-2012: Saint Lucia Energy Balance completed by OLADE

2013-2018: Activity data is extrapolated based on proxy information in a derived energy balance. Activity in the commercial/institutional sector is based on the trends in GDP for Saint Lucia

Emission factor:

Tier 1 defaults from the 2006 IPCC Guidelines

Method approach

Tier 1, 2006 IPCC Guidelines

Method Changes

N

Assumptions & observations

It is assumed that GDP trends in Saint Lucia is a suitable proxy for the extrapolation of data for this sector from 2012 (the most recent year for which energy balance data is available).

Recalculation

Y

Recalculation justification & summary of change

Recalculations are done due to the use of 2006 IPCC Guidelines when compared to the revised 1996 IPCC guidelines for the last inventory.

Major recalculations in the year 2000 are present after addressing time-consistency issues in the energy balances between 2000 and 2001 in the original Saint Lucia energy balances. For 2005 and 2010, fuel consumption is aligned to the previous inventory.

The differences in for CH_4 and N_2O emissions when compared to all the previous National Communication Inventories represent significant variations. These deviations may be due to the difference in the emission factors and the GWP used in this inventory, 2006 IPCC Guidelines Tier 1 emission factors and 4th assessment report global warming potentials and other errors in numbers due to rounding off figures as the values in previous NC's are very small.

Improvements

Templates prepared to Improved data collection from LPG retailers but has not been completed in time for inclusion in the inventory.

QA/QC processes

Standard QA/QC procedures have been undertaken on emissions calculations as outlined in the QA/QC plan. Limitations on data availability for this sector precludes many additional QA/QC processes that would be beneficial .

Time series consistency issues

No activity data from 2013-2018. Extrapolation using GDP trends in Saint Lucia to estimate activity across the years. Extreme trends in the early part of the time-series, particular for 2000 – 2002 make the data particularly uncertain in this period and standard techniques have been applied to try and provide time-series consistency.

Uncertainties

The key uncertainty with the time-series is whether the methods used to extrapolate activity data from 2013-2018 are representative of the actual change in emissions from the sector. There is normally uncertainty associated with the extrapolations themselves, and uncertainty in whether the methodologies used for the extrapolation are time-series consistent.

Verification

No category-specific verification is possible due to lack of data against which to compare emissions outputs against.

Method Statements E8 Residential

E8: Residential

Relevant Categories

1A4b Residential

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

LPG, Charcoal, Kerosene, Firewood

Background

This method statement includes emissions from the residential sector in the use of LPG, firewood, charcoal, and kerosene. There is generally a lack of data collection in this category and therefore most of the data was extrapolated based on population trends. Emissions from kerosene not estimated after 2010, it is assumed that combustion of this fuel is low. The major use of fuel in the residential sector in Saint Lucia is LPG. Note that charcoal and firewood emissions are excluded for CO_2 as they are biogenic in origin.

Data sources

Activity data:

2000-2010: Saint Lucia Energy Balances

2010-2012: Saint Lucia Energy Balance completed by OLADE

2013-2018: Activity data is extrapolated based on proxy information in a derived energy balance. Activity in the residential sector is based on the trends in population for Saint Lucia (World Bank Data)

Emission factor:

Tier 1 defaults from the 2006 IPCC Guidelines

Method approach

Tier 1, 2006 IPCC Guidelines

Method Changes

N

Assumptions & observations

It is assumed that population trends in Saint Lucia is a suitable proxy for the extrapolation of data for this sector from 2012 (the most recent year for which energy balance data is available). Kerosene activity in the sector is not estimated from 2010, it is assumed that these values are extremely low.

Recalculation

Y

Recalculation justification & summary of change

Recalculations are done due to the use of 2006 IPCC Guidelines when compared to the revised 1996 IPCC guidelines for the last inventory.

The recalculations for CO_2 are within 4% for National Communication Inventory for 2000, 0% for National Communication Inventory for 2005 and 1% for National Communication Inventory for 2010 but there are larger recalculations to the CH_4 and N_2O emissions when compared to all the previous National Communication Inventories. This is due to the use of 2006 IPCC Guidelines emission factors in preference to the Revised 1996 Guidelines.

Improvements

Templates prepared to Improved data collection from LPG retailers but has not been completed.

QA/QC processes

Standard QA/QC procedures have been undertaken on emissions calculations as outlined in the QA/QC plan. Limitations on data availability for this sector precludes many additional QA/QC processes that would be beneficial.

Time series consistency issues

No activity data from 2013-2018. Extrapolation using population trends in Saint Lucia to estimate activity across the years. No activity data estimated for kerosene from 2011-2018.

Uncertainties

The key uncertainty with the time-series is whether the methods used to extrapolate activity data from 2013-2018 are representative of the actual change in emissions from the sector. There is normally uncertainty associated with the extrapolations themselves, and uncertainty in whether the methodologies used for the extrapolation are time-series consistent.

Verification

No category-specific verification is possible due to lack of data against which to compare emissions outputs against.

Method Statements E9 Agriculture and Forestry

E9: Agriculture and Forestry

Relevant Categories

1A4ci Stationary

1A4cii Off-road vehicles and other machinery

1A4ciii Fishing (mobile combustion)

Relevant Gases

CO_2, CH_4, N_2O

Relevant fuels, activities

Diesel

Background

This method statement includes emissions from the agriculture/forestry/fishing sector in the use of diesel. There is generally a lack of data collection in this category and therefore most of the data was extrapolated based on GDP trends.

Data sources

Activity data:

2000-2010: Saint Lucia Energy Balances

2010-2012: Saint Lucia Energy Balance completed by OLADE

2013-2018: Activity data is extrapolated based on proxy information in a derived energy balance. Activity in this sector is based on the trends in GDP for Saint Lucia

2010-2019: Activity data from the Fisheries Department on fuel consumed

Emission factor:

Tier 1 defaults from the 2006 IPCC Guidelines

Method approach

Tier 1, 2006 IPCC Guidelines

Method Changes

N

Assumptions & observations

It is assumed that GDP trends in Saint Lucia is a suitable proxy for the extrapolation data for this sector from 2012 (the most recent year for which energy balance data is available).

Recalculation

Y

Recalculation justification & summary of change

Recalculations are done due to the use of 2006 IPCC Guidelines when compared to the revised 1996 IPCC guidelines for the last inventory.

The recalculations for CO_2 are within 1 % for National Communication Inventory for 2000 2005 and 2010 but there are larger differences recalculations to the CH_4 and N_2O emissions when compared to all the previous National Communication Inventories. This may be due to the difference in the emission factors and the GWP used in this inventory, 2006 IPCC Guidelines Tier 1 emission factors and forth assessment report global warming potentials as well as rounding errors as the values are very small in previous NC's.

Improvements

No sector-specific improvements are currently planned.

QA/QC processes

Standard QA/QC procedures have been undertaken on emissions calculations as outlined in the QA/QC plan. Limitations on data availability for this sector precludes many additional QA/QC processes that would be beneficial.

Time series consistency issues

No activity data from 2013-2018 for agriculture and forestry and limited data for fisheries. Extrapolation using GDP trends in Saint Lucia to estimate activity across the years.

Uncertainties

The key uncertainty with the time-series is whether the methods used to extrapolate activity data from 2013-2018 are representative of the actual change in emissions from the sector. There is normally uncertainty associated with the extrapolations themselves, and uncertainty in whether the methodologies used for the extrapolation are time-series consistent.

Verification

No category-specific verification is possible due to lack of data against which to compare emissions outputs against.

Method Statements IP1 Non-Energy Products from Fuels and Solvent Use

IP1: Non-Energy Products from Fuels and Solvent Use (Precursor Emissions)

Relevant Categories

2D1 Lubricant Use, 2D3a Domestic Solvent Use, 2D3b Road paving with asphalt, 2D3d Coating applications, 2H2 Food and Beverages Industry

Relevant Gases

NMVOC

Relevant fuels, activities

- Non combustion emissions from the use of lubricants
- Emissions from Domestic Solvent use
- Emissions from asphalt use for road paving
- Emissions from coating applications
- Emissions from food and beverage production

Background

Direct emissions of NMVOC. Carbon emitted in the form of non-CO_2 species which oxidizes to CO_2 in the atmosphere. Amount of CO_2e estimated from the emissions of these non CO_2 gases using default factors from the IPCC 2019 Refinement (Volume 1, Chapter 7, Precursors, page 7.7).

Data sources

2D1

- Lubricant used for National navigation, domestic aviation and Road Transport.

Proxy taken from Energy Balance (See MS E1)

2D3a

- Population of Saint Lucia. Statistical Digest Saint Lucia: Estimated_mid_year_population_by_sex_and_five_year_ago_groups_annual_2011_to_2018 (2).xlsx Provided by Uranda via email 27/04/2020

2D3b

- Tonnes of Asphalt imported. Extrapolated data from Central Statistics Office (2014). Flow Statistics by Commodity. HS Codes 27149010, 27149020 and 27150090. Provided in a spreadsheet in email communication from Uranda Xavier November 20, 2014.
- Extrapolated using Economic and Social Review 2017, Ministry of Finance: Rate of growth GDP constant prices

2D3d

- Kg of paint imported categorised by application type. Extrapolated data from Customs and Excise Import data provided by Statistics Office. Email Communication from National Bureau of Statistics, Nov 20, 2014. Spreadsheet - Selected commodities kg 2001-2010.
- Extrapolated using Economic and Social Review 2017, Ministry of Finance: Rate of growth GDP constant prices

2H2

- Production data for Livestock, Fish landing, Rum obtained from the 2017, 2012, 2011, 2006, 2002 Statistical Digest of Saint Lucia
- Bread and Cakes, Beer and biscuits extrapolated using GDP on production data from the previous inventory.
  - Original data for Beer from: Windward & Leeward Brewery Ltd. (2014). Received in an email from Marvin Joseph 30 Oct 201
  - Original data for Bread and Cakes: Flour use data gathered by Ministry of Commerce. Email Communication from Ava Marius, December 1st, 2014. Conversions of flour to bread and cakes based on information collected from Ideal Bakery, Mannees Bakery, Cadassse Bakery, Central Bakery for year 2000 inventory.
- Extrapolated using Economic and Social Review 2017, Ministry of Finance: Rate of growth GDP constant prices

Method approach

2D1 – Tier 1:

Methods for calculating carbon dioxide (CO_2) emissions from non-energy product uses follow a basic formula, in which the emission factor is composed of a carbon content factor and a factor that represents the fraction of fossil fuel carbon that is Oxidised During Use (ODU). Default ODU factor applied.

Methodologies for the following sectors are taken from the relevant chapters of the EMEP1/EEA2 Emission Inventory Guidebook (and referenced from the 2006 IPCC Guidelines).

2D3a – Tier 1:

Default Tier 1 approach is to multiply the population of the country with a default emission factor. The Tier1 emission factors assume an average or typical range of products used in the domestic sector, and are representative for the domestic solvent use sector as a whole

2D3b – Tier 1:

Default Tier 1 approach is to multiply activity rate of road paving with asphalt with a default emission factor. The Tier 1 emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all sub-processes in the road paving process.

2D3d – Tier 2:

Tier 2 approach utilised as types of coating applications have been assumed which allow specific emission factors to be applied. These emission factors vary according to their VOC content. To apply the Tier2 approach, both the activity data and the emission factors need to be stratified according to the different processes that may occur in the country. This has been done for Saint Lucia using categorisation of paint types e.g. decorative coating application.

2H2 – Tier 2:

Tier 2 approach utilises stratified activity data and emission factor by type of food and beverage production. Default Tier 2 emission factors have been taken from the guidebook are product based e.g. beer, bread. The emission factors in this approach still will include all sub-processes within the industry between the feeding of raw materials until the produced food and beverages are shipped to customers.

Method Changes

Y

Assumptions & observations

2D1

- Total amount of lubricants lost during their use is assumed to be fully combusted and these emissions are directly reported as CO_2 emissions
- 90 % of the mass of lubricants is oil and 10 % is grease

2D3a

- Assumed an average or typical range of products used in the domestic sector and are representative for the domestic solvent use sector as a whole. The 'other countries' default from the GB has been used for Saint Lucia.

2D3b

- Assumed that amount of asphalt consumed is equal to the imports of bitumen to Saint Lucia. It is assumed that all bitumen imported is used for asphalt production for roadways
- Assume an averaged or typical technology and abatement implementation in the country

2D3d

- Assumed that import of coating applications is related to GDP change for extrapolation.
- Assumptions made on the use of different type of product based on type and quality of paint

2H2

- Assumed that production of food and beverages is relative to GDP change for extrapolation.
- 0.15 tonne of grain is required to produce 1 tonne of beer (Passant, 1993)
- Weight of slaughtered animals for meat production

Recalculation

Y

Recalculation justification & summary of change

Recalculations due to changes in emission factors between the 1996 and 2006 IPCC Guidelines. Lubricant use estimated for the first time.

Improvements

2D1

- Improvements to the energy balance (see MS E1)

2D3a

- Acquire data on import or production of solvents or solvent containing materials to categorise use of household products that contain NMVOCs. Would require a national survey to characterize solvent and product use in Saint Lucia

2D3b

- Acquire extended time series for asphalt import.
- Consult users of asphalt on technologies used to move to Tier 2 methodology. Need to stratify the road paving in the country to model the different product and process types occurring in the national road paving industry.

2D3d

- Acquire extended time series for coating applications import.
- Getting access to production data for all paint manufacturing activities would improve the emissions estimate for coating applications.

2H2

- Acquire extended time series for food and beverage production. Supported by MOUs with data providers.
- Tier 3 is not available for this source category.

QA/QC processes

No specific QA/QC processes. Checks documented within compilation files.

Time series consistency issues

Time series issues across sectors due to lack of activity data. Extrapolation has been used extensively using GDP growth factors.

Uncertainties

Activity data uncertainty range between 2 – 10% using expert judgement with reference to EMEP EEA Guidebook Chapter 5, Table 2-1 'Indicative error ranges in activity data for uncertainty analysis'.

Emission factor uncertainty obtained from EF 95 % percentile ranges given in the Guidebook.

Uncertainty particularly high for domestic solvent use as there are likely to be differences in the use of consumer products in Saint Lucia compared to the default given due to differences in car ownership, household size, wealth, lifestyle, product formulation, environmental awareness and climate (EMEP/ EEA).

Verification

No specific verification has been carried out. Recommendation to compare emission factors used by neighbouring countries for highly uncertain categories such as 2D3a.

Method Statements IP2 N_2O from Product Uses

IP2: N_2O from Product Uses

Relevant Categories

2G3a N_2O from Product Uses – Medical Applications

Relevant Gases

N_2O

Relevant fuels, activities

-

Background

Evaporative emissions of nitrous oxide (N_2O) from various types of product use e.g. Medical applications (anaesthetic use, analgesic use and veterinary use).

Data sources

Data from previous inventory report extrapolated.

Source: Customs and Excise Import data provided by Statistics Office. Email Communication from Uranda Xavier, Nov 20, 2014

Extrapolated using: Economic and Social Review 2017, Ministry of Finance: Rate of growth GDP constant prices

Method approach

IPCC Guidebook only presents one method for this source as there is no other reliable estimation method that the one utilised. Total emissions are equal to 50% of the quantity of N_2O supplied in the previous year and 50% of the N_2O supplied in the current year multiplied by an emission factor. The default EF is 1 as it is assumed that none of the administered N_2O is chemically changed by the body, and all is returned to the

Atmosphere.

Method Changes

Y

Assumptions & observations

- It has been assumed that the only source in Saint Lucia is in medical applications.
- Assumed that there is no production in Saint Lucia, so import data can be used as a proxy for use.

Recalculation

Y

Recalculation justification & summary of change

Slight recalculation due to consideration of stock change over the time series, by applying 50% assumption from the 2016 Guidebook as explained in the method approach.

Improvements

Acquire consistent time series by updating time series based on import data. Remove the need for extrapolation.

QA/QC processes

No specific QA/QC processes as only one data source so no need to compare activity data submitted by various manufacturers.

Time series consistency issues

Consistent time series obtained by extrapolating import data using GDP, however this adds to uncertainty in the estimates.

Uncertainties

Emission factor uncertainty is likely to be insignificant as there is no evidence that N_2O used for medical applications is absorbed by the human body.

Activity data uncertainty is high due to the incomplete time series and the need for extrapolation, however the data set itself is reliable as it is a central source which is considered complete for Saint Lucia.

Verification

Recommendation to compare N_2O emissions from types of product use included in the national
inventory with information submitted by other similar countries.

Method Statements IP3 Stationary air conditioning and refrigeration

IP3: Stationary air conditioning and refrigeration

Relevant Categories

2F1a Stationary air conditioning and refrigeration

Relevant Gases

HFC-125, HFC 134a, HFC-32

Relevant fuels, activities

In use and end of life emission of stationary air cooled air conditioners and refrigerators (all sizes).

Background

Emissions arise from leakage of the refrigerant used in refrigeration and air conditioning units. This refrigerant has a high global warming potential therefore; small quantities can have disproportionate impact on GHG emissions. Units include small residential refrigerators, residential and commercial air conditioning, large scale refrigeration systems in supermarkets. The larger systems require top up on a regular basis and consume bulk imported gases when serviced. Small residential refrigerators tend to have very low release rates. As more units are imported for use, the Bank of these gases contained in the units increases with releases assumed to occur continually.

Data sources

Number of imported equipment units - Central Statistical Office (2020).

Imports of refrigerators and air conditioners 2010-2019. Hector Hippolyte, Statistical Clerk. Provided in spreadsheets on 05-June 2020.

2006/2019 IPCC default factors on charge, leakage rate and lifetime (Table 7.9) with country specific assumptions and factoring.

Method approach

Tier 2a – Emission factor approach.

Imports of Refrigeration and air-conditioning (RAC) systems have been classified into three sub-application domains (Domestic refrigeration, medium and large commercial refrigeration, and residential and commercial A/C). Default values for charge, lifetime, operation emissions and end of life emission have been taken from Table 7.9 in Chapter 7 ODS Substitutes, 3 Industrial Processes and Product Use (IPCC, 2006). Gas charge of the stock across the time series is then determined by taking into consideration retirement age, and the default charge of a unit. In use leakage and end of life emission are then estimated based on the stock charge across the time series and an import weighted GWP factor applied to estimate CO_2eq emissions.

Method Changes

Y

Assumptions & observations

- All imported units use f-gases
- Charge, lifetime, leakage rates of units matches average 2006 IPCC defaults.
- Blends for different appliances proportionate to bulk imports

Recalculation

Y

Recalculation justification & summary of change

Update on time series and methodology compared to 2010 estimates which has integrated more national data to the estimates. Previous estimates used the IPCC 1996r and the potential emissions methodology which has been replaced in the 2006 IPCC Guidelines.

Improvements

Proposed/Planned:

- Better import and stock data for units in use and for bulk imports
- Servicing information
- Unit size and charge
- Improve the attribution of different gases rather than the bulk import GWP weighting applied to large refrigeration and stationary air conditioning.

QA/QC processes

Simple stock charge estimates compared to imported f-gas from 'Total gases imported Bulk'. Documented in compilation file.

Time series consistency issues

Extrapolation of import equipment statistics from 2001 to estimate import units between 1995-2000. Two activity data sources provided for 2001-2010 and 2011-2018 which suggest consistency issues. Validating the consistency between the developing of these data sets required.

Uncertainties

Activity data uncertainty estimated based on expert judgement – high uncertainty due to inconsistency between parts of the time series and no information about charge of units entering Saint Lucia.

Emission factor uncertainty derived as a product of uncertainty from default values assumed for Charge, Lifetime and Emission Factors for Refrigeration and Air-Conditioning Systems taken from Table 7.9 (V3, Chp7, IPCC, 2006).

Uncertainty estimates can be improved by seeking industrial advice on uncertainties to obtain expert judgement.

Verification

Comparison with bulk import data. Further verification processes as specified in the 2006 GB would require further data on the annual national HFC refrigerant market as declared from chemical manufacturers or the refrigerant distributors with the annual HFC refrigerant compared to the estimates derived by the Tier 2 method described here.

Method Statements IP4 Mobile air conditioning

IP4: Mobile air conditioning

Relevant Categories

2F1b Mobile air conditioning

Relevant Gases

HFC 134a (assumed only)

Relevant fuels, activities

In use, and disposal emissions. In-use emissions include re-filling of AC units.

Background

Mobile air conditioning emissions of fluorinated gases (F-gases) occur from leakages from air conditioning units in vehicles while in use and when disposed of. Saint Lucia imports all its road vehicles. Since the early 90s an increasing number have air conditioning using F- gases. When vehicles are serviced, their air conditioning units are regularly topped up using bulk imported gases. Bulk gas imports are tracked by customs and as part of national efforts to control ozone depleting substances and to implement the Kigali agreement. The bulk import data does not differentiate the use for mobile and other air conditioning units. It also does not indicate the level of stockpiling of bulk gases vs that use to replace leaked gases or input into new systems.

Data sources

Number of registered vehicles, Saint Lucia– Transport Division (2020). Vehicles by Type and Year 2000- 2018. Kora Francis, Chief Transport Officer (Ag.). Provided in a spreadsheet on 24-Apr. 2020.

Number of imported vehicles – Central Statistical Office & Customs and Excise Department.

Estimated number of imported AC units**

2006 IPCC (Table 7.9) with country specific assumptions and factoring

Method approach

The method used is an adapted 2006 IPCC tier 2A methodology. The model is based around statistics on the vehicle stock and assumptions about the percentage of air conditioning units installed, their f-gas charge (in kg) in that vehicle stock. Assumptions on the lifespan of vehicles also provides variables to determine when vehicles are scrapped and the resulting emissions from disposal. See below for details on assumptions. Vehicle registration and import data sourced from the Transport Division, Customs & Excise Department and Central Statistical Office was used as vehicle stock estimates. Vehicle registration data was provided as an average of three data sets used to verify total transport stock: Transport Division, Customs and Excise and Statistical Office. The percentage AC are based on Table 5: Estimated Consumption of HFC 134a in the MAC Sector Survey Report Final 18.7.2017. We have assumed that in 1995 there were zero AC units with F-gases growing to 90% by 2010 and remaining at 90% from then. The charge, in-use losses, losses during re-charge and lifetime of air-conditioning units are based on averages of 2006/2019 IPCC Table 7.9 ranges. We have assumed that there is no recovery of gases from scrapped systems.

There is no conclusive evidence that this 2a method is comparable with bulk statistics. (See QA/QC section).

Method Changes

Y

Assumptions & observations

- Average age of vehicles before scrappage = 16 years (2006/2019 IPCC Table 7.9 (average))
- AC charge = 1.25 kg (2006/2019 IPCC Table 7.9 (average))
- % AC in vehicles 0% in 1995 – 90% from 2010
- In use leakage = 15% per year (2006/2019 IPCC Table 7.9 (average))
- No recovery/recycling/destruction of gas on scrappage.

Recalculation

Y

Recalculation justification & summary of change

Previous estimates were f-gas potential based on bulk import information. These recalculations attempt to include a more accurately modelled estimate for actual releases using vehicle statistics and assumptions on leakage amounts using 2006/2019 IPCC defaults.

Currently the estimates are not comparable with previous inventory calculations which were based on estimates of potential emissions using the 1996 Guidebook.

Improvements

Improve the vehicle statistics, % AC, charge of AC, Scrappage rates, Data on AC gas, recovery/destruction/export

Reconciliation with imports: Improvements to the reconciliation of the bulk import s and their stockpiles and final usage would improve the estimates. Surveys on vehicle servicing and amounts of f-gas used would help provide a more accurate picture of emissions.

QA/QC processes

- Checking of trends for steady growth and plateauing as would be expected for these emissions.
- Could further look at implied emission factors comparing with other countries.
- Reconciliation of bottom up tier 2 estimates with bulk import information. However, bulk imports seem low and do not really account for the amount lost through the bottom up model. Further reconciliation work required through consultation with import data providers.

Time series consistency issues

Vehicle stock time series consistency fine but is 20% different to vehicle stock estimates from the ODS survey previously used in the inventory. Time series consistency issues with bulk import data, could reflect demand, and reality that Saint Lucia do not import a consistent amount of F-gas. However, this needs further verification.

Uncertainties

Key uncertainties are in the assumptions on % f-gases in air conditioning, their leakage rates and their charges. Currently default 2006 IPCC factors have been used from which uncertainties can be derived (see 2006 IPCC table 7.9).

Activity data uncertainty estimated based on expert judgement of variation in vehicle stock numbers from data sources and uncertainty in bulk import data time series.

Verification

Simple verification has been done for the estimates described in this method statement by comparing bulk import with bottom up estimates, however more consultation required with national estimates to reconcile this.

Vehicle stock data been verified through the involvement of several reporting organisations.

Method Statements A1 Enteric Fermentation

A1: Enteric Fermentation

Relevant Categories

Emissions calculated from Non-Dairy Cattle, Sheep, Goat and Swine. There is deemed to be no Dairy Cattle in Saint Lucia, and horses and mules and asses are Not Occurring.

Relevant Gases

CH_4

Relevant fuels, activities

Livestock population is the main activity data required for enteric fermentation. The unit is annual average population (AAP) heads per year for each subcategory. AAP is calculated:

Days alive * (number of animals produced annually/365)

Background

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 feed consumed. Ruminant livestock (e.g. cattle, sheep) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g. swine, horses).

Data sources

The data for 2000-2010 is from the Ministry of Agriculture and derived from Veterinary and Livestock Services Division Quarterly and Yearly Reports. Since the percentage of dairy cattle is not significant, the total cattle are entered as Non-Dairy Cattle. From 2011-2018, the time series has been extrapolated based on the percentage trend of the international data set from the UN's Food and Agriculture Organisation (FAO). We applied the percentage trend from the FAO statistics, to the activity data from the previous inventory.

Method approach

The approach taken is a Tier 1 approach from the 2006 IPCC Guidelines (V4, Chp10, equation 10.19).

Default emission factors were used for the calculation, taken from tables 10.11 (cattle) and 10.10 (other livestock). The emission factor used from Table 10.10 was for the 'developing country', and from Table 10.11 was 'Latin America'.

Global warming potentials applied were from the IPCC second assessment report.

Method Changes

Previously the 1996 IPCC guidelines and subsequent emission factors were used.

Assumptions & observations

Livestock assumptions:

- Typical animal masses are assumed to be the same as the 2006 IPCC defaults.
- Trend analysis from the FAO statistics was used for extrapolating livestock population from 2011-2018 for all subcategories.
- There are unusually no estimates for Dairy Cattle as there was such a small percentage.

Parameter assumptions:

- Saint Lucia was assumed to share the regional characteristics of a 'developing country' when choosing a default emission factor for all livestock categories (other than Cattle).
- Saint Lucia was assumed to share the regional characterises of 'Latin America' when choosing the default emission factor for cattle.

Recalculation

Recalculation in emissions from Non-Dairy Cattle

Recalculation justification & summary of change

There are small recalculations, as emissions increased for 2000, 2005 and 2010 (0.056 recalculations), based on updating the emission factor from the 1996 to the 2006 IPCC Guidelines, and changing the regional characteristics assumed from North America (as in the previous inventory) to Latin America.

Improvements

- Develop country specific emission factors.
- Update the time series with new livestock data, particularly after 2010 where the inventory currently extrapolates.
- Collect more data on livestock characteristics which could lead to a Tier 2 methodology, such as feed intake, gross energy usage, average animal mass etc.

QA/QC processes

- Data compilation spreadsheet and data collection template were QA/QC by two agricultural experts in the Aether team.
- Sources of data, emission factors, other factors and constants were all referenced.
- Comments when compiling and checking were left directly in the compilation files with an initial of who left the comment and a date of when it was left.

- All formulas were checked and QA'd, in order to ensure the correct calculation was taking place and the correct information was being read from the files.

Time series consistency issues

Time series appears to be consistent

Uncertainties

- Uncertainty analysis was conducted based on expert judgement. These uncertainties included:
- Emission factors since mostly 2006 IPCC defaults were used as there were no country-specific emission factor studies
- Extrapolation of the livestock numbers after 2010

Verification

FAO data and the previous inventory were used for verification

Method Statements A2 Manure Management

A2: Manure Management

Relevant Categories

Emissions calculated from Non-Dairy Cattle, Sheep, Goat, Swine, Broilers and Laying Hens. There is deemed to be no Dairy Cattle in Saint Lucia, and horses and mules and asses are Not Occurring.

Relevant Gases

CH_4, N_2O

Relevant fuels, activities

Nitrogen excretion in manure, Manure management systems and livestock populations were all required in order to calculation emissions from manure management.

Background

Both methane and nitrous oxide are emitted from livestock manure management systems during the storage and treatment of manure. The amount of emissions will be dictated by the type of manure management system, the Nitrogen excretion rates of the animal, and the conditions under which the manure is treated, such as average temperature and region.

Data sources

The data for 2000-2010 is from the Ministry of Agriculture and derived from Veterinary and Livestock Services Division Quarterly and Yearly Reports. Since the percentage of dairy cattle is not significant, the total cattle are entered as Non-Dairy Cattle. From 2011-2018, the time series has been extrapolated based on the percentage trend of the international data set from the UN's Food and Agriculture Organisation (FAO). We applied the percentage trend from the FAO statistics, to the activity data from the previous inventory.

In the previous inventory, total poultry figures were provided. This was updated in this inventory, by applying the split of broilers and laying hens in the FAO statistics, directly to the activity data from Saint Lucia's previous inventory.

AWMS was based on data reported by Dr. George Joseph Chief Veterinary Officer for the year 2000 inventory.

Method approach

The approach taken is a Tier 1 approach from the 2006 IPCC Guidelines (V4, Chp10, equation 10.19).

Methane Emissions

For calculating methane emissions, default emission factors were used from Table 10.14 (Cattle) and Table 10.15 (Other livestock) in volume 4.

The temperature assumed was ‘Warm’ and the region assumed was ‘Latin America’ for Cattle and Swine, and ‘Developing Country’ for all other livestock types.

Nitrous Oxide Emissions

For calculating N¬¬2O emissions, Typical Animal Mass (previously not needed in the IPCC 1996 Guidelines) was taken from the defaults in the 2006 Guidelines, from Tables 10A-9, with the region assumed as ‘Latin America’ for cattle and swine, and ‘Developing Country’ for all other livestock types.

Fraction of Manure Nitrogen per AWMS was based on data reported by Dr. George Joseph Chief Veterinary Officer for the year 2000 inventory.

Nitrogen Excretion Rates were defaults from Table 10.19 where the region ‘Latin America’ was assumed. Fraction of Nitrogen lost from each Manure management system is taken from the 2006 IPCC Guidelines.

Method Changes

- Typical Animal Mass is now required for the Nitrogen excretion rate calculations whereas it was not in the 1996 IPCC Guidelines.
- Broilers and Laying Hens were split for the first time for this inventory, whereas it was total poultry previously.
- Previous 1996 IPCC default emission factors and calculations were used, these have been updated to include 2006 IPCC Guidelines.
- In the previous inventory, one of the AWMS was classified as ‘drylot/solid storage’, consistent with the 1996 IPCC Guidelines. These have since been updated in the 2006 IPCC Guidelines, where drylot and solid storage are both separate classifications. Based off the descriptions, we assigned the fraction of ‘drylot/solid storage’ simply to solid storage.

Assumptions & observations

Livestock assumptions:

- Typical animal masses are assumed to be the same as the 2006 IPCC defaults.
- Trend analysis from the FAO statistics was used for extrapolating livestock population from 2011-2018 for all subcategories.
- FAO statistics split of broilers and laying hens assumed to be the same for Saint Lucia

Parameter assumptions:

- Saint Lucia was assumed to share the regional characteristics of a ‘developing country’ when choosing a default emission factor for all livestock categories (other than Cattle).
- Saint Lucia was assumed to share the regional characterises of ‘Latin America’ when choosing the default emission factor for cattle.
- Average annual temperature assumed to be ‘warm’.

AWMS assumptions:

- AWMS and the fractions assumed to be the same across the time series.
- Assumed the ‘drylot/solid storage’ classification from the 1996 IPCC guidelines, to be just ‘solid storage’ in the 2006 guidelines.
- No default for solid storage for poultry, so assumed to be ‘Solid Storage’ with litter.

Recalculation

Recalculations in methane emissions from Non-dairy cattle, Goats, horses and swine (unable to determine recalculations in poultry as livestock now split by broilers and laying hens).

Recalculation justification & summary of change

- For non-dairy cattle, emissions changed by about 5%.
- For goats, emissions changed by about 1-2%.
- For horses, emissions changed by about 1-2%.
- For swine, emissions changed by about 1-2%.
- These recalculations are due to changes in the default emission factors

Improvements

- Develop country specific emission factors.

- Update the time series with new livestock data, particularly after 2010 where the inventory currently extrapolates.
- Collect more data on livestock characteristics which could lead to a Tier 2 methodology, such as feed intake, gross energy usage, average animal mass etc.
- Updated data on manure management systems and their fractions

QA/QC processes

- Data compilation spreadsheet and data collection template were QA/QC by two agricultural experts in the Aether team.
- Sources of data, emission factors, other factors and constants were all referenced.
- Comments when compiling and checking were left directly in the compilation files with an initial of who left the comment and a date of when it was left.
- All formulas were checked and QA'd, in order to ensure the correct calculation was taking place and the correct information was being read from the files.
- Validation workshop carried out.

Time series consistency issues

Time series appears to be consistent

Uncertainties

- Uncertainty analysis was conducted based on expert judgement. These uncertainties included:
- Emission factors since mostly 2006 IPCC defaults were used as there were no country-specific emission factor studies
- Extrapolation of the livestock numbers after 2010

Verification

FAO data and the previous inventory were used for verification

Method Statements A3 Direct N_2O from Managed Soils

A3: Direct N_2O from Managed Soils

Relevant Categories

3C4: 1. Synthetic fertilizer 2. Animal manure, compost, sewage sludge, 3. Crop residue 4. Changes to land use or management

Relevant Gases

N_2O, CO_2

Relevant fuels, activities

- Quantities of inorganic N fertilizer applied (ton/yr),
- Livestock population (AAP), manure management systems (Pastures/range/ paddock, solid storage, pit storage below animal confinement, anaerobic digester), proportion of compost applied (Ton/year), quantities of dung/urine deposited in the field (ton/year, litres/year)
- Cultivated area
- Acreage converted to Agricultural land

Background

Direct N_2O emissions are derived from applied synthetic fertilizer, animal manure, decomposition of crop residues and land use change or change in land management

Data sources

Synthetic fertilisers: Data on quantity of N applied for 2000-2010 taken from the previous inventory, originally supplied by the Ministry of Agriculture. 2011-2018 figures are extrapolated from the 2010 figures, using FAOSTAT estimates of percentage change between 2010 and 2018.

Animal manure applied to fields: The quantity of N applied to soils in animal manure (as fertiliser as deposited whilst grazing), is based on the livestock population and nitrogen excretion, subtracting N losses in manure management. See method statement "2_Manure Management" for further details of livestock population data sources and nitrogen excretion assumptions.

Quantity of limestone applied to soils: Local expert judgement

Crop residues: Crop production and harvested area estimates are taken from FAOSTAT (http://www.fao.org/faostat/en/#data), accessed 08/06/2020

Method approach

All emissions are estimated according to 2006 IPCC, tier1

2006 IPCC Guidelines (V4, Chp11). N_2O emissions from managed soils, and CO_2 emissions from lime and urea application. Section 11.2.

Global warming potentials applied were from the IPCC second assessment report.

Method Changes

The previous inventory was compiled using IPCC 1996 guidelines.

Assumptions & observations

Crop residue N input:

- This was calculated based on FAOSTAT crop production and area harvested data.
- Perennial crops were not included in the calculations.
- IPCC default parameters from Table 11.2 in Chapter 11 of the 2006 IPCC Guidelines for % dry matter in fresh yield, ratio of above ground dry matter to yield, ratio of below ground biomass to above ground residues and nitrogen content of residues were used for beans and pulses and tubers.
- However, other crop types could not be matched to the standard IPCC categories given in Table 11.2. Expert judgement was used to parameterise these crops, based where possible on that used in the Jamaican GHG inventory.
- Estimates of N applied in crop residues from the previous inventory were not used, as the methodology underlying these is not known.

Completeness:

- Emissions of CO_2 from application of urea is not estimated, due to lack of activity data on quantity applied
- Emissions from mineralisation of nitrogen following carbon stock change of soil organic matter on mineral soils is not estimated, due to insufficient data on carbon stock changes of soil organic matter.
- Emissions from cultivation of histosols are assumed not to occur.
- Application of sewage sludge to soils assumed not to occur, as according to communications with a local expert the local sewage treatment plant only occasionally produces sludge, and this is likely only used on gardens.
- Application of compost or other organic fertilisers to soils is not estimated, due to lack of activity data.

Recalculation

Yes, there are some recalculations for emissions from synthetic fertiliser, organic fertiliser (manure) and crop residues

Recalculation justification & summary of change

Synthetic fertiliser: small recalculations (-0.11) in this category due to updated values of synthetic fertilisers provided by FAO statistics and updated default emission factors.

Organic fertiliser (manure): large recalculations (-0.83) in this category due to updated value for manure applied to soil (due to updated N excretion rate defaults) and default emission factors for manure management (see Manure management method statement on changes to N excretion rate calculations).

Crop residues: large recalculations (-0.64) in this category due to updated total production statistics from FAO and updated default emission factors for Fraction of Nitrogen in Crops.

Improvements

- Need data on urea application, biomass burning and changes to land use or management sub-categories.
- A more complete time series of synthetic fertiliser application would also be beneficial to resolve the time series inconsistencies mentioned below.
- Develop country specific emission factors.
- Update the time series with new livestock data (for total manure applied to soils), particularly after 2010 where the inventory currently extrapolates.

QA/QC processes

- Data compilation spreadsheet and data collection template were QA/QC by two agricultural experts in the Aether team.
- Sources of data, emission factors, other factors and constants were all referenced.
- Comments when compiling and checking were left directly in the compilation files with an initial of who left the comment and a date of when it was left.
- All formulas were checked and QA'd, in order to ensure the correct calculation was taking place and the correct information was being read from the files.
- Validation workshop carried out

Time series consistency issues

The time series of synthetic fertiliser application could be significantly improved. At present, a static average value is reported for 2000-2009, followed by a marked jump in 2010. The time series 2011-2018 based on FAOSTAT estimates also shows high volatility.

Uncertainties

Uncertainty analysis was conducted based on expert judgement. These uncertainties included:

Emission factors since mostly 2006 IPCC defaults were used as there were no country-specific emission factor studies

Verification

FAO data and the previous inventory were used for verification

Method Statements A4 Indirect N_2O from Managed Soils

A4: Indirect N_2O from Managed Soils

Relevant Categories

3C5 Indirect N_2O emissions from managed soils

Relevant Gases

N_2O

Relevant fuels, activities

- Annual amount of inorganic N fertilizer applied, kg N yr^{-1}
- Annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}
- Annual amount of N in crop residues, kg N yr^{-1}
- Annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}

Background

Indirect emissions of N_2O take place through two pathways. The first is volatilisation of N as NH3 and oxides of N (NOx), and the deposition of these gases and their products NH4+ and

NO3- onto soils and the surface of lakes and other waters. The N may come from applied synthetic fertiliser and other agricultural fertilisers such as manure, urine and dung.

The second pathway is the leaching and runoff from land of N from synthetic and organic fertiliser additions, crop residues, mineralisation of N associated with loss of soil C in mineral and drained/managed organic soils, and urine and dung deposition from grazing animals.

Data sources

- Nitrogen volatilization
- Synthetic fertiliser applied was collected from FAO statistics (see Direct N_2O Managed Soils method statement for further details)
- Amount of organic fertiliser applied comes from the sum of manure applied to soils as fertiliser (using livestock values from previous inventory and extrapolated by FAO statistics, AWMS from the previous inventory, and updated 2006 IPCC Nitrogen excretion rate defaults)
- Indirect N_2O FracGasF and FracGasM emission factors taken from the 2006 IPCC Guidelines
- Nitrogen leaching and runoff
- Synthetic fertiliser applied was collected from FAO statistics (see Direct N_2O Managed Soils method statement for further details)
- Amount of organic fertiliser applied comes from the sum of manure applied to soils as fertiliser (using livestock values from previous inventory and extrapolated by FAO statistics, AWMS from the previous inventory, and updated 2006 IPCC Nitrogen excretion rate defaults)
- Crop production to estimate crop residues taken from FAO statistics (see Direct N_2O Managed Soils method statement for further details)
- FracLEACH and N leached defaults taken from the 2006 IPCC Guidelines

Method approach

The approach taken is a Tier 1 approach from the 2006 IPCC Guidelines (V4, Chp 11).

Method Changes

Updated methodology for calculating Nitrogen excretion rates (see Manure management method statement) which now includes average animal mass. This figure was used to calculate amount of organic fertilisers.

Previously 1996 IPCC default emission factors and calculations were used, these have been updated to include 2006 IPCC Guidelines.

Assumptions & observations

N input assumptions:

- The apparent consumption of synthetic fertilizer is derived from the difference between imports and exports within Saint Lucia
- Typical animal masses are assumed to be the same as the 2006 IPCC defaults. Manure management system assumed to be the same as those reported in 2019 Biennial Update Report.

Parameter assumptions:

- Fraction of synthetic fertiliser N that volatilises, and fraction of N that leaches are assumed to be the defaults in the 2006 IPCC Guidelines.

Recalculation

Y

Recalculation justification & summary of change

Nitrogen volatilization: relative recalculations across the time series (average of -44%) due to updated figures of inorganic fertiliser from FAO stats, updated indirect Fraction Gas defaults from the 2006 IPCC Guidelines, and updated organic fertiliser from manure.

Nitrogen leaching: large recalculations across the time series (average of 94%) due to updated FRACleach and nitrogen leached default emission factors, and updated organic fertiliser from manure and inorganic fertiliser statistics

Improvements

- Update the time series with new livestock data, particularly after 2010 where the inventory currently extrapolates.
- Collect more data on livestock characteristics which could lead to a Tier 2 methodology, such as feed intake, gross energy usage, average animal mass etc.
- Updated data on manure management systems and their fractions
- Updated data on synthetic fertiliser application
- Develop country specific emission factors.

QA/QC processes

- Data compilation spreadsheet and data collection template were QA/QC by two agricultural experts in the Aether team.
- Sources of data, emission factors, other factors and constants were all referenced.
- Comments when compiling and checking were left directly in the compilation files with an initial of who left the comment and a date of when it was left.
- All formulas were checked and QA'd, in order to ensure the correct calculation was taking place and the correct information was being read from the files.
- Validation workshop carried out.

Time series consistency issues

Time series appears to be consistent

Uncertainties

- Uncertainty analysis was conducted based on expert judgement and the 2006 IPCC Guidelines. These uncertainties included:
- Emission factors since mostly 2006 IPCC defaults were used as there were no country-specific emission factor studies
- Extrapolation of the livestock numbers after 2010

Verification

-

Method Statements A5 Indirect N_2O from Manure Management

A5: Indirect N_2O from Manure Management

Relevant Categories

3C6 Indirect N_2O emissions due to volatilization of N from manure management and indirect N_2O emissions due to leaching from manure management.

Relevant Gases

N_2O

Relevant fuels, activities

- Nitrogen volatilization
- This calculates the amount of Nitrogen in manure which is lost due to volatilisation. To calculate this, it requires activity data on:
- Number of heads of livestock per category
- Nitrogen excretion rates
- Fraction of total annual N excretion for each livestock category that is managed in the manure management system
- Percentage of managed manure N that volatises as Ammonia (NH3) and NOx
- Nitrogen leaching is not included as tier 1 approach is used

Background

Indirect N_2O emissions result from volatilize nitrogen losses that occur primarily in the forms of ammonia and NOx. The fraction of excreted organic nitrogen that is mineralised to ammonia nitrogen during manure collection and storage depends primarily on time and also, temperature. Nitrogen is also lost through runoff and leaching into soils from the solid storage of manure.

Data sources

Nitrogen volatilization

Livestock data: The data for 2000-2010 is from the Ministry of Agriculture and derived from Veterinary and Livestock Services Division Quarterly and Yearly Reports. Since the percentage of dairy cattle is not significant, the total cattle are entered as Non-Dairy Cattle. From 2011-2018, the time series has been extrapolated based on the percentage trend of the international data set from the UN's Food and Agriculture Organisation (FAO). We applied the percentage trend from the FAO statistics, to the activity data from the previous inventory.

Animal waste systems: AWMS was based on data reported by Dr. George Joseph Chief Veterinary Officer for the year 2000 inventory.

Nex rate are estimated based on default values in the IPCC (2006)

FracGASMS (percentage of managed manure nitrogen for a livestock category that volatilises in the manure system)

Emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water taken from the 2006 IPCC Guidelines

Method approach

The approach taken is a Tier 1 approach from the 2006 IPCC Guidelines (V4, Chp 10).

Nitrogen volatilization:

- For calculating N_2O emissions, Typical Animal Mass (previously not needed in the IPCC 1996 Guidelines) was taken from the defaults in the 2006 Guidelines, from Tables 10A-9, with the region assumed as 'Latin America' for cattle and swine, and 'Developing Country' for all other livestock types.
- Fraction of Manure Nitrogen per AWMS was based on data reported by Dr. George Joseph Chief Veterinary Officer for the year 2000 inventory.
- Nitrogen Excretion Rates were defaults from Table 10.19 where the region 'Latin America' was assumed. Fraction of Nitrogen lost from each Manure management system is taken from the 2006 IPCC Guidelines.
- FracGasMS (percentage of managed manure nitrogen for a livestock category that volatilisations in the manure management system)
- Emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water taken from the IPCC Guidelines

Method Changes

- Typical Animal Mass is now required for the Nitrogen excretion rate calculations whereas it was not in the 1996 IPCC Guidelines.
- Broilers and Laying Hens were split for the first time for this inventory, whereas it was total poultry previously.
- Previously 1996 IPCC default emission factors and calculations were used, these have been updated to include 2006 IPCC Guidelines.
- In the previous inventory, one of the AWMS was classified as 'drylot/solid storage', consistent with the 1996 IPCC Guidelines. These have since been updated in the 2006 IPCC Guidelines, where drylot and solid storage are both separate classifications. Based off the descriptions, we assigned the fraction of 'drylot/solid storage' simply to solid storage.

Assumptions & observations

Livestock assumptions:

- Typical animal masses are assumed to be the same as the 2006 IPCC defaults.

- Trend analysis from the FAO statistics was used for extrapolating livestock population from 2011-2018 for all subcategories.
- FAO statistics split of broilers and laying hens are assumed

Parameter assumptions:

- Saint Lucia was assumed to share the regional characteristics of a ‘developing country’ when choosing a default emission factor for all livestock categories (other than Cattle).
- Saint Lucia was assumed to share the regional characterises of ‘Latin America’ when choosing the default emission factor for cattle.
- Average annual temperature assumed to be ‘warm’.
- Emission factor for N_2O emissions from nitrogen leaching and runoff taken from the IPCC guidelines
- FracGasMS (percentage of managed manure nitrogen for a livestock category that volatilisations in the manure management system)
- Emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water taken from the IPCC Guidelines

AWMS assumptions:

- AWMS and the fractions assumed to be the same across the time series.
- Assumed the ‘drylot/solid storage’ classification from the 1996 IPCC guidelines, to be just ‘solid storage’ in the 2006 guidelines.
- FRACGas defaults from the 2006 IPCC Guidelines were used. There is no FRACGas default for poultry and solid storage, so assumed to be ‘Solid storage with poultry litter’

Recalculation

Y

Recalculation justification & summary of change

Nitrogen volatilization: relative recalculations across the whole time series (average of -44%) due to updated figures of inorganic fertiliser from FAO stats, updated indirect Fraction Gas defaults from the 2006 IPCC Guidelines, and updated organic fertiliser from manure.

Improvements

Update the time series with new livestock data, particularly after 2010 where the inventory currently extrapolates.

Collect more data on livestock characteristics which could lead to a Tier 2 methodology, such as feed intake, gross energy usage, average animal mass etc.

Develop country specific emission factors.

QA/QC processes

Data compilation spreadsheet and data collection template were QA/QC by two agricultural experts in the Aether team.

Sources of data, emission factors, other factors and constants were all referenced.

Comments when compiling and checking were left directly in the compilation files with an initial of who left the comment and a date of when it was left.

All formulas were checked and QA’d, in order to ensure the correct calculation was taking place and the correct information was being read from the files.

Validation workshop carried out.

Time series consistency issues

Time series appears to be consistent

Uncertainties

Uncertainty analysis was conducted based on expert judgement and IPCC guidance. These uncertainties included:

Emission factors since mostly 2006 IPCC defaults were used as there were no country-specific emission factor studies

Extrapolation of the livestock numbers after 2010

Verification

-

Method Statements A6 CO_2 from Liming Application

A6: CO_2 from Liming Application

Relevant Categories

3C2 CO_2 emissions from liming application

Relevant Gases

CO_2

Relevant fuels, activities

Amount of calcic limestone or dolomite applied

Background

Liming is used to reduce the acidity in soils and to improve plant growth in managed systems. By adding carbonates to the soils in the form of lime (e.g. calcic limestone or dolomite), it leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate, which evolves into CO_2 and water

Data sources

The amount of limestone applied to soils was obtained through local expert judgement

Method approach

The approach taken is a Tier 1 approach from the 2006 IPCC Guidelines (V4, Chp 11, equation 11.12).

Method Changes

Emission factors from the 1996 IPCC Guidelines updated to be those in the 2006 IPCC Guidelines

Assumptions & observations

The emission factor for tonnes of Carbon was the default from the 2006 IPCC Guidelines
Expert judgement as the sole indicator of limestone applied to soils

It is assumed that the quantity has remained the same across the 18 year time series, which is considered to be unlikely.

Recalculation

Y

Recalculation justification & summary of change

Not applicable as there were no emissions from liming calculated in the previous inventory

Improvements

- Updated limestone data not solely based off expert judgement and not the same number for the whole time series
- Data on dolomite in addition, as this is currently missing
- Data from urea would allow us to calculate CO_2 emissions from urea quantity

QA/QC processes

- Data compilation spreadsheet and data collection template were QA/QC by two agricultural experts in the Aether team.
- Sources of data, emission factors, other factors and constants were all referenced.

- Comments when compiling and checking were left directly in the compilation files with an initial of who left the comment and a date of when it was left.
- All formulas were checked and QA'd, in order to ensure the correct calculation was taking place and the correct information was being read from the files.
- Validation workshop carried out.

Time series consistency issues

Time series appears to be consistent

Uncertainties

Uncertainty analysis was conducted based on expert judgement. These uncertainties included:

Emission factors since mostly 2006 IPCC defaults were used as there were no country-specific emission factor studies

Verification

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Method Statements LU1 Activity Data in LULUCF

LU1: Activity Data in LULUCF

Relevant Categories

3B Land remaining in the same land use and land converted to other land use (forest land, cropland, grassland, wetlands, settlements, and other land)

Relevant Gases

N/A

Relevant fuels, activities

N/A

Background

This method statement covers the data and methodology used to generate the land use activity data required for the inventory. The land use data is from the Saint Lucia agriculture, forestry and other land use (AFOLU) GHG inventory and forest reference emission level/Forest reference level REDD+ project by the Coalition of Rainforest Nations (CfRN).

The data was collected using a sampling approach at the national scale for every year 2000-2018 using FAO's Collect Earth tool.

Land use data is categorised into 16 different land uses, 2501 land area parcels (24.63 ha each) are analysed overtime (IPPC Approach 3 for land representation).

The 16 land use classes and their mapping to the IPCC land use classifications are as follows:

Forestland:

- Elfin Forest
- Cloud montane
- Montane rainforest
- Semi-evergreen forest
- Semi-deciduous forest
- Littoral evergreen
- Mangroves
- Plantation

Croplands:

- Perennial crop
- Annual crop

Grassland:

- Non-woody grass
- Woody/mixed forest

Wetland:

- Flooded lands

Settlement:

- Urban areas

Other land:

- Other
- Mining

Disturbances (fire, hurricane, shifting cultivation and logging) and the year they occurred were recorded and accounted for.

The compilation of the inventory for these land use categories adopts the tier 1 approach of IPCC, see **MS LU2**.

Data sources

Saint Lucia AFOLU Greenhouse gas inventory and forest reference emission level/Forest reference level REDD+ (Collect Earth tool)

Method approach

2006 IPCC Approach 3 for land representation

Method Changes

Y

Assumptions & observations

All land is managed, based on expert judgement of local technicians

Recalculation

N

Recalculation justification & summary of change

N/A

Improvements

The current method can detect land use changes that were not detected with the previous method.

QA/QC processes

- Cross-check of sample plots with technicians from a neighbouring country (still under implementation)
- The team included experts from Belize and Panama who had done the exercise previously in their countries
- The team also included forestry offices who knew the areas and ensured that the changes were valid
- Total area checks

Time series consistency issues

The time series is consistent.

Uncertainties

- Uncertainties are estimated from the statistical analysis of the sample design. The land uses and land-use changes that have a minor representation in Saint Lucia´s total area and consequently, have fewer sample plots for Collect Earth analysis, thus the uncertainty is higher than areas with a large share in the total area.

- There are other sources of uncertainty that are not quantified, for example, the user´s visual interpretation of the land use. However, this uncertainty is minimized with the QA/QC procedures applied.

Verification

Internal verification from experts from neighbouring countries.

Method Statements LU2 CO_2 Emissions and Removals in LULUCF

LU2: CO_2 Emissions and Removals in LULUCF

Relevant Categories

3B Land remaining in the same land use and land converted to other land use (forest land, cropland, grassland, wetlands, settlements and other land)

Relevant Gases

CO_2

Relevant fuels, activities

- Annual growth in carbon stocks (gain loss method)
- Above ground and below ground biomass
- Annual decrease in carbon stocks due to biomass losses
- Disturbances (logging), wood removals and fuelwood removals
- Harvest losses
- Emissions and removals in land converted to other land use (stock-change method)

Background

The emissions and removals include the annual increase in carbon stock in biomass, the loss of carbon from wood removals, the loss of carbon from fuel wood removals and the loss of carbon from disturbances.

The input data for inventory is the land use and land use change area from Collect Earth (approach 3). Information on land representation is provided in Method Statement LU1. The emissions and removals are estimated with the use of different emission factors: default values from the IPCC guidelines and National Forest Inventory.

Data sources

Previous GHG Inventory (Saint Lucia AFOLU Greenhouse gas inventory (2010)) has been used as a guidance for the appliance of emission factors, however the exact source of emission factors are the 2006 IPCC Guidelines and 2019 Refinement for average annual aboveground biomass growth, litter and dead wood stock in all land uses. Above ground biomass stock in forestland is estimated with raw data from the National Forest Inventory while the fraction of biomass loss during disturbances (natural or human driven) are estimated based on expert judgement. All other parameters applied such us wood carbon fraction of dry matter, ration of below ground biomass to above ground biomass are obtained from the IPCC guidelines.

Collect Earth tool is used to obtain the land use and land-use change (activity data) in Saint Lucia for the period 2000-2018.

Method approach

Gain-loss method for the land remaining in the same land use and stock-change method when land converted to other land use (Tier 1 approach). In the case of land converted to forestland, a tie2 approach is applied.

Method Changes

N/A

Assumptions & observations

- The Tier 1 assumption for dead wood and litter pools for all land-use categories is that these pools are in steady state when the land remains in the same land-use category. Thus, emissions and removals are accounted as zero.
- When a disturbance or management event occurs, it is assumed that the carbon in biomass is released to the atmosphere in the year of the event.

Recalculation

N

Recalculation justification & summary of change

N/A

Improvements

There is an opportunity to improve the LULUCF estimation of emissions and removals with the inclusion of the estimation of emissions and removals in Soil Organic Carbon, Deadwood and Litter (default IPCC emissions factors)

QA/QC processes

The LULUCF sector' inventory was elaborated by the Coalition for Rainforest Nations, but the quality control was performed by Aether as part of the Saint Lucia GHG training program.

Time series consistency issues

The time series is consistent

Uncertainties

Uncertainties arises from the combination of multiple factors. Activity data uncertainty is discussed in Method Statement LU1. Emission factors are obtained mainly from the 2006 IPCC Guidelines and 2019 Refinement to the 2006 IPCC Guidelines, with high level of uncertainties. Country-specific emission factors are used for biomass stock in forestland (National Forest Inventory) but the uncertainty is unknown.

Verification

Results were compared to the previous inventory. The level of emissions and removals in the current Inventory for the year 2010 is 36% lower than the level of emissions and removals from the previous inventory. The same verification done for the year 2000 results that the current inventory is 86% higher than the previous inventory. Despite the results are not numerically comparable, the are several elements that can explain the differences.

Method Statements LU3 CH_4, N_2O emissions from forest fires

LU3: CH_4, N_2O Emissions from Forest Fires

Relevant Categories

3C1 Emissions from biomass burning

Relevant Gases

CH_4, N_2O

Relevant fuels, activities

Non-CO_2 emissions from biomass burning
Wildfires and controlled burning

Background

While Collect Earth analysis is able to detect biomass burning in all land uses, only one forest fire event in forest land was detected.

Data sources

Data on burnt areas are generated with the visualization of burnt sample plots in Collect Earth analysis

Method approach

- Tier 1 approach
- Area burnt from Collect Earth
- Mass of fuel available for combustion x Combustion factor estimated and agreed with the Forestry Division Team
- Emission factor – CH_4 and N_2O from the 2019 IPCC Refinements

Method Changes

N/A. Forest fires were not estimated in previous inventories

Assumptions & observations

Burning did not result in conversion of land cover/Land use category

Recalculation

N/A

Recalculation justification & summary of change

N/A

Improvements

The area of forest fires that resulted with the use of Collect Earth could not be representing the reality, given the characteristics of the tool. It is recommended to apply a different method to detect the areas burnt for the entire period (e.g. MODIS)

QA/QC processes

Checking Excel formulae

Total area checks and final emissions from LULUCF

Time series consistency issues

The time series is consistent

Uncertainties

The main sources of uncertainty are the coarse resolution of burnt areas data and the mass of fuel available.

Verification

No verification undertaken.

Method Statements W1 Solid Waste Disposal to Land

W1: Solid Waste Disposal to Land

Relevant Categories

4A1 – Managed waste disposal sites

Relevant Gases

CH_4

Relevant fuels, activities

Municipal solid waste, clinical waste, industrial waste

Background

In 1996 the solid waste management act was brought into force establishing managed Landfills within Saint Lucia. Two disposal sites were established: the Vieux Fort and Ciceron disposal sites. In 2003/4 the Ciceron site was closed and the Deglos Sanitary Landfill site was opened.

While all disposal sites had daily cover the Deglos Sanitary Landfill also has linings and leachate collection and treatment. Weighbridges were included in this new site and the Vieux Fort site was updated in 2003/2004 to include weighbridges.

Prior to 1996 there were no managed waste disposal sites and waste collection was managed by the local council. Waste was disposed of in open dump sites and usually burnt.

Data sources

- Weighbridge data and waste composition data provided by Saint Lucia Solid Waste Management Authority.
- Population statistics from the Central Statistics Office.
- IPCC defaults.

Method approach

- T1 IPCC FOD Landfill model.
- The region used was the Caribbean and climate was considered to be moist and wet tropical.
- Prior to 2003 the amount of solid waste disposed of in the managed disposal sites was calculated using the population and the Caribbean IPCC default for waste generation per capita. From 2003 weighbridge data at the disposal sites was available and used directly.

Method Changes

N

Assumptions & observations

- All disposal sites have been considered managed due to the implementation of daily cover.
- Prior to 1996 there was no proper disposal of solid waste, and only open burning was practiced.
- Excluding recycling, 100% of waste is disposed to solid waste disposal sites, waste disposed to open dumps or open burnt is considered negligible.
- Split between food waste and garden waste from organics percentage in the waste composition data provided by the SLWMA for 2018 assumed to be 50:50.

Recalculation

Y

Recalculation justification & summary of change

There has been a decrease in emissions across the time series. There have been recalculations in the waste disposal to landfill data between 2004 and 2010. It is also unclear from the information available what assumptions were made about the percentage of waste sent to solid waste disposal sited before 1996 in the previous inventory. A different assumption for this would explain why recalculations are seen.

Improvements

Quantification of waste disposed in open dumps

QA/QC processes

- Calculations displayed transparently with documentation of data sources, assumptions and methods in compilation files.
- Calculations and data collection spreadsheet was reviewed by a waste sector expert.

Time series consistency issues

- Waste composition studies are done periodically, extrapolation for the years in between these studies.
- Weighbridge data is available for 2003 onwards. For the years prior to 2003 the waste disposed of in solid waste disposal sites was calculated using population and the IPCC default waste generation rate.
- Population estimates cover 2011-2018. Census data is available periodically for years earlier than 2011, extrapolation was used to complete years not covered by census data.

Uncertainties

The uncertainty in waste disposed to SWDS was estimated to be ±50%, as weighbridge data was only available for the later years. The uncertainty of the fraction of waste disposed of in SWDS was estimated to be ±30%. There is a good understanding of the amount of waste disposed of in SWDS from 1996 over back-yard burning and other minor activities not estimated. ±30% uncertainty was estimated for the waste composition. Combined this gave an uncertainty of ±65.5% in the activity data. IPCC default emission factors and parameters were used for estimations of emissions from SWDS therefore the uncertainty in the emission factors was estimated to be ±29.2% giving a combined uncertainty of ±72%.

Verification

The previous inventory was used for verification.

Method Statements W2 Biological Treatment: Composting

W2: Biological Treatment: Composting

Relevant Categories

4B1 – Biological treatment: Composting

Relevant Gases

CH_4, N_2O

Relevant fuels, activities

Municipal Solid Waste (Green waste)

Background

Prior to 2015 waste was composted on a very small scale and no data is available on the amount of waste composted. Larger scale composting started in 2015 at the Vieux-fort disposal site with 4 tonnes being composted in that year and an estimated two tonnes in subsequent years. There is some additional small scale composting taking place at schools, farms and households but there is also no data on waste quantities for this activity.

Data sources

Waste quantities composted from SLSWMA
IPCC defaults.

Method approach

T1
IPCC default emission factors for CH_4 and N_2O were used.

Method Changes

N

Assumptions & observations

Emissions from composting prior to 2015 and from schools will be minor.

Recalculation

N

Recalculation justification & summary of change

N/A

Improvements

- More frequent collection of data on waste composted at the waste disposal sites and at schools.
- Collection of data on composting by households.

QA/QC processes

- Calculations displayed transparently with documentation of data sources, assumptions and methods in compilation files.
- Calculations and data collection spreadsheet was reviewed by a waste sector expert.

Time series consistency issues

Amount of waste composted is available only for 2015 and 2019. It was estimated that half the amount of waste composted in 2015 was composted in the years 2016 - 2018.

Uncertainties

- The uncertainty in the amount of waste disposed by composting was estimated to be ±50% as data collected periodically and amount of waste composted prior to 2014 and at schools, farms and households is unknown. The IPCC default was used for the emission factor therefore the uncertainty estimated was ±100 % and the combined uncertainty ±xx%.
- For N_2O emissions the IPCC defaults for the EF was used and parameters were used and uncertainty was estimated to be ±100%.

Verification

-

Method Statements W3 Wastewater Treatment

W3: Wastewater Treatment

Relevant Categories

4D1 – Domestic wastewater treatment, 4D2 – Industrial wastewater treatment

Relevant Gases

CH_4, N_2O

Relevant fuels, activities

Domestic wastewater, wastewater from brewing, wastewater from distilling

Background

The water and sewerage company Inc. (WASCO) was first started in 1965, under a different name, and has responsibility over water supply and treatment. They manage one wastewater treatment facility: the Beausejour Stabilisation ponds. This site is made up of two aerated ponds and a fermentation pit. 6.6% of households were connected to the sewer system in 2010, covering wastewater both discharged to the sea and treated at the Beausejour Stabilisation ponds. Domestic wastewater is predominantly treated through pit latrines (23% in 2010) and septic systems (63% in 2010) with the latter increasing in use and the former decreasing.

Industrial wastewater is only applicable to alcohol production in Saint Lucia, namely brewing and distilling of rum. Wastewater from brewing is treated in aerobic treatment plants while wastewater from distilling is discharged to the sea.

Data sources

- Population data from the CSO census (extrapolated for years in between census) and CSO estimated mid-year population statistics.
- Annual number of stay-over arrivals and average overnight stay from CSO selected visitor stats 2002 to 2011-1 and selected visitor stats 2012 to 2019-1.
- Wastewater treatment type split obtained from Table 21 of the 2010 census report.
- Protein consumption for Saint Lucia from FAOSTAT.
- Production of rum obtained from CSO production of major industrial commodities 2006-2017 & 1991-2005 datasets.
- Density of rum and beer from the previous inventory calculation files.

- Beer production obtained from the Saint Lucia GHG Inventory Waste Report, produced by Stiebert consulting and Enviro Economics.
- IPCC defaults.

Method approach

T1

- Domestic CH_4 emissions were calculated using total population adjusted to include the tourist population. The additional tourist population was calculated using the annual stay-over tourists visiting Saint Lucia multiplied average fraction of the year tourists stayed. The split of population using different treatment types was also adjusted to include the tourist population. IPCC default "Asia, Middle East, Latin America" was used for Biochemical Oxygen Demand (BOD) and IPCC defaults were used for MCF (by treatment type) and Bo.
- Industrial CH_4 emissions were calculated using annual production and IPCC defaults for wastewater generation, COD, MCF and BOD.
- Domestic nitrous oxide emissions were calculated using protein consumption per capita from FAOSTAT, Saint Lucia populations (adjusted for tourists) and IPCC defaults for the fraction of nitrogen in protein consumption, fraction of protein not consumed in wastewater, the emission factor for N_2O emissions from wastewater. The IPCC default factor for adjusting domestic wastewater treatment to include co-discharge of industrial wastewater was also used.

Method Changes

Y - The adjustment to population for tourists was calculated by multiplying the average fraction of the year tourists stayed by stay-over numbers. The previous inventory calculated the tourist population using the stay-over number divided by the average length of stay.

Assumptions & observations

- The IPCC default "Asia, Middle East, Latin America" was used for BOD. It was assumed this was the most applicable region to Saint Lucia of those provided.
- To adjust the fractions of population utilising the wastewater treatment types to include the tourist population it was assumed that 50% of tourists' wastewater was treated by anaerobic plants and 50% by the Beausejour Stabilisation ponds.
- It was assumed that 50% of the population linked to a sewer's wastewater was treated through sea discharge and 50% was treated at the Beausejour Stabilisation ponds.
- As the Beausejour Stabilisation ponds are both aerobic and anaerobic the MCF for an aerobic treatment plant.
- Where wastewater treatment type was described as other, none or not stated in the census data the wastewater treatment type was assumed to be none and the corresponding MCF of 0.1 was used.

Recalculation

Y

Recalculation justification & summary of change

Slight recalculations in CH_4 and N_2O emissions from domestic wastewater treatment due to different calculation methodology for the adjustment of population for tourist numbers.

Improvements

More up to date beer production data.

The Beausejour stabilisation pond was estimated to be between a well-managed aerobic treatment system and an anaerobic one. A review over whether this assumption is correct would be beneficial.

QA/QC processes

Calculations displayed transparently with documentation of data sources, assumptions and methods in compilation files.

Calculations and data collection spreadsheet was reviewed by a waste sector expert.

Time series consistency issues

- Census data is periodical. Linear extrapolation was used for population and fraction of population using the wastewater treatment types for years in between census years.
- Beer production data was only available for 2000-2010, it was assumed that beer production has remained the same since 2010.
- Statistics on annual stay-over tourist numbers and average stay was not available for 2000 and 2001. 2002 values were used for these years.

Uncertainties

- The uncertainty in population was estimated to be ±5 % and the IPCC default was used for BOD therefore the uncertainty estimated was ±30 %. No industrial correction factor for CH_4 emissions from wastewater treatment giving an additional ±20 % uncertainty for the activity data for domestic wastewater treatment. The uncertainty in the fraction of population utilising the wastewater treatment types was estimated to be ±30 % as there are a number of different systems in use and extrapolation had to be used for years in between census years. Overall, the uncertainty in the activity data for domestic wastewater treatment was 47.2 %. IPCC default emission factors and parameters were used for domestic wastewater treatment therefore the uncertainty was estimated to be ±30 % and the combined uncertainty ±55.8 %.
- For N_2O emissions the uncertainty in population was estimated to be ±5 % and uncertainty in protein consumption ±10%. The IPCC default factors for fraction of protein not consumed and correction for co-discharge were used and uncertainty was estimated to be ±10 % and ±20% respectively. The overall uncertainty in the activity data was estimated to be ±25 %. IPCC defaults for the emission factors and parameters were used for N_2O emissions from wastewater and uncertainty was estimated to be ±1000 % giving a combined uncertainty ±106.2 %.
- For CH_4 emissions the uncertainty in the industrial production data was estimated to be ±25 %, this is due to the extrapolation that was undertaken to complete the time series and as a value for density had to be used to convert volume to tonnes and additional uncertainty of ±5 % was included. IPPC default values for wastewater production per unit production were used giving a high estimated uncertainty of ±100 %. IPPC default values was also used for COD with an estimated uncertainty of ±25 %. The overall uncertainty of the activity data was ±106.2 %. IPCC defaults for the emission factors and parameters were used for CH_4 emissions from wastewater and uncertainty was estimated to be ±30 % giving a combined uncertainty ±2 5%.

Verification

The previous inventory was used for verification.

Annex IV Improvement Plan

This section presents the improvement plan for Saint Lucia's GHG inventory, it was last updated in July 2020.

Table 20: Improvement plan, 2000 – 2018 GHG inventory published in 2020

Improvement title	Improvement description	Sector	Weakness	Effort required to carry out task	Priority	Status	Responsible organisation
Institutional Arrangements – energy division	Development of the Energy Divisions system for processing the energy balance	Cross-cutting	Institutional arrangements	Medium	High	Not Started	Department of Sustainable Development
Maintaining inventory team	Ensure that there are at least two experts (senior and junior) for each inventory sector and that seniors are able to provide training	Cross-cutting	Institutional arrangements	High	High	Not Started	Department of Sustainable Development
QA/QC Log	Develop a log to enable to national QA/QC coordinator to track QA/QC activities	Cross-cutting	QA/QC	Low	Medium	Not Started	Department of Sustainable Development
Electricity generation country-specific factor	Develop a country-specific factor which allows the method for 1A1a to be improved to Tier 2	Energy	Activity data / Human Resources	Medium	High	In progress	Department of Sustainable Development; Energy Division
Compressed lignite briquettes	Check customs data to see if lignite is imported in briquette and included in charcoal sold in Saint Lucia	Energy	Activity data / Human Resources	Medium	Low	Not Started	Department of Sustainable Development; Energy Division & Forestry Division

Manufacturing Industries and Construction activity data disaggregation	Try to establish the amount of fuel used in each of the 1A2 subcategories, including the distilleries and other industries as well	Energy	Activity data / Human Resources	High	Medium	Not Started	Energy Division
Domestic and international aviation fuel split	Improve understanding of split of fuel use between domestic and international aviation. Survey the primary domestic aviation operators for fuel use data to aid the development of the energy balance	Energy	Activity data / Human Resources	Medium	Medium	Not Started	Energy Division
Road vehicles total fuel sold	Establish the fuel sold by Rubis and SOL in Saint Lucia in a given year and validate against import / export statistics	Energy	Activity data	Medium	High	Not Started	Depart of Sustainable Development; Energy Division;
Domestic and international shipping fuel split	Improve understanding of split of fuel use between domestic and international shipping. Survey the primary domestic shipping tour operators and fishing division for fuel use data to aid the development of the energy balance	Energy	Activity data	Medium	Medium	In progress	Energy Division
Domestic vs commercial fuel	Census data (due to be surveyed soon) will likely include information on the fuel used domestically. Analysis will be needed to understand whether this can be used to extrapolate the time-series. Rubis and SOL will also have some overall fuel use information for LPG and kerosene	Energy	Activity data	High	Medium	Not Started	Energy Division/Department of Sustainable Development
Temporarily stored unrefined oil	Some unrefined oil is stored temporarily at Buckeye and then re-exported, but there are some fugitive emissions	Energy	Activity data	Medium	Low	Not Started	Energy Division/Department

	associated (currently NE). Contact Buckeye to understand data that is collected on this process, and the amount of unrefined oil that is stored if known.						of Sustainable Development
Data aggregation systems for the annual number of vehicles	Improve data collection of the number of new vehicles operating on Saint Lucia as well as the total number of vehicles licensed each year	Energy / IPPU	Activity data	High	High	Not Started	Transport Division; Energy Division
Understand the fleet composition	Understand what data is collected throughroad surveys, to see if the data provides information that can be used to estimate the vehicle usage in Saint Lucia by vehicle type (i.e. using road surveys to estimate use of the road by vehicle type)	Energy / IPPU	Activity data	High	High	Not Started	Ministry of Infrastructure; Transport Division; Energy Division
Refrigeration and AC categorisation and survey	Imported equipment: charge per unit, gases used and replacement/servicing routines.	Industrial Processes	Activity data	Medium	High	Not Started	Central Statistical Office
Consumption of SF6	Data on the number of units, the charge and the fluid recharge programme for SF6 systems in Saint Lucia	Industrial Processes	Activity data	Low	Low	Not Started	Windward Island Gases/ LUCELEC
Import & consumption data	Import and/or production of solvents or solvent containing materials. National survey to characterize solvent and product use	Industrial Processes	Activity data	Low	Low	Not Started	Customs & Excise Department
Facility production data	Mass of carbonate consumed, tonnes (Tier 1)	Industrial Processes	Activity data	Low	Low	Not Started	Caribbean Ceramics

Livestock data	Updated livestock data after 2010, specifically re-assess the definition of Dairy/Non-Dairy Cattle. This can be updated with the next agriculture census.	Agriculture	Activity data	Medium	High	In progress	Ministry of Agriculture
Animal Waste Management System	We require updated fraction of the animal waste management systems, as the information was last taken from a 1997 study	Agriculture	Activity data	Medium	Medium	Not Started	Ministry of Agriculture
Urea Application Data	Urea application is currently not accounted for in the inventory as the data we provided was too disaggregated - one number for the whole time series. This data could be included if we have more confidence in the data. This can be updated with the next agriculture census.	Agriculture	Activity data	Low	Low	In progress	
Updated synthetic fertiliser data	Currently the data is currently taken from export and import data. It would be good to get updated data, specifically amount of synthetic fertiliser which is directly applied to soils. This can be updated with the next agriculture census.	Agriculture	Activity data	Medium	Low	Not Started	Ministry of Agriculture
Updated liming data	Currently we have one figure based off expert judgement, which is the same across the time series. It would be good to obtain data across the time series, directly from a source we are confident with. This can be updated with the next agriculture census.	Agriculture	Activity data	Medium	Medium	Not Started	Ministry of Agriculture

Crop production data	Currently the data is taken from FAO statistics, and the categorisation are defaults from the 2006 IPCC Guidelines. This can be updated with the next agriculture census.	Agriculture	Activity data	Medium	Medium	In progress	Ministry of Agriculture
Crop residue burning data	This will be difficult to obtain, currently there is no data collected for the crop areas burnt so emissions are calculated to be zero. This can be updated with the next agriculture census.	Agriculture	Activity data	High	Low	Not Started	Ministry of Agriculture
New emission factors (growth rates)	Updated Biomass Stocks (Forest Inventory)	LULUCF	Other	High	High	Not Started	Forestry Department
Biomass Burning in croplands and grasslands	Area(ha), location, biomass lost (%)	LULUCF	Activity data	Medium	Medium	Not Started	Ministry of Agriculture
Harvested Wood Products	Production, importation and exportation of different wood products	LULUCF	Activity data	Medium	Low	Not Started	Forestry Department, Customs Department
Soil Organic Carbon	Carbon stock under different soil types; land use, management & input factors.	LULUCF	Activity data	High	Low	Not Started	Ministry of Agriculture
Composting activity data	Regular collection on amount of waste composted at the waste disposal sites, schools, farms and households.	Waste	Activity data	High	Medium	Not Started	
Open burning activity data	Quantification of waste disposed of in open dumps / open burnt.	Waste	Activity data	High	Medium	Not Started	

Beausejour wastewater MCF	Better understanding of the process in the Beausejour wastewater treatment ponds, to improve the accuracy of the MCF.	Waste	Other	Medium	High	Not Started	
Brewery production	Updated brewery production data.	Waste	Activity data	Low	Medium	Not Started	
Brewery wastewater	Information on the volume of wastewater produced by breweries and distilleries in Saint Lucia.	Waste	Activity data	High		Not Started	