2024

Eswatini's National Inventory Document: 1990-2022

NID CREDITS AND AUTHORS

Contact for Eswatini National GHG Inventory

Name:	Duduzile Nhlengethwa-Masina
Title:	Director
Unit:	Eswatini Meteorological Service
Organization:	Ministry of Tourism and Environmental Affairs
Address:	P.B. Box 2652, Mbabane, H100, Eswatini
Telephone:	+268 2404 8859
Email:	climatechange.eswatini@gmail.com
Website:	https://www.gov.sz/index.php/ministries-departments/ministry-of-tourims-environments-a-communications www.swazimet.gov.sz

List of Eswatini NID authors and contributions

Main author:	Centre for Sustainable Energy Research, University of Eswatini
Editor:	Nhlengethwa-Masina Duduzile, Ms, MTEA
Chapter 1:	Nhlengethwa-Masina Duduzile, Ms, MTEA Mavimbela Gcina, Dr, University of Eswatini
Chapter 2:	Mavimbela Gcina, Dr, University of Eswatini
Chapter 3:	Mavimbela Gcina, Dr, University of Eswatini Mkhonta Simiso, Prof, University of Eswatini Zwane Nosiphiwe, Dr, University of Eswatini
Chapter 4:	Ndlovu Thabile, Dr, University of Eswatini
Chapter 5:	Mabaso Sizwe, Dr, University of Eswatini Tfwala Samkele, Dr, University of Eswatini
Chapter 6:	Dlamini Wisdom, Dr, University of Eswatini
Chapter 7:	Ndlovu Thabile, Dr, University of Eswatini
Chapter 8:	Mavimbela Gcina, Dr, University of Eswatini Ndlovu Thabile, Dr, University of Eswatini
Chapter 9:	Mavimbela Gcina, Dr, University of Eswatini Ndlovu Thabile, Dr, University of Eswatini
Chapter 10:	Mavimbela Gcina, Dr, University of Eswatini Ndlovu Thabile, Dr, University of Eswatini

Suggested quote for Eswatini NID

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NID CONTENTS

NID ACRONYMS AND ABBREVIATIONS

AFOLU	Agriculture, Forestry and Other Land Use
AR5	IPCC Fifth Assessment Report
AR6	IPCC Sixth Assessment Report
BTR	Biennial transparency report
C	Confidential (notation key)
CBIT	Capacity-building Initiative for Transparency
CBIT-GSP	Capacity-building Initiative for Transparency and Global Support Programme
CC	Carbon Content
CCF	Carbon Content Factor
CL	Crown Land
CH_4	Methane
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
COVID-19	Coronavirus Disease 2019
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
CRT	Common Reporting Tables
D	Default value for emission factors
EEA	Eswatini Environment Authority
EF	Emission Factor
ES	Executive Summary
FRL	Forest Reference Level
GHG	Greenhouse Gas
GWP	Global Warming Potentials
HFC	Hydrofluorocarbons
ICAT	Initiative for Climate Action Transparency
IE	Included elsewhere (notation key)
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use (sector)
kt	kilo tonne or gigagram
LULUCF	Land use, land-use change and forestry (sector)
MTEA	Ministry of Tourism and Environmental Affairs
MPG	Modalities, procedures and guidelines for the transparency framework of the Paris Agreement
N_2O	Nitrous oxide
NA	Not applicable (notation key)
NDC	Nationally Determined Contributions

NE	Not Estimated (notation key)
NF_3	Nitrogen trifluoride
NGI	National Greenhouse gas Inventory
NID	National Inventory Document
NIR	National Inventory Report
NMVOC	Non-methane volatile organic compound
NO	Not occurring (notation key)
NO_x	Nitrogen oxides
ODS	Ozone depleting substances
ODU	Oxidation During Use
PFC	Perfluorocarbons
QA/QC	Quality assurance and quality control
REDD+	Reducing Emissions from Deforestation and Forest Degradation plus additional forest-related activities
RedINGEI	Latin American Network of National Greenhouse Gas Inventories, or *Red Latinoamericana de Inventarios Nacionales de Gases de Efecto Invernadero* in Spanish
SF_6	Sulfur hexafluoride
SNL	Swazi Nation Land
SO_x	Sulfur oxides
TDL	Title Deed Land
UNEP-CCC	United Nations Environment Programme Copenhagen Climate Centre
UNFCCC	United Nations Framework Convention on Climate Change

NID EXECUTIVE SUMMARY

RE.1. Background information on GHG inventories and climate change

1.1. National GHG inventories and climate change

Climate change remains a significant threat to humanity and sustainable development worldwide. Despite ongoing efforts to mitigate its effects, the IPCC's sixth Assessment Report (AR6) indicates substantial gaps between projected emissions from implemented policies and those needed according to Nationally Determined Contributions (NDCs), along with insufficient financial support to achieve climate goals. Concurrently, rapid changes in various environmental domains are causing extensive adverse impacts, highlighting the need for strengthened commitments and improved transparency in meeting climate targets.

Eswatini prepared its 2022 greenhouse gas (GHG) inventory following the Modalities, Procedures, and Guidelines (MPGs) adopted by the Paris Agreement. Covering emissions from 1990 to 2022 for the five sectors which are Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use, Land Use Change, and Forestry (LULUCF), and Waste. The inventory estimates emissions of CO_2, CH_4, N_2O, HFCs, and SF_6. Nitrogen trifluoride (NF_3) and perfluorocarbons (PFCs) are not occurring in the country. However, emissions of precursors (NO_x, CO, NMVOC, and SO_x) were not estimated due to capacity constraints with the IPCC software.

Eswatini's 2018 GHG inventory reported total emissions of 2,765.05 Gg CO_2 equivalent without LULUCF and 3,240.10 Gg with LULUCF, the latter being a net emitter. The country made efforts to improve its reporting for LULUCF from Tier 1 to Tier 2, and this has been undertaken in the current inventory submission. Adjustments according to the updated Global Warming Potentials (GWPs) in alignment with the fifth assessment report (AR5) of the IPCC have also been incorporated. The GHG inventory is essential for fulfilling Eswatini's commitments to the UNFCCC and the Paris Agreement, aiding in global efforts to limit temperature increases and plan for future NDC submissions, including the REDD+ Report and NDC 3.0 due in 2025.

1.2. National circumstances and institutional arrangements

Efforts are in progress to enhance the collection of activity data from various sectors to improve systematic inventory preparation. Due to capacity constraints, the University of Eswatini's research centres have assisted in compiling the GHG inventory, with various departments and stakeholders providing data and quality control.

The MTEA's inventory focal point played a crucial role in ensuring the inventory's transparency, accuracy, and completeness while the United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC) provided quality assurance. Currently, there are no legal frameworks governing the GHG inventory preparation, however, existing arrangements align with departmental functions, such as the Energy

Department's annual energy balance preparation and EEA's data collection on HFCs and waste management.

The Ministry of Agriculture plays a vital role in collecting agricultural activity data and hosts the Land Use Department, which supports land use aspects of the inventory. The Forestry Department manages the national forest inventory, contributing necessary data for the forestry component.

To facilitate data sharing with the associated institutions, memoranda of understanding will be established to facilitate systematic inventory compilation, through the support of the Capacity-building Initiative for Transparency (CBIT). Experts from these institutions will form a GHG Inventory Working Group, part of the National Climate Change Committee, which advises on transparency programs, including Biennial Transparency Reports.

While Eswatini has yet to formalize its GHG inventory working plan, a Transparency Coordination Platform (TCP) and NDC Registry are under development to archive relevant data. The finalized GHG inventory will be validated by tasked teams and then shared with the National Climate Change Committee and Cabinet for review.

1.3. Methodologies and data sources

The inventory compilation primarily utilized IPCC default emission factors and Tier 1 methodology, except for specific categories where Tier 2 was employed such as road transport, fugitive Emissions from Solid Fuels and the land use, land use change and forestry sector.

Most of the key categories still used the Tier 1 approach due to challenges such as data availability, aggregated data, and lack of country-specific emission factors.

Data for the inventory was sourced from previous inventories, energy balances, national reports, and ICAT projects. In cases of data gaps, techniques such as extrapolation and interpolation were employed based on expert judgement.

1.4. QA/QC plan and implementation

The QA/QC plan for the inventory had the following components:

- Organizational Structure: The inventory compilation was carried out by teams, each consisting of at least one member from the UNESWA's research centres (Centre for Sustainable Energy Research and Centre for Climate Change and Sustainability) and one government officer from a relevant ministry/department.
- General Inventory QC Procedures: Consistency checks were performed between the previous inventory and the current inventory by each team to ensure accuracy.

- Source-Specific QC Procedures: In each team, data sources were checked to ensure accurate transfer of data into the inventory compilation software. Particular attention was paid to ensuring that data was entered in the correct units.
- QA procedures: The inventory was reviewed by the Director of Meteorology and UNEP-CCC.

1.5. General uncertainty assessment

The inventory compilation teams opted for the flexibility for a qualitative assessment, noting that in general uncertainty is high because most of the inventory uses Tier 1 methodology. This is confirmed by the energy category uncertainty quantitative assessment where it is found that uncertainty for methane and nitrous oxide emissions is in excess 150%.

1.6. General assessment of completeness

The inventory compilation teams ensured continuity and completeness in estimating all categories from the previous inventory. Categories marked as not estimated in CRT Table 9 are either not present in Eswatini or are labelled "IE" (included elsewhere) due to insufficient data disaggregation for specific subcategories.

Regarding greenhouse gases, Eswatini's inventory reports on CO_2, CH_4, N_2O, HFC, and SF_6, but does not include PFC or NF_3, as data indicates these gases are not present in the country.

1.7. Metrics

The inventory compilation utilized Global Warming Potentials (GWP) based on a 100-year time horizon from the fifth assessment report.

1.8. Summary of any flexibility applied

Eswatini applied certain flexibilities during the inventory compilation process. Although the team (UNESWA) was unable to perform complete quality control, they collaborated closely with sectoral experts from the government and public enterprises to ensure quality control of the activity data. Additionally, the previous QA/QC plan was deemed obsolete due to recent changes in the inventory preparation process, necessitated by the implementation of the Enhanced Transparency Framework (ETF) within a constrained timeframe.

Flexibility was also applied regarding uncertainty analysis, wherein qualitative presentation of the uncertainty was used, with the exception of the Energy Sector where default qualitative uncertainty assessment was used to describe uncertainty. There is need to strengthen capacity for undertaking the qualitative uncertainty analysis.

RE.2. Summary of trends related to national emissions and removals

2.1. Trend in aggregated GHG emissions and removals

Eswatini's net GHG emissions (including removals) rose from -2062.59 kt of CO_2eq in 1990 to -1922.2 kt in 2022. GHG emissions from sources (excluding land use, land-use change, and forestry - LULUCF) increased slightly from 2094.86 kt in 1990 to 2213.94 kt in 2022, with fluctuations in between, peaking at 2374.74 kt in 2000 and moving to 2213.94 kt in 2022.

In 2022, emissions from the Energy sector totalled 1265.56 kt of CO_2eq, broken down as 1123.29 kt for CO_2, 103.58 kt for CH_4, and 38.69 kt for N_2O. The Industrial Processes and Product Use sector emitted 4.09 kt of CO_2, with various HFC emissions totalling 56.92 kt and 0.04 kt for N_2O and 1.34 kt for SF_6. The agriculture sector emitted 99.38 kt of CO_2, 507.86 kt of CH_4, and 258.81 kt of N_2O, while the Waste sector released 6.23 kt of CO_2, 70.87 kt of CH_4, and 1.11 kt of N_2O. The LULUCF sector served as a carbon sink, storing -4136.13 kt of CO_2. Details on these emissions are summarized in Tables 2-1 and 2-2, and precursor gases, as well as indirect CO_2 and N_2O emissions, have not been estimated.

2.2. Trend in emissions and removals by sector and GHG

In 2022, Eswatini's net emissions were estimated at -1854.1 kt of CO_2 equivalent (CO_2eq). This net figure was composed of a LULUCF sink of -4136.1 kt CO_2eq and emissions from various sectors: energy (1,265.55 kt CO2eq), agriculture (866.05 kt CO_2eq), waste (78.2 kt CO_2eq), and IPPU (72.15 kt CO_2eq). Without considering LULUCF, total emissions were estimated at 2282.02 kt CO_2eq, with the energy sector contributing about 55% and agriculture about 38%, while waste and IPPU accounted for 3.4% and 3.2%, respectively.

Compared to 2018, the 2022 net emissions decreased by 42.15 kt CO_2eq, primarily due to a reduction in emissions from the agriculture sector. However, when compared to 1990 levels, the 2022 emissions increased by 207.1 kt CO_2eq, mainly due to a rise of 332.6 kt CO_2eq from the energy sector, while agriculture emissions declined by 233.8 kt CO_2eq. The overall net emissions increase is attributed to significant land use changes in the AFOLU sector, driven by expansions in cropland for sugar cane and encroachment by human settlements.

Eswatini's net greenhouse gas (GHG) emissions are estimated based on CO_2, CH_4, N_2O, HFCs, and SF_6, with NF_3 and PFCs currently not occurring in Eswatini. The net CO_2 for 2022 is estimated at -2903.15 kt CO_2eq, which is relatively stable compared to -2892.35 kt CO_2eq in 2018, but this represents an 11% increase from the 1990 estimate of -3278.52 kt CO_2eq.

Net CH_4 emissions have shown a consistent decline from 1990 to 2022, with the 2022 estimate of 682.31 kt CO2eq reflecting a decrease of 4.6% from 2018 and 18.7% from 1990. Similarly, net N_2O emissions also declined steadily, with a 2022 estimate of 298.65 kt CO_2eq, down 4.6% from 2018 and 18.7% from 1990. In contrast, HFC emissions have steadily increased, with a 2022 estimate of 66.79 kt CO_2eq, representing a 38% rise from 2018, though the 1990 estimate for HFCs was nearly zero. SF_6 emissions remained constant at 1.34 kt CO_2eq throughout the period from 1990 to 2022. Eswatini's total GHG emissions by gas, excluding LULUCF, indicate that CO_2 accounts for 55.7% of total emissions, followed by CH_4 (30.8%), N_2O (13.5%), HFCs (3.0%), and SF_6 (0.6%).

When comparing the latest inventory year (2022) with the previous inventory year (2018), CO_2 emissions decreased by 0.3%, methane by 4.9%, nitrous oxide by 4.6%, and HFCs increased significantly by 38.2%, while sulphur hexafluoride emissions remained constant.

A comparison with the 1990 estimates shows that CO_2 emissions have risen by 40.3%, methane has decreased by 19.7%, nitrous oxide has decreased by 18.6%, HFCs have increased from zero in 1990 to 66.8 kt of CO_2eq in 2022, and sulphur hexafluoride levels have remained constant.

2.3. Trend in precursor gas emissions

These were not estimated.

2.4. Trend in other substances that have an impact on climate

These were not estimated.

2.5. Trend in GHG intensity indicators

These were not estimated.

RE.3. Overview of source and sink category emissions estimated and trends

3.1. Energy (CRT 1)

3.1.1. Overview of the sector

The total energy sector emissions estimate for the year 2022 are1265.6 kt of CO_2eq. The total energy sector made up mostly of fuel combustion activities, 1.A, contributing 1253.44 kt of CO_2eq and fugitive emissions contributing 12.11 kt of CO_2eq, i.e. 99.04% and 0.96%, respectively.

3.1.2. Fuel combustion (CRT 1.A)

The emissions in 1.A are estimated at 930.8 kt of CO_2eq for 1990, increasing to 1265.8 kt of CO_2eq in 2018 and declining slightly to 1253.4 kt of CO_2eq in 2022. Transport (1.A.3) contributes most of the emissions in the fuels combustion sector, with a contribution of 69.2% in the 2022 estimate. The other subsectors contribute as follows: 19.9% for Manufacturing Industries and Construction (1.A.2), and 10.9% for Other Sectors (1.A.4). Energy Industries (1.A.1) has no contribution as the only activity that used to occur stopped in 2012.

3.1.2.1. Comparison of the sectoral approach with the reference approach

The CO_2 emissions from the reference approach are 1096.9 kt CO_2 in 2022, a decline of 1% from the 2018 estimate and an increase of 37.8% from the 1990 estimate. The reference approach estimates are generally close to the estimates from the sectoral approach. There are differences exceeding 5% in some years which were are still making sense of but should be resolved eventual.

3.1.2.2. International bunker

The international bunker emissions estimate for 2022 is 14.90 kt of CO_2eq, a decline of 29.7 from the 2018 emissions estimate and a decline of 38.2 from the 1990 emissions estimate.

3.1.2.3. Feedstocks and no-energy use of fuels

Feedstocks not occurring and no-energy use of fuels estimated under IPPU.

3.1.2.4. Energy industries (CRT 1.A.1)

Not occurring since 2012.

3.1.2.5. Manufacturing industries and construction (CRT 1.A.2)

The emissions estimate for 2022 is 249 kt of CO_2eq, an increase of 15% from the 2018 estimate and a decline of 40% from 1990 estimate. The decline in the trend is attributed to decline in coal used in manufacturing.

3.1.2.6. Transport (CRT 1.A.3)

Transport emissions estimate for 2022 is 867.2 kt of CO_2eq, an increase of 8.5% from the 2018 estimate and an increase of 183.5% from the 1990 estimate. The primary driver of the increase is road transportation.

3.1.2.7. Other sectors (CRT 1.A.4)

Other sectors emissions estimate for 2022 is 137.2 kt of CO_2eq, a decline of 45% from the 2018 estimate and a decline of 33% from the 1990 estimate. The shift is primarily due to fuel switching from LPG and kerosene to electricity.

3.1.2.8. Other (not specified elsewhere) (CRT 1.A.5)

All fuels accounted for in the in specific categories, hence no estimates done under this sector.

3.1.3. Fugitive emissions from fuels (CRT 1.B)

The emissions estimate in this subsector for 2022 is 12.11 kt of CO_2eq, a decrease of 14 % from the 2018 estimate and an increase of 456% from the 1990 estimate. Emissions in this subcategory are driven by output of the single coal mine in operation up to 2022.

3.1.3.1. Solid fuels (CRT 1.B.1)

The emissions are already summarized above.

3.1.3.2. Oil and natural gas (CRT 1.B.2)

Emissions from distribution of petroleum products are yet to be done. Time and data constraints have prevented the team from doing them at this time.

3.1.4. CO_2 transport and storage (CRT 1.C)

This activity is not occurring.

3.1.4.1. Transport of CO_2 (CRT 1.C.1)

This activity is not occurring.

3.1.4.2. Injection and storage (CRT 1.C.2)

This activity is not occurring.

3.2. Industrial processes and product use (CRT 2)

3.2.1. Overview of the sector

In 2022, the emissions from the Industrial Processes and Product Use (IPPU) sector were from non-energy products linked to fuels and solvents, particularly lubricant (2.D.1) and paraffin wax (2.D.2) usage, as well as products replacing ozone-depleting substances (ODS) like refrigeration and air conditioning (2.F.1) and various electrical equipment (2.G.1). Although emissions for this sector showed an increasing trend from 1990 to 2022, mainly due to the introduction of hydrofluorocarbons (HFCs) for refrigeration and air-conditioning, very few subcategories were applicable in Eswatini. Notably, glass production doesn't generate emissions, as it relies on recycled materials, while ceramics ceased production in 2017.

The IPPU sector's total CO_2 equivalent emissions stood at 72.15 kt, equating to approximately 3.16% of the country's GHGs emissions, which totalled 2281.95 kt for 2022. A staggering 740% increase in emissions was noted from 1990 to 2022 for the IPPU sector, correlating with the introduction of HFCs, which were not available until the mid-1990s and have high global warming potentials (GWP). The emissions increased significantly in 2010, as the first introduced equipment reached their end of life, assumed to be 15 years, leading to significant refrigerant release.

Extrapolated data indicated that lubricant and paraffin wax consumption slightly decreased by 2% and 3% from 2018 to 2022, while HFC emissions rose by approximately 38%, driven by increased HFC use in refrigeration and air conditioning. HFCs now account for 92% of emissions from the IPPU sector. Emissions from sulphur hexafluoride (SF_6) remained stable over the years, as annual usage has stayed consistent.

3.2.2. Mineral industry (CRT 2.A)

This category only had GHGs from ceramic production which were coming from a brick manufacturing company that closed in 2017. Emissions from this subcategory seized in 2017, hence for 2022, there were no emissions from this sector.

3.2.3. Chemical industry (CRT 2.B)

This category is not occurring in Eswatini.

3.2.4. Metal industry (CRT 2.C)

This category is not occurring in Eswatini.

3.2.5. Non-energy products from fuels and solvent use (CRT 2.D)

Emissions from this category originate from lubricants and greases as well as paraffin wax. This category contributes approximately 0.3% to sector emissions, with lubricant use accounting for the majority and paraffin wax use contributing only 1% of that 0.3% in 2022. Emissions from this category have remained relatively stable throughout the time series, based on available data.

3.2.6. Electronic industry (CRT 2.E)

This category is not occurring in Eswatini.

3.2.7. Product uses as substitutes for ODS (CRT 2.F)

This sector emissions originate from Hydrofluorocarbons (HFCs) which are used mainly in the refrigeration and air-conditioning sector. All refrigerants used for manufacturing and servicing are imported, as there is no local production. Common refrigerant blends used in the country include R-404A, R-407C, R-408A, R-410A, and R-507A, which contain various HFCs like HFC-134A, R-125, R-143A, and R-32.

In 2022, emissions from this subcategory accounted for approximately 92% of the total sector emissions, primarily driven by the phase-out of ozone-depleting substances (ODS) scheduled to conclude by 2030. As more imported equipment is charged with HFCs, there has been a corresponding increase in HFCs used for servicing, leading to rising emissions since their introduction into the market.

3.2.8. Other product manufacture and use (CRT 2.G)

[Include a brief summary of Section 4.8.1 of the NID focused on results]
The use of SF6 in electrical equipment is the main contributor to this category. The estimated emissions were based on the amount of SF6 used on an annual basis to refill these electrical equipment, which was consistent across the time series. the emissions from this subcategory were therefor 1.22 kt CO_2 eq.

Additionally, nitrous oxide (N_2O) is found in products where it is used as a propellant in aerosol products. Data for N_2O emissions was sourced from a previous inventory and the total emissions of N2O were 0.04 kt CO2 eq for 2022.

Overall, this category accounts for 2% of emissions from industrial processes and product use (IPPU), with the majority attributable to SF6.

3.2.9. Other (please specify) (CRT 2.H)

These were not estimated due to capacity constraints.

3.3. Agriculture (CRT 3)

3.3.1. Overview of the sector

The 2022 GHG emissions in the agriculture sector totalled 866.05 kt CO_2eq, primarily from CO_2, CH_4, and N_2O emissions. CO_2 emissions (99.38 kt) were solely from crop residues, while CH_4 emissions (18.14 kt) were dominated by enteric fermentation in livestock, particularly non-dairy cattle (14.78 kt) and goats (2.62 kt). N_2O emissions (0.98 kt) were mainly linked to agricultural soils. Enteric fermentation was the largest source of CH_4, with minimal contributions from manure management and other livestock. Negligible emissions came from field burning of residues and specific practices like dolomite application.

3.3.2. Enteric fermentation (CRT 3.A)

GHG emissions from enteric fermentation have shown a declining trend from 1990 to 2022, with cattle consistently being the largest contributors to methane emissions. Cattle emissions decreased from 622.89 kt in 1990 to 413.81 kt in 2022. Sheep emissions also declined over the years, from 3.42 kt in 1990 to 2.32 kt in 2022. In contrast, swine emissions increased slightly from 0.67 kt in 1990 to 1.14 kt in 2022, likely due to changes in swine production. The "Other" category, which includes mules, asses, and goats, experienced an increase in emissions from 45.72 kt in 1990 to 73.3 kt in 2022. Overall, total emissions from all subcategories combined decreased from 672.7 kt in 1990 to 490.57 kt in 2022.

3.3.3. Manure management (CRT 3.B)

Manure management in Eswatini is poorly documented, relying on expert judgment. Cattle are the largest contributors to GHG emissions from manure management, though their emissions declined from 20.05 kt in 1990 to 13.28 kt in 2020. Sheep emissions decreased slightly over time, while swine emissions increased due to changes in production. Emissions from the "Other" category, including mules, asses, and goats, rose from 11.22 kt in 1990 to 18.53 kt in 2022. Total GHG emissions remained relatively stable, increasing slightly from 32.65 kt in 1990 to 33.43 kt in 2022.

3.3.4. Rice cultivation (CRT 3.C)

Not applicable in Eswatini.

3.3.5. Agricultural soils (CRT 3.D)

Direct and indirect N_2O emissions from managed soils in Eswatini showed a steady decline from 1990 to 2022. Direct emissions decreased by 27%, from 288.54 kt CO_2eq in 1990 to 210.67 kt CO_2 eq in 2022. Indirect emissions dropped by 21%, from 35.3 kt CO_2eq to 27.74 kt CO_2 eq during the same period. These reductions were linked to sources such as synthetic fertilizers, organic additions, urine, and crop residues. Overall, total emissions from managed soils declined from 323.84 kt CO_2eq in 1990 to 238.31 kt CO_2eq in 2022.

3.3.6. Prescribed burning of savannahs (CRT 3.E)

Reported under FOLU sector.

3.3.7. Field burning of agricultural residues (CRT 3.F)

Reported under FOLU sector.

3.3.8. Liming (CRT 3.G)

Eswatini lacks activity data or systems to track limestone application on soils, relying instead on import records for estimates. GHG emissions from urea application in the country have steadily declined between 1990 and 2022, dropping from 3.89 kt CO_2eq in 1990 to 1.94 kt CO_2eq in 2022.

3.3.9. Urea application (CRT 3.H)

Eswatini's predominantly agricultural population heavily relies on urea to enhance crop yields. However, the country lacks systems or activity data to track urea usage, with annual application estimates based on import records. Greenhouse gas emissions from urea application have fluctuated between 1990 and 2022, peaking at 176.86 kt CO_2eq in 2015 before declining to 97.43 kt CO_2eq in 2022.

3.3.10. Other carbon-containing fertilizers (CRT 3.I)

Not applicable.

3.3.11. Other (please specify) (CRT 3.J)

Not applicable.

3.4. Land use, land-use change and forestry (CRT 4)

3.4.1. Overview of the sector

[Include a brief summary of Section 6.1.2 of the NID focused on results]

3.4.2. Land-use definitions and land representation approaches

[Include a brief summary of Section 6.2 of the NID focused on results]

3.4.3. Country-specific approaches

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.4. Forest land (CRT 4.A)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.5. Cropland (CRT 4.B)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.6. Grassland (CRT 4.C)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.7. Wetlands (CRT 4.D)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.8. Settlements (CRT 4.E)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.9. Other land (CRT 4.F)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.10. Harvested wood products (CRT 4.G)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.4.11. Other (please specify) (CRT 4.H)

[Include a brief summary of Section **Error! Reference source not found.** of the NID focused on results]

3.5. Waste (CRT 5)

3.5.1. Overview of the sector

The waste sector in Eswatini encompasses all categories, though to varying extents. Emissions were estimated using the Tier 1 method, drawing on data from multiple sources, including the Eswatini Central Statistics Office and the Eswatini Environment Authority, while the main activity data was the population data. Total emissions from the waste sector were recorded at 78.17 kt CO_2 equivalent in 2022, representing 3.43% of the overall emissions for that year.

The highest emissions stemmed from open burning, accounting for 6.1 kt CO_2, 2.58 kt CH_4 and 0.003 kt from N_2O. Emissions have shown an increasing trend since 1990, with a total rise of 43% over this period, primarily influenced by population growth.

Wastewater treatment was the largest contributor within the sector, responsible for approximately 52% of total emissions in 2022, followed by solid waste disposal sites (SWDS) at 32% and open burning at 17%. Overall, emissions have gradually increased across all years within the inventory, since they are based on population.

3.5.2. Solid waste disposal (CRT 5.A)

The emissions from this subcategory are mainly CH_4 and they account for 32% of the sector emissions. Since these are also based on population, they also show a steady increase over time.

3.5.3. Biological treatment of solid waste (CRT 5.B)

In Eswatini, only about 1% of Municipal Solid Waste (MSW) was estimated to be composted, leading to minimal greenhouse gas emissions from composting activities. Consequently, the greenhouse gas emissions associated with composting are regarded as negligible.

3.5.4. Incineration and open burning of waste (CRT 5.C)

In Eswatini, incineration is mainly used for managing healthcare risk waste, producing emissions that include CH_4, CO_2, and N_2O. for 2022, the total emissions from incineration were 0.13 kt CO_2 eq. in this category, open burning of waste was also estimated to contribute 12.96 kt CO_2 eq in 2022. This comes mainly from waste management practices in rural areas which accounts for about 69% of waste generated in the country. Therefore open burning of waste generates over 99% of the emissions in this category.

3.5.5. Wastewater treatment and discharge (CRT 5.D)

Wastewater handling leads to emissions of methane (CH4) and nitrous oxide (N2O). For inventory purposes, all wastewater was classified under domestic treatment and discharge due to data segregation challenges, and emissions are estimated based on population data, which is gradually increasing. This category accounts for 40.30 kt CO_2 equivalence of the waste sector emissions which is about 51% of the total sector emissions.

3.5.6. Other (please specify) (CRT 5.E)

This subcategory is not applicable.

RE.4. Other information

4.1. Indirect CO_2 and N_2O emissions

These were not estimated due to capacity constraints.

4.2. Recalculations

There were no recalculations for this inventory.

RE.5. Analysis of key categories

[Include a brief summary of Section 1.4 of the NID focusing on results rather than the applied theory or methodology]

RE.6. Improvements introduced

This is not applicable as this is the first BTR.

Chapter 1. NATIONAL CIRCUMSTANCES, INSTITUTIONAL ARRANGEMENTS AND CROSS-CUTTING INFORMATION

1.1. Background information on GHG inventories and climate change

1.1.1. Climate change

Climate change continues to be one of the greatest threats to mankind and sustainable development across the globe. Efforts to mitigate climate change has yielded minimal results with the sixth Assessment Report of the IPCC (AR6) indicating that there are gaps between projected emissions from implemented policies and those from NDCs and finance flows fall short of the levels needed to meet climate goals across all sectors and regions.[1] This happens at a time where widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred, leading to widespread adverse impacts and related losses and damages to nature and people. Not only is the strengthening of commitments necessary, but so is the need to ensure current commitments are being met and the need for enhanced transparency.

1.1.2. National greenhouse gas inventories

Eswatini prepared her 2022 GHG inventory in accordance with the Modalities, Procedures and Guidelines (MPGs), adopted by the first Conference of the Parties serving as the meeting of the parties to the Paris Agreement (Decision 18/CMA.1), applying some of the flexibilities available to developing countries. In particular, the inventory covers the period from 1990 to 2022, with 2022 being the reporting year. Each year covers five (5) sectors, namely Energy; Industrial Processes and Product Use (IPPU); Agriculture; Land Use, Land Use Change and Forestry (LULUCF); and Waste, wherein carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) are estimated. Nitrogen trifluoride (NF_3) and Perfluorocarbons (PFCs) does not occur in country as none of the industries produce these gases. Emissions from precursors (NO_x, CO, NMVOC and SO_x) were not estimated owing to capacity constraints that came with the use of the IPCC software which the country was utilising for the first time.

Eswatini previously submitted her 2018 inventory as part of her first Biennial Update report, wherein the country's total emissions stood at 2,765.05 Gg CO_2 equivalent without LULUCF and 3,240.10 Gg CO_2 equivalent with LULUCF, noting that LULUCF was a net emitter. However, the uncertainty for LULUCF was high and Eswatini committed through her NDC 2.0 to improve from Tier 1 to Tier 2, which has been undertaken in the current inventory submission. Furthermore, a waste characterisation assessment was undertaken which led to changes in the solid waste emissions estimations This along with the change in Global Warming Potentials (GWPs) prescribed by the fifth assessment report (AR5) of the IPCC in accordance with paragraph 37 of the modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement (MPGs) accounts for a change in the country's emission trends, however recalculations have not been assessed.

[1] https://www.ipcc.ch/report/ar6/syr/resources/spm-headline-statements

The GHG Inventory serves to fulfil Eswatini's commitments to the UNFCCC and to the Paris Agreement and constitutes information that can be synthesised with that from other Parties to ascertain how the global community is doing towards limiting the global temperature increase to within 2 degrees Celsius above preindustrial temperatures, and that of attaining net-zero by mid-century. The inventory will further be utilised for the country's REDD+ Report and the development of the REDD+ Strategy. It will also inform the review of the country's NDC and developing NDC 3.0 which is due for submission in 2025.

1.2. Description of national circumstances and institutional arrangements

1.2.1. National entity or national focal point

Eswatini's National Focal Point to the United Nations Convention on Climate Change (UNFCCC) and the Paris Agreement is the Ministry of Tourism and Environmental Affairs (MTEA) where the National Meteorological Service (Met) serves as the technical office responsible for coordinating climate action and transparency work. However, the Government of the Kingdom of Eswatini is currently developing a bill that will give legal mandates for climate change management in the Kingdom of Eswatini.

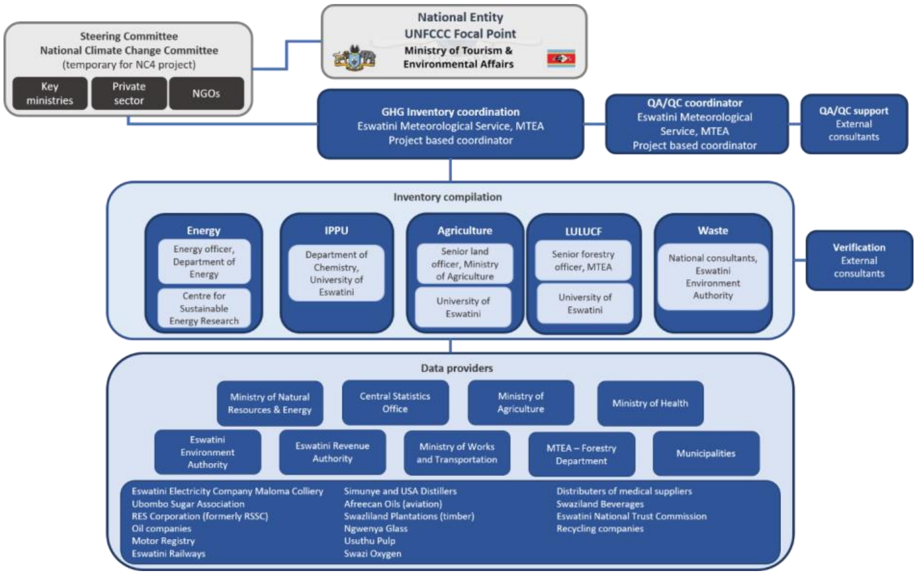
1.2.2. Inventory preparation process

While MTEA is responsible for the preparation of the country's GHG inventory, the need to work with the sectors that emit/remove GHGs in the country was identified. In particular, the Ministry of Natural Resources and Energy, Energy Department assists with the Energy Sector Inventory; the Eswatini Environment Authority (EEA) with the IPPU inventory; the Ministry of Agriculture with the Agriculture inventory; the Ministry of Tourism and Environmental Affairs, Forestry Department in collaboration with the Land Use Section of the Ministry of Agriculture for the FOLU inventory; while the EEA also assists with the waste inventory.

Efforts are ongoing to improve continuous activity data collection from the various sectors in order to allow for the systematic preparation of the GHG inventory. However, due to capacity constrains the GHG inventory has been prepared with the assistance of the University of Eswatini's research centres, with experts from the aforementioned departments and institutions assisting with consultations with data providers and different stakeholders as and when necessary and with quality control.

The inventory focal point within MTEA also contributed to the quality control, and served as the inventory compiler, checking for transparency, accuracy, completeness and consistency of the inventory and the inventory document. The United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC) performed the inventory and National Inventory Document's quality assurance.

Figure 1-1. Structure diagram of Eswatini's national inventory system



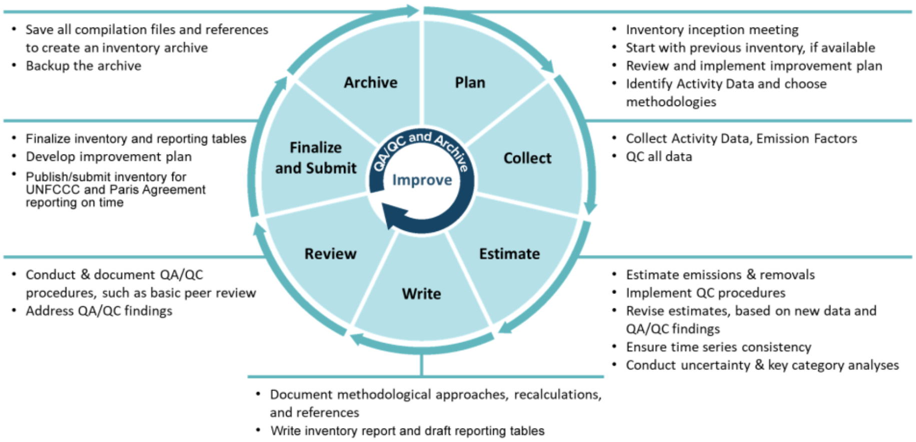
There are currently no legal arrangements for the preparation of the GHG inventory, however, the institutional arrangements described above are supported by the alignment of the GHG inventory compilation exercise with the work of the respective departments/department as follows:

1. Department of Energy, Ministry of Natural Resources and Energy: The department is responsible for the preparation of the country's annual energy balance. The data needed for the preparation of the energy sector inventory largely overlaps with that needed for the energy balance, as such the data collection tools for the energy balance, with the support of the Initiative for Climate Action Transparency (ICAT), was improved to ensure the collected data is comprehensive and well disaggregated to also support the inventory preparation.
2. Eswatini Environment Authority, a public enterprise within the Ministry of Tourism and Environmental Affairs is responsible for the Montreal Protocol and the Kigali Amendment, which had the authority collecting a lot of data and information related to IPPU, such as data on HFCs and SF_6. The authority is also responsible for the country's waste strategy which has them collecting data of waste management across the country.
3. The Ministry of Agriculture collects data for various agricultural activities in support of the Ministry's activities. Efforts have been made to improve some of the data collection in order to improve data required for inventories. The Ministry also hosts a Land Use Department whose services include, but are not limited land planning; engineering planning; soil conservation; and soil survey. This places the Ministry in a good position to support the land use aspects of the inventory.
4. The Forestry Department of the Ministry of Tourism and Environment's mandate includes maintaining a comprehensive national forest inventory, with an adequate planning capability and technical forest management capacity. This mandate

positions the Department for collecting data required for the forestry component of the inventory

With Support from the Capacity-building Initiative for Transparency (CBIT), Memoranda of Understanding are being prepared between the GHG Inventory Entity and the aforementioned institutions in order to facilitate systematic inventory compilation. Experts from these institutions constitute the GHG Inventory Working Group which is part of the multi-layered National Climate Change Committee whose Operational level serves as a Steering Committee for transparency programmes, including preparation of Biennial Transparency Reports and National Communications.
Figure 1-1 above highlights some of the key data providers. Eswatini is yet to formalise her permanent GHG inventory working plan, Figure 1-2 below gives on an overview of how the cycle is anticipated.

Figure 1-2. Eswatini's anticipated national greenhouse gas inventory cycle



Source: [example based on Figure 2 of the *Inventory Planning* template of the *Toolkit for Building National GHG Inventory Systems* of the United States Environmental Protection Agency]

1.2.3. Archiving of information

While the UNFCCC Reporter Tool provides some archiving capabilities regarding the Common Reporting Table, a Transparency Coordination Platform (TCP) and an NDC Registry Platforms are currently under development to be used to archive various aspects of the work including activity data used for the inventory compilation.

1.2.4. Processes for official consideration and approval of inventory

The National GHG Inventory after being finalised by the compiling team and validated by the GHG Inventory Task Team and stakeholders, it is then shared with the National Climate Change Committee-Operational and with Cabinet for information.

1.3. General description of methodologies and data sources

The inventory compilation mostly made use of IPCC default emission factors and Tier 1 methodology with the exception of the following categories/subcategories where Tier 2 was employed:

- *Road Transport*: Vehicle fuel economy and scrappage rates used were obtained from South Africa where the fuel is imported from.
- *Fugitive emissions from solid fuels*: The emission factors for where sourced from the mine where a study was undertaken
- *Forestry and Other Land Use Sector*

The following sectors continued to use Tier 1 approach despite having emerged as Key Categories in the 2018 inventory due to different reasons including poor availability of data, aggregated data and lack of country specific emission factors. Some of these categories include:

- Enteric Fermentation, Non-dairy Cattle, CH_4:
- Direct N_2O MS - Organic inputs - Manure application
- Indirect N_2O from MM - Non-Dairy Cattle
- Wastewater - Domestic Wastewater handling
- Manufacturing Industries and Construction – Solid and liquid Fuels
- Railways - Liquid Fuels
- Solid waste disposal on land
- Other Sectors - Liquid Fuels
- Indirect N_2O MS - Indirect N_2O leaching
- Direct N_2O MS - Organic fertilisers - Urine and dung
- MSW Open burning
- Enteric Fermentation – Goats
- Direct N_2O MS - N inputs
- Other Sectors - Biofuels

Sources of data for the inventory includes the following:

- Previous inventory
- Energy balance
- Relevant national reports and inventories
- ICAT projects

Where there were data gaps, data filling techniques were employed which included extrapolation, interpolation etc, depending on expert judgement for that category. Table 1-1 gives a summary of the methods applied by category and sector.

Table 1-1.

Summary report for methods applied to Eswatini inventory

Code	GHG source and sink categories	CO_2		CH_4		N_2O		HFC		PFC		SF_6		NF_3	
		Method	Emission Factor	Method	Emission Factor	Method	Emission Factor	Method	Emission Factor	Method	Emission Factor	Method	Emission Factor	Method	Emission Factor
1.	**Energy**	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
1.A.	Fuel combustion	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
1.A.1.	Energy industries	NA	NA	NA	NA	NA	NA								
1.A.2.	Manufacturing industries and construction	T1,NA	D,NA	T1,NA	D,NA	T1,NA	NA								
1.A.3.	Transport	T2,NA	D,NA	T2,NA	D,NA	T2,NA	D,NA								
1.A.4.	Other sectors	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
1.A.5.	Other (please specify)	NA	NA	NA	NA	NA	NA								
1.B.	Fugitive emissions from fuels	NA	NA	T2,NA	CS,NA	NA	NA								
1.B.1.	Solid fuels	NA	NA	T2,NA	CS,NA	NA	NA								
1.B.2.	Oil and natural gas and other emissions from energy production	NA	NA	NA	NA	NA	NA								
1.C.	CO_2 transport and storage	NA	NA												
2.	**Industrial processes and product use**	T1,NA	D,NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.A.	Mineral industry	NA	NA												
2.B.	Chemical industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.C.	Metal industry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.D.	Non-energy products from fuels and solvent use	T1,NA	D,NA	NA	NA	NA	NA								
2.E.	Electronic industry					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.F.	Product uses as substitutes for ODS							NA	NA	NA	NA	NA	NA		
2.G.	Other product manufacture and use	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.H.	Other (please specify)	NA	NA	NA	NA	NA	NA								
3.	**Agriculture**	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
3.A.	Enteric fermentation			T1,NA	D,NA										
3.B.	Manure management			T1,NA	D,NA	T1,NA	D,NA								
3.C.	Rice cultivation			NA	NA										
3.D.	Agricultural soils			NA	NA	T1,NA	D,NA								
3.E.	Prescribed burning of savannahs			NA	NA	NA	NA								
3.F.	Field burning of agricultural residues			NA	NA	NA	NA								
3.G.	Liming	T1,NA	D,NA												
3.H.	Urea application	T1	D												
3.I.	Other carbon-containing fertilizers	NA	NA												
3.J.	Other (please specify)	NA	NA	NA	NA	NA	NA								
4.	**Land use, land-use change and forestry**	T2,NA	D,NA	NA	NA	NA	NA								
4.A.	Forest land	NA	NA	NA	NA	NA	NA								
4.B.	Cropland	T2,NA	D,NA	NA	NA	NA	NA								
4.C.	Grassland	NA	NA	NA	NA	NA	NA								
4.D.	Wetlands	NA	NA	NA	NA	NA	NA								
4.E.	Settlements	NA	NA	NA	NA	NA	NA								
4.F.	Other land	NA	NA	NA	NA	NA	NA								
4.G.	Harvested wood products	NA	NA												
4.H.	Other (please specify)	NA	NA	NA	NA	NA	NA								
5.	**Waste**	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
5.A.	Solid waste disposal			NA	NA										
5.B.	Biological treatment of solid waste			T1,NA	D,NA	T1,NA	D,NA								
5.C.	Incineration and open burning of waste	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
5.D.	Wastewater treatment and discharge			T1,NA	D,NA	T1,NA	D,NA								

Code	*GHG source and sink categories*	*CO_2*		*CH_4*		*N_2O*		*HFC*		*PFC*		*SF_6*		*NF_3*	
		Method	*Emission Factor*	*Method*	*Emission Factor*	*Method*	*Emission Factor*	*Method*	*Emission Factor*	*Method*	*Emission Factor*	*Method*	*Emission Factor*	*Method*	*Emission Factor*
5.E.	Other (please specify)	NA	NA	NA	NA	NA	NA								
6.	**Other (please specify)**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
	Memo items	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
1.D.1.	International bunkers	NA	NA	NA	NA	NA	NA								
1.D.1.a.	Aviation	T1,NA	D,NA	T1,NA	D,NA	T1,NA	NA								
1.D.1.b.	Navigation	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
1.D.2.	Multilateral operations	T1,NA	D,NA	T1,NA	D,NA	T1,NA	D,NA								
1.D.3.	CO_2 emissions from biomass	NA	NA	NA	NA	NA	NA								
1.D.4.	CO_2 captured	NA	NA	NA	NA	NA	NA								
5.F.1.	Long-term storage of C in waste disposal sites	NA	NA	NA	NA	NA	NA								
	Indirect N_2O	NA	NA	NA	NA	NA	NA								
	Indirect CO_2	NA	NA												

Notes:

- Use the following notation keys to specify the method applied: D = IPCC default; T1 = IPCC tier 1; T1a, T1b, T1c = IPCC tier 1a, tier 1b and tier 1c, respectively; T2 = IPCC tier 2; T3 = IPCC tier 3; CR = CORINAIR; CS = country-specific; M = model; RA = reference approach; OTH = other.
- Use the following notation keys to specify the emission factor applied: D = IPCC default; CR = CORINAIR; CS = country-specific; M = model; PS = plant-specific; OTH = other.

Source: [], based on the **Summary3** spreadsheet of the CRT.

1.4. Description of key categories

The key category analysis for the 2022 inventory was conducted using Approach 1 with the criteria unaltered at 95%. The analysis is done for both key categories including LULUCF and key categories excluding LULUCF.

Table 1-2, an adaptation of Table7 of the CRT, provides a summary of the key category analysis. The key category analysis in both level analysis and trend analysis shows mostly energy sector and AFOLU subcategories in the top 95% of sources and sinks. While LULUCF, Road Transport and Fugitive emissions from solid fuels are estimated using Tier 2 methodology, the results will be used to inform on more categories to be considered for Tier 2 methodology in Eswatini.

Table 1-2.
Summary of 2022 key categories analysis approach 1, showing key categories for instances where LULUCF is included and excluded.

KEY CATEGORIES OF EMISSIONS AND REMOVALS (2)	Gas	Criteria used for key source identification		Key category excluding	Key category including
		L	T	LULUCF	LULUCF
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	X	X	X	X
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	X	X	X	X
1.A.3.b Road Transportation	CO_2	X	X	X	X
1.A.3.c Railways	CO_2	X	X	X	X
1.A.4 Other Sectors - Liquid Fuels	CO_2	X	X	X	X
1.A.4 Other Sectors - Solid Fuels	CO_2		X	X	X
1.A.4 Other Sectors - Biomass	CH_4	X	X	X	X
3.A Enteric Fermentation	CH_4	X	X	X	X
3.B Manure Management	N_2O	X		X	
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	X	X	X	X
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	X	X	X	
3.H Urea Application	CO_2	X	X	X	X
4.A.1 Forest Land Remaining Forest Land	CO_2	X	X		X
4.A.2 Land Converted to Forest Land	CO_2	X	X		X
4.B.2 Land Converted to Cropland	CO_2	X	X		X
4.E.2 Land Converted to Settlements	CO_2		X		X
5.A Solid Waste Disposal	CH_4	X		X	
5.D Wastewater Treatment and Discharge	CH_4	X		X	

Note:
Source: [], based on the **Table7** spreadsheet of the CRT.

1.5. General description of the QA/QC plan and implementation

The inventory QA/QC plan is summarized as follows:

Organizational structure: The inventory compilation was done by teams working on specific categories. Each team had at least one member from the University of Eswatini's centres (Centre for Sustainable Energy Research and Centre for Climate Change and Sustainability) and at least one government officer from a relevant ministry/department. In addition, for the waste categories, officers from Eswatini Environment Authority were involved. The Centres are responsible for implementation of the plan.

General Inventory QC procedures: Consistency checks between the previous inventory and the current inventory was done by each team.

Source-specific QC procedures: In each team, data sources were checked to ensure data is transferred accurately between the source and the inventory compilation software. In particular, the use of correct units was constantly checked.

QA procedures: The inventory was reviewed by the Director of Meteorology and UNEP-CCC.

1.6. General uncertainty assessment

The inventory compilation teams opted for the flexibility to use qualitative discussions for the uncertainty assessment. However, in the energy category, a quantitative discussion has been provided. Uncertainties vary from about 6% up to about 13% for CO_2 in the energy subcategories but are generally very high (about 200% or more) for CH_4 and N_2O. In the long term Eswatini can gradually begin to measure and document country specific emission factors in fuel combustion activities.

In general, most of the sectors had high uncertainties due to the use of Tier 1 approach.

1.7. General assessment of completeness

1.7.1. Information on completeness

The inventory compilation teams ensured that all categories that were estimated in the previous inventory continue to be estimated in the current inventory. Most of the categories tagged as not estimated in the CRT Table 9 are either not occurring in Eswatini or while some are labelled IE as they are estimated elsewhere because the data's level of disaggregation does not allow for estimation in the actual subcategories. However, in the case of estimates taking place elsewhere because of data aggregation, Eswatini will continue to improve data collection and eventually have emissions estimates in the actual subcategories..

Among the gases which countries are required to report on, i.e. CO_2, CH_4, N_2O, HFC, PFC, SF_6 and NF_3, Eswatini's inventory is without PFC and NF_3 as all information gathered by the team indicates that they are not occurring.

1.8. Metrics

Global warming potentials (GWP) (100-year time-horizon) from the fifth assessment report were used in the inventory compilation. Table 1-3 provides a summary of the GWPs from the fifth assessment report.

Table 1-3.

Global warming potential and global temperature potential used in the inventory, values for a 100-year time-horizon

Trade or common name	Chemical formula	Global warming potential	Global temperature potential
Carbon dioxide	CO_2	1	1
Methane	CH_4	28	4
Fossil methane	CH_4	30	6
Nitrous oxide	N_2O	265	234
HFC-23	CHF_3	12,400	12,700
HFC-32	CH_2F_2	677	94
HFC-41	CH_3F_2	116	16
HFC-125	CHF_2CF_3	3,170	967
HFC-134	CHF_2CHF_2	1,120	160
HFC-134a	CH_2FCF_3	1,300	201
HFC-143	CH_2FCHF_2	328	46
HFC-143a	CH_3CF_3	4,800	2,500
HFC-152	CH_2FCH_2F	16	2
HFC-152a	CH_3CHF_2	138	19
HFC-161	CH_3CH_2F	4	<1
HFC-227ea	CF_3CHFCF_3	3,350	1,460
HFC-236cb	$CH_2FCF_2CF_3$	1,210	185
HFC-236ea	CHF_2CHFCF_3	1,330	195
HFC-236fa	$CF_3CH_2CF_3$	8,060	8,380
HFC-245ca	$CH_2FCF_2CHF_2$	716	100
HFC-245fa	$CH_2FCF_2CHF_2$	858	121
HFC-365mfc	$CH_3CF_2CH_2CF_3$	804	114
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	1,650	281
Sulfur hexafluoride	SF_6	23,500	28,200
Nitrogen trifluoride	NF_3	16,100	18,100
PFC-14	CF_4	6,630	8,040
PFC-116	C_2F_6	11,100	13,500
PFC-218	C_3F_8	8,900	10,700
PFC-318	$c\text{-}C_4F_8$	9,540	11,500
PFC-31-10	C_4F_{10}	9,200	11,000
PFC-41-12	C_5F_{12}	8,550	10,300
PFC-51-14	C_6F_{14}	7,910	9,490
PCF-91-18	$C_{10}F_{18}$	7,190	8,570
Trifluoromethyl sulfur pentafluoride	SF_5CF_3	17,400	20,200
PFC-c216	$c\text{-}C_3F_6$	9,200	11,000
HFE-125	CHF_2OCF_3	12,400	10,900
HFE-134	CHF_2OCHF_2	5,560	1,430
HFE-143a	CH_3OCF_3	523	73
HCFE-235da2	$CHF_2OCHClCF_3$	491	68
HFE-245cb2	$CH_3OCF_2CF_3$	654	91
HFE-245fa2	$CHF_2OCH_2CF_3$	812	114
HFE-347mcc3	$CH_3OCF_2CF_2CF_3$	530	74
HFE-347pcf2	$CHF_2CF_2OCH_2CF_3$	889	124
HFE-356pcc3	$CH_3OCF_2CF_2CHF_2$	413	57
HFE-449sl (HFE-7100)	$C_4F_9OCH_3$	421	59
HFE-569sf2 (HFE-7200)	$C_4F_9OC_2H_5$	57	8
HFE-43-10pccc124 (H-Galden 1040x)	$CHF_2OCF_2OC_2F_4OCHF_2$	2,820	436
HFE-236ca12 (HG-10)	$CHF_2OCF_2OCHF_2$	5,350	1,420
HFE-338pcc13 (HG-01)	$CHF_2OCF_2CF_2OCHF_2$	2,910	442
HFE-227ea	$CF_3CHFOCF_3$	6,450	3,630
HFE-236ea2	$CHF_2OCHFCF_3$	1,790	260
HFE-236fa	$CF_3CH_2OCF_3$	979	138
HFE-245fa1	$CHF_2CH_2OCF_3$	828	116
HFE 263fb2	$CF_3CH_2OCH_3$	1	<1
HFE-329mcc2	$CHF_2CF_2OCF_2CF_3$	3,070	718
HFE-338mcf2	$CF_3CH_2OCF_2CF_3$	929	131
HFE-347mcf2	$CHF_2CH_2OCF_2CF_3$	854	120
HFE-356mec3	$CH_3OCF_2CHFCF_3$	387	54
HFE-356pcf2	$CHF_2CH_2OCF_2CHF_2$	719	101
HFE-356pcf3	$CHF_2OCH_2CF_2CHF_2$	446	62
HFE 365mcf3	$CF_3CF_2CH_2OCH_3$	<1	<1

Trade or common name	*Chemical formula*	*Global warming potential*	*Global temperature potential*
HFE-374pc2	$CHF_2CF_2OCH_2CH_3$	627	88
PFPMIE	$CF_3OCF(CF_3)CF_2OCF_2OCF_3$	9,710	11,300
Chloroform	$CHCl_3$	16	2
Methylene chloride	CH_2Cl_2	9	1
Methyl chloride	CH_3Cl	12	2
Halon-1201	$CHBrF_2$	376	52

Note:
Source: IPCC Fifth Assessment Report (AR5)

1.9. Summary of any flexibility applied[2]

Flexibility provisions applied in the inventory compilation are summarized as follows:

[2] Countries may elect either to report the information on specific flexibility provisions applied in a separate chapter or to integrate this information into sectoral chapters relevant to where specific flexibility provisions have been applied.

Table 1-4.
Summary of the flexibility provisions applied

Commented [TN1]: I have started the table afresh as the original has issues with aditing

These were not estimated.	Year	Sector	Category	Gas	**Description of the application of flexibility**	**Clarification of capacity constraint**	**Timeframe for improvement**	**Progress made in addressing areas of improvement**
Para. 35 of decision 18/CMA.1 (QC procedures)	All	All	-	-	Eswatini could not fully quality control. However, the team that was working on the inventory (UNESWA team) was working closely with sectoral experts from Government and other Public Enterprises, who helped with the quality control, especially of the activity data,	Time was the key constraint.	-	-
Para. 34 of decision 18/CMA.1 (QA/QC plan)	All	All	-	-	The previous QA/QC plan no longer applicable due to changes in effected in the preparation of the inventory in order to implement the ETF within a limited time frame.	With the limited timeframe within which Eswatini prepared the GHG Inventory, and the limited number of professionals working in this area, it was difficult to update the QA/QC and implement it .	Eswatini will work towards developing and improving the QA/QC plan within the next 6 years.	-
Para. 29 of decision 18/CMA.1 (Uncertainty Assessment)	All	All			Eswatini's seeks to use qualitative description f uncertainty due to capacity constraint		Eswatini seeks to improve the uncertainty assessment over the next 6 years subject to capacity building in this area	

Chapter 2. TRENDS IN GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1. Description of trend for aggregated GHG emissions and removals

Eswatini's net GHG emissions (including removals) have increased from -2062.59 kt of CO_2 eq in 1990 to -1922.2 kt of CO_2 eq in 2022. Eswatini's GHG emissions from sources (excluding LULUCF) have slightly increased over the years from 2094.86 kt of CO_2 eq in 1990 to 2213.94 kt of CO_2 eq in 2022. The years in between have seen national emissions fluctuate with the following values: 2231.03 kt of CO_2 eq in 1995; 2374.74 kt of CO_2 eq in 2000; 2207.95 kt of CO_2 eq in 2005; 2118.6 kt of CO_2 eq in 2010; 2335.92 kt of CO_2 eq in 2015 to 2267.68 kt of CO_2eq in 2018 to 2165.32 kt of CO_2eq in 2020 to 2213.94 kt of CO_2eq in 2022.

For the latest inventory year (2022), Energy sector emissions by gases were as follows: 1123.29 kt CO_2eq, 103.58 kt CO_2eq and 38.69 kt CO_2eq for CO_2, CH_4, and N_2O, respectively. For the Industrial Processes and Product Use sector emissions by gas 4.09 kt of CO_2eq for CO_2, 0.04 kt of CO_2eq for N_2O, 2.4 kt of CO_2eq for HFC-32, 22.5 kt of CO_2eq for HFC-125, 17.5 kt of CO_2eq for HFC-134a, 18.8 kt of CO_2eq for HFC-143a, 5.5 kt of CO_2eq for HFC-227ea and 1.34 kt of CO_2eq for SF_6 in the latest inventory year. For the Agriculture sector 99.38 kt of CO_2eq, 507.86 kt of CO_2eq and 258.81 kt of CO_2eq for CO_2, CH_4, and N_2O, respectively in the latest inventory year. And finally, the Waste sector emissions for the latest inventory year are 6.23 kt of CO_2eq, 70.87 kt of CO_2eq and 1.11 kt of CO_2eq for CO_2, CH_4, and N_2O, respectively. The carbon sink, LULUCF, accounts for -4136.13 kt of CO_2 stored. These information is summarized in Table 2-1 and Table 2-2. Precursor gases, indirect CO_2 and N_2O are currently not estimated.

Table 2-1.
Summary for the national GHG inventory by sectors and categories

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs [1]	PFCs [1]	Unspecified mix of HFCs and PFCs [1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_X	Total GHG emissions/ removals [2]
	(kt)			CO_2 eq (kt) [3]			(kt)						CO_2 equivalents (kt) [3]
Total national emissions and removals	**-2,903.15**	**24.37**	**1.13**	**66.79**	**NA,NO**	**NO**	**0.00**	**NO**	**NA,NO**	**NA,NO**	**IE,NA,NO**	**NA,NO**	**-1,854.18**
1. Energy	**1,123.29**	**3.70**	**0.15**						**NO**	**NO**	**NO**	**NO**	**1,265.55**
1.A. Fuel combustion	1,111.18	3.70	0.15						NO	NO	NO	NO	1,253.44
1.A.1. Energy industries	NO	NO	NO						NE	NE	NE	NE	NO
1.A.2. Manufacturing industries and construction	224.63	0.38	0.05						NE	NE	NE	NE	249.02
1.A.3. Transport	848.22	0.18	0.05						NE	NE	NE	NE	867.22
1.A.4. Other sectors	38.33	3.13	0.04						NE	NE	NE	NE	137.21
1.A.5. Other	NO	NO	NO						NO	NO	NO	NO	NO
1.B. Fugitive emissions from fuels	12.11	IE,NO	IE,NO						NE	NE	NE	NE	12.11
1.B.1. Solid fuels	12.11	NO	NE						NE	NE	NE	NE	12.11
1.B.2. Oil and natural gas and other emissions from energy production	IE,NO	IE,NO	IE,NO						NE	NE	NE	NE	IE,NO
1.C. CO_2 Transport and storage	NO												NO
2. Industrial processes and product use	**4.09**	**NA,NE**	**0.00**	**66.79**	**NA,NO**	**NO**	**0.00**	**NO**	**NE**	**NE**	**NE**	**NE**	**72.15**
2.A. Mineral industry	NE								NE	NE	NE	NE	NE
2.B. Chemical industry	NE	NE	NE	NO	NO	NO	NE	NO	NE	NE	NE	NE	NO
2.C. Metal industry	NE	NE	NE	NO	NO	NO	NE	NO	NE	NE	NE	NE	NO
2.D. Non-energy products from fuels and solvent use	4.09	NA,NE	NA,NE						NE	NE	NE	NE	4.09
2.E. Electronic industry			NA,NE	NO	NO	NO	NE	NO					NA,NO

2.F. Product uses as substitutes for ODS				66.79	NO	NO		NO					66.79
2.G. Other product manufacture and use	NE	NE	0.00	NO	NA,NO	NO	0.00	NO	NE	NE	NE	NE	1.26
2.H. Other [4]	NE	NE	NE						NE	NE	NE	NE	NE
3. Agriculture	**99.38**	**18.14**	**0.98**						**NA,NO**	**NA,NO**	**IE,NA,NO**	**NO**	**866.05**
3.A. Enteric fermentation		17.52											490.56
3.B. Manure management		0.62	0.08								IE,NO		37.69
3.C. Rice cultivation		NE									NO		NE
3.D. Agricultural soils		NA	0.90						NA	NA	NA		238.42
3.E. Prescribed burning of savannahs		NO	NO						NE	NE	NE	NE	NO
3.F. Field burning of agricultural residues		NE	NE						NE	NE	NE	NE	NE
3.G. Liming	1.94												1.94
3.H. Urea application	97.43												97.43
3.I. Other carbon-containing fertilizers	NA												NA
3.J. Other	NO	NO	NO						NO	NO	NO	NO	NO
4. Land use, land-use change and forestry [5]	**-4,136.13**	**NA,NO**	**IE,NA,NO**						**NA**	**NA**	**NA**	**NA**	**-4,136.13**
4.A. Forest land [5]	-4,204.54	NA,NE	IE,NA,NE						NA	NA	**NA**		-4,204.54
4.B. Cropland [5]	54.86	NA,NE	IE,NA,NE						NA	NA	NA		54.86
4.C. Grassland [5]	-9.42	NA,NE	IE,NA,NE						NA	NA	NA		-9.42
4.D. Wetlands [5]	NA,NE	NA,NE	IE,NA,NE						NA	NA	NA		IE,NA,NE
4.E. Settlements [5]	17.98	NA,NE	IE,NA,NE						NA	NA	NA		17.98
4.F. Other land [5]	4.99	NA,NO	NA,NO						NA	NA	NA		4.99
4.G. Harvested wood products [5]	NO												NO
4.H. Other [5]	NO	NO	NA,NO						NA	NA	NA	NA	NA,NO

5. Waste	**6.23**	**2.53**	**0.00**						**NO**	**NO**	**NO**	**NO**	**78.20**
5.A. Solid waste disposal [(6)]		**0.88**							**NE**	**NE**	**NE**		24.72
5.B. Biological treatment of solid waste		0.00	0.00						NO	NO	NO		0.11
5.C. Incineration and open burning of waste [(6)]	**6.23**	0.22	0.00						NE	NE	NE	NE	13.09
5.D. Wastewater treatment and discharge		1.43	0.00						NO	NO	NO		40.30
5.E. Other [(6)]	NO	NO	NO						NO	NO	NO	NO	NO
6. Other *(please specify)* [(7)]	**NE**	**NE**	**NE**	**NE**	**NE**	**NO**	**NE**	**NO**	**NE**	**NE**	**NE**		**NO**
Other sources of emissions/removals [IPCC Software 5.C]	NE	NE	NE	NE	NE	NO	NE	NO	NE	NE	NE		NO

Memo items: [(8)]													
1.D.1. International bunkers	14.88	0.00	0.00						NE	NE	NE	NE	14.90
1.D.1.a. Aviation	14.88	0.00	0.00						NE	NE	NE	NE	14.90
1.D.1.b. Navigation	NO	NO	NO						NE	NE	NE	NE	NO
1.D.2. Multilateral operations	NE	NE	NE						NE	NE	NE	NE	NE
1.D.3. CO_2 emissions from biomass	2,378.86												2,378.86
1.D.4. CO_2 captured	NE												NE
5.F.1. Long-term storage of C in waste disposal sites	157.28												157.28
Indirect N_2O			NE										NE

Indirect CO_2	NE												NE

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = not occurring; IE = included elsewhere; C = confidential.
Source: [], based on the **Summary1** spreadsheet of the CRT.

Table 2-2.

Summary for the national GHG inventory [2022] by sectors and categories

Code	GREENHOUSE GAS SOURCE AND	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	Total
	SINK CATEGORIES	CO_2 equivalents (kt) [2]								
1.	**Total (net emissions)** [1]	**-2,903.15**	**682.31**	**298.65**	**NO**	**NO**	**NO**	**NA,NO**	**NO**	**-1,922.20**
1.A.	**1. Energy**	**1,123.29**	**103.58**	**38.69**						**1,265.55**
1.A.1.	1.A. Fuel combustion	1,111.18	103.58	38.69						1,253.44
1.A.2.	1.A.1. Energy industries	NO	NO	NO						NO
1.A.3.	1.A.2. Manufacturing industries and construction	224.63	10.73	13.66						249.02
1.A.4.	1.A.3. Transport	848.22	5.09	13.90						867.22
1.A.5.	1.A.4. Other sectors	38.33	87.75	11.13						137.21
1.B.	1.A.5. Other	NO	NO	NO						NO
1.B.1.	1.B. Fugitive emissions from fuels	12.11	IE,NO	IE,NO						12.11
1.B.2.	1.B.1. Solid fuels	12.11	NO	NE						12.11
1.C.	1.B.2. Oil and natural gas and other emissions from energy production	IE,NO	IE,NO	IE,NO						IE,NO
2.	1.C. CO_2 transport and storage	NO								NO
2.A.	**2. Industrial processes and product use**	**4.09**	**NA,NE**	**0.04**	**NO**	**NO**	**NO**	**NA,NO**	**NO**	**4.13**
2.B.	2.A. Mineral industry	NE	NE	NE						NE
2.C.	2.B. Chemical industry	NE	NE	NE	NO	NO	NO	NE	NO	NO
2.D.	2.C. Metal industry	NE	NE	NE	NO	NO	NO	NE	NO	NO
2.E.	2.D. Non-energy products from fuels and solvent use	4.09	NA,NE	NA,NE						4.09
2.F.	2.E. Electronic Industry			NA,NE	NO	NO	NO	NE	NO	NA,NO
2.G.	2.F. Product uses as ODS substitutes				NO	NO	NO		NO	NO
2.H.	2.G. Other product manufacture and use	NE	NE	0.04	NO	NO	NO	NA,NO	NO	0.04
3.	2.H. Other	NE	NE	NE	NO	NO	NO	NO	NO	NO
3.A.	**3. Agriculture**	**99.38**	**507.86**	**258.81**						**866.05**
3.B.	3.A. Enteric fermentation		490.56							490.56
3.C.	3.B. Manure management		17.29	20.40						37.69
3.D.	3.C. Rice cultivation		NE							NE
3.E.	3.D. Agricultural soils		NA	238.42						238.42
3.F.	3.E. Prescribed burning of savannahs		NO	NO						NO
3.G.	3.F. Field burning of agricultural residues		NE	NE						NE
3.H.	3.G. Liming	1.94								1.94
3.I.	3.H. Urea application	97.43								97.43
3.J.	3.I. Other carbon-containing fertilizers	NE								NE
4.	3.J. Other	NO	NO	NO						NO
4.A.	**4. Land use, land-use change and forestry** [1]	**-4,136.13**	**NA,NO**	**IE,NA,NO**						**-4,136.13**
4.B.	4.A. Forest land	-4,204.54	NE	NA,NE						-4,204.54
4.C.	4.B. Cropland	54.86	NE	IE,NA,NE						54.86
4.D.	4.C. Grassland	-9.42	NE	IE,NA,NE						-9.42
4.E.	4.D. Wetlands	IE,NA,NE	NA,NE	NA,NE						IE,NA,NE
4.F.	4.E. Settlements	17.98	NE	NA,NE						17.98
4.G.	4.F. Other land	4.99	NA,NO	NA,NO						4.99
4.H.	4.G. Harvested wood products	NO								NO
5.	4.H. Other	NO	NO	NA,NO						NA,NO
5.A.	**5. Waste**	**6.23**	**70.87**	**1.11**						**78.20**
5.B.	5.A. Solid waste disposal		24.72							24.72
5.C.	5.B. Biological treatment of solid waste		0.07	0.04						0.11

Code	GREENHOUSE GAS SOURCE AND	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	Total
5.D.	5.C. Incineration and open burning of waste	6.23	6.16	0.70						13.09
5.E.	5.D. Waste water treatment and discharge		39.93	0.37						40.30
6.	5.E. Other	NA,NO	NO	NO						NA,NO
	6. Other *(as specified in summary 1)*									
1.D.1.	**Memo items:** [3]									
1.D.1.a.	**1.D.1. International bunkers**	14.88	0.00	0.02						14.90
1.D.1.b.	1.D.1.a. Aviation	14.88	0.00	0.02						14.90
1.D.2.	1.D.1.b. Navigation	NO	NO	NO						NO
1.D.3.	**1.D.2. Multilateral operations**	NE	NE	NE						NE
1.D.4.	**1.D.3. CO_2 emissions from biomass**	2,378.86								2,378.86
5.F.1.	**1.D.4. CO_2 captured**	NE								NE
	5.F.1. Long-term storage of C in waste disposal sites	157.28								157.28
	Indirect N_2O									
	Indirect CO_2 [4]									
	Total CO_2 equivalent emissions without LULUCF									
	Total CO_2 equivalent emissions with LULUCF									
	Total CO_2 equivalent emissions, including indirect CO_2, without LULUCF									
	Total CO_2 equivalent emissions, including indirect CO_2, with LULUCF									

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = n ot occurring; IE = included elsewhere; C = confidential.
Source: [], based on the **Summary2** spreadsheet of the CRT.

2.2. Description of trend by sector and gas

2.2.1. Description of trend by sector

In 2022, Eswatini net emissions are estimated at -1854.1 kt of CO_2eq. The breakdown of the net emissions is as follows: LULUCF sink estimate -4,136.1 kt CO2e; emissions from the energy sector 1,265.55 kt of CO_2eq, followed by agriculture with 866.05 kt of CO_2eq, waste sector with 78.2 kt of CO_2eq and last, the least contributing sector, IPPU with 72.15 kt of CO_2eq. Table 2-3 and Figure 2-1 summarizes the Eswatini's net emissions from 1990 to 2022.

When LULUCF is excluded, total emissions are estimated at 2282.02 kt of CO_2eq. The energy sector leads emissions, contributing 55% of the total, followed by agriculture which contributes 38% of the total. The waste sector and IPPU sectors are the least contributors, with waste contributing 3.4% and IPPU contributing 3.2% of the total. Table 2-4 and Figure 2-2 summarize total emissions for Eswatini.

The 2022 net emissions are less than the 2018 estimate by 42.15 kt of CO_2eq, with the agriculture sector leading in the decline of emissions. However, when compared with the 1990 estimate, the 2022 estimate represents an increase of 207.1 kt of CO_2eq. The increase when comparing with the base year is driven by the energy sector emissions which increase by 332.6 kt of CO_2eq while the agriculture sector declined by 233.8 kt of CO_2eq. With the decline in the agriculture sector mainly offsetting the increase from energy, the net emissions are increasing as a result of 3.B (Land) under the AFOLU sector. The increase in 3.B are a result of significant land use changes as previously untouched land has been included in expansions in cropland, especially sugar cane activities and some land has been consumed by human settlements.

Table 2-3.

Eswatini inventory: net GHG emissions by sector (kt CO_2 eq)

Sector	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
Energy	932.93	1,124.34	1,370.28	1,105.24	998.17	1,162.35	1,279.88	1,209.35	1,219.09	1,265.55
IPPU	8.71	11.51	23.42	32.02	53.67	58.47	53.86	59.52	69.64	72.22
Agriculture	1,099.89	1,040.01	934.18	1,029.10	1,043.06	1,093.37	908.80	875.24	870.71	866.05
LULUCF	-4,157.45	-4,157.45	-4,146.90	-4,145.50	-4,144.01	-4,137.96	-4,129.27	-4,136.77	-4,134.73	-4,136.13
Waste	54.67	59.38	63.35	66.56	69.69	72.77	74.78	76.46	77.33	78.20
Total net	**-2,061.25**	**-1,922.20**	**-1,755.66**	**-1,912.57**	**-1,979.41**	**-1,751.00**	**-1,811.95**	**-1,916.20**	**-1,897.96**	**-1,854.10**

Figure 2-1.
Eswatini inventory: total net GHG by sector (kt CO_2eq), 1990 -2022

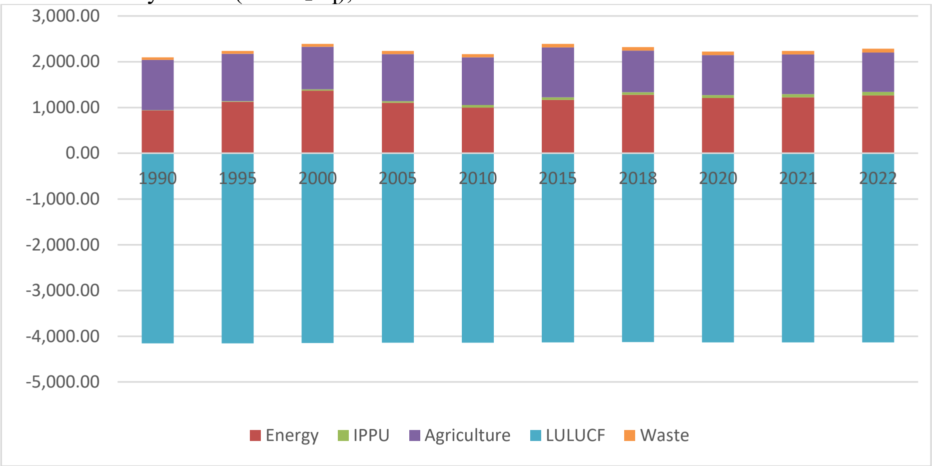
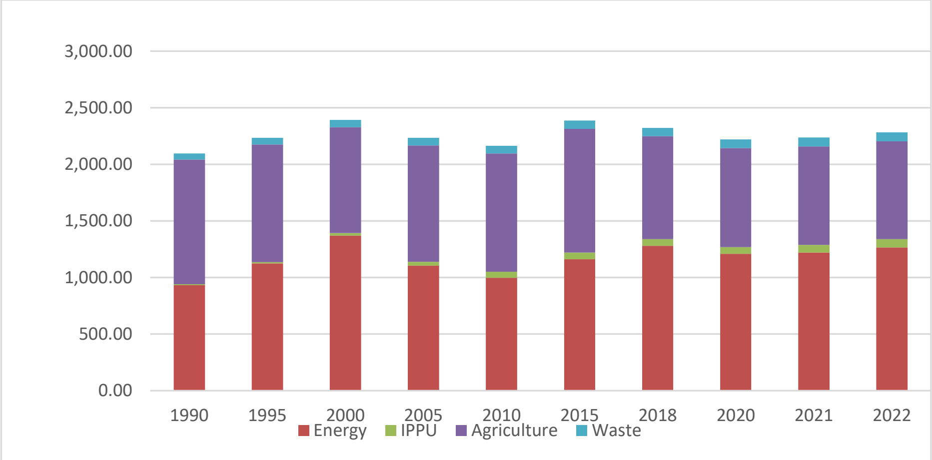


Table 2-4.
Eswatini's inventory: total GHGs by sector (kt CO_2eq)

Sector	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
Energy	932.93	1,124.34	1,370.28	1,105.24	998.17	1,162.35	1,279.88	1,209.35	1,219.09	1,265.55
IPPU	8.71	11.51	23.42	32.02	53.67	58.47	59.00	59.52	69.64	72.15
Agriculture	1,099.89	1,040.01	934.18	1,029.10	1,043.06	1,093.37	908.80	875.24	870.71	866.05
Waste	54.67	59.38	63.35	66.56	69.69	72.77	74.78	76.46	77.33	78.20
Total net	**2,096.20**	**2,235.25**	**2,391.23**	**2,232.93**	**2,164.60**	**2,386.96**	**2,322.46**	**2,220.57**	**2,236.78**	**2,282.03**

Figure 2-2.
Eswatini inventory: total GHGs without LULUCF by sector (kt CO_2eq), 1990-2022



2.2.2. Description of trend by greenhouse gas

Table 2-5 gives a summary of the each GHG for the inventory time series.

Table 2-5.
Eswatini's inventory: emissions and removals by GHG (kt CO_2eq)

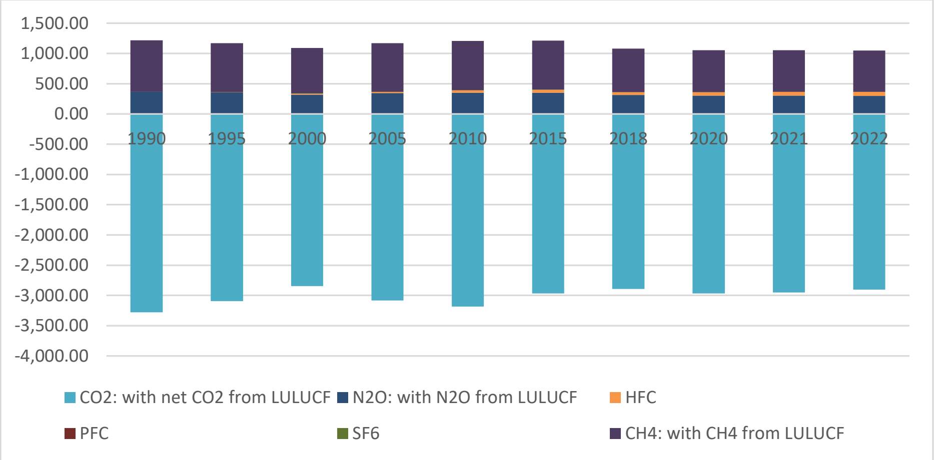
GHG	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
CO_2: without net CO_2 from LULUCF	878.93	1,063.78	1,302.75	1,064.33	958.85	1,172.81	1,236.92	1,168.50	1,183.11	1,232.98
CO_2: with net CO_2 from LULUCF	-3,278.52	-3,093.67	-2,844.15	-3,081.17	-3,185.16	-2,965.15	-2,892.35	-2,968.27	-2,951.62	-2,903.15
CH_4: without CH_4 from LULUCF	848.61	811.06	750.43	800.02	810.72	812.77	717.70	691.31	687.08	682.31
CH_4: with CH_4 from LULUCF	848.61	811.06	750.43	800.02	810.72	812.77	717.70	691.31	687.08	682.31

N_2O: without N_2O from LULUCF	367.32	356.19	321.56	343.61	349.03	350.34	313.05	305.51	300.97	298.65
N_2O: with N_2O from LULUCF	367.32	356.19	321.56	343.61	349.03	350.34	313.05	305.51	300.97	298.65
HFC	0.00	2.87	15.14	23.69	44.69	49.74	48.30	53.95	64.31	66.79
PFC	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs	NO	0.00	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	**2,094.86**	**2,231.03**	**2,374.74**	**2,207.95**	**2,118.60**	**2,335.92**	**2,267.68**	**2,165.32**	**2,171.16**	**2,213.94**
Total net (with LULUCF)	**-2,062.59**	**-1,926.42**	**-1,772.16**	**-1,937.55**	**-2,025.41**	**-1,802.04**	**-1,861.59**	**-1,971.45**	**-1,963.57**	**-1,922.20**
Total (without LULUCF, with indirect)	**2,094.86**	**2,231.03**	**2,374.74**	**2,207.95**	**2,118.60**	**2,335.92**	**2,267.68**	**2,165.32**	**2,171.16**	**2,213.94**
Total net (with LULUCF, with indirect)	**-2,062.59**	**-1,926.42**	**-1,772.16**	**-1,937.55**	**-2,025.41**	**-1,802.04**	**-1,861.59**	**-1,971.45**	**-1,963.57**	**-1,922.20**

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = not occurring; IE = included elsewhere; C = confidential.
Source: based on the **Table10s6** spreadsheet of the CRT.

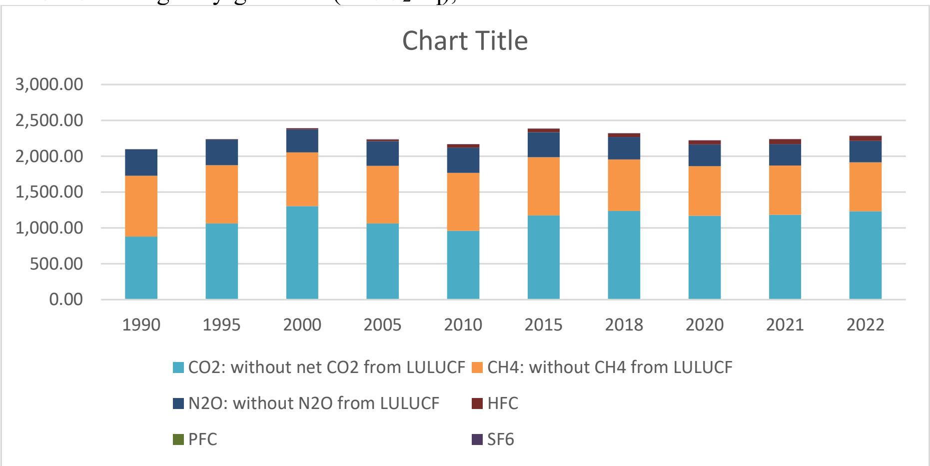
Eswatini's net GHG emissions are estimated from CO_2, CH_4, N_2O, HFC and SF_6. NF_3 and PFCs are currently not included in the estimate as all data and information gathered indicates they are not occurring. Net CO_2, estimates for 2022 are -2903.15 kt CO_2eq, hence remain fairly constant when compared with the -2892.35 kt of CO_2eq for the year 2018. However, net CO_2 show an 11% increase from the 1990 estimate of -3278.52 kt of CO_2eq. Net CH_4 estimates show a steady decline over the period 1990-2022. The 2022 estimate of 682.31 kt of CO_2eq represents a decline of 4.6% and 18.7% from the 2018 and 1990 estimates, respectively. Net N_2O estimates also show a steady decline over the period 1990-2022. The 2022 estimate of 298.65 kt of CO_2eq represents a decline of 4.6% and 18.7% from the 2018 and 1990 estimates, respectively. The HFC estimate shows a steady increase over the 1990-2022 period, with the 2022 estimate of 66.79 kt of CO_2eq representing a 38% increase from the 2018 estimate. It is noted that the 1990 estimate for HFC is close to zero. SF_6 is estimated to remain steady at 1.34 kt of CO_2eq throughout the period from 1990 to 2022. Table 2-5 and Figure 2-3 summarizes the Eswatini's emissions by gas with LULUCF for the period 1990-2022.

Figure 2-3.
Eswatini inventory: total net GHGs on a gas-by-gas basis (kt CO_2eq), 1990 -2022



Eswatini's total GHG emissions by gas excluding LULUCF are summarized by Table 2-5 and Figure 2-4. Carbon dioxide contributes 55.7% to total emissions in the latest inventory year. Methane, nitrous oxide, HFC and sulphur hexafluoride contribute 30.8%, 13.5%, 3.0% and 0.6%, respectively, to total emissions excluding LULUCF. A comparison of the latest inventory year and the last inventory year (2018) shows the following changes in the estimates by gas: carbon dioxide decreases by 0.3%, methane decreases by 4.9%, nitrous oxide decreases by 4.6%, HFCs increase by 38.2% and finally, sulphur hexafluoride remains constant. A similar comparison between the latest inventory year and 1990 shows the following changes to the estimates by gas: carbon dioxide increases by 40.3 %, methane decreased by 19.7%, nitrous oxide decreased by 18.6%, HFCs were estimated at zero for 1990 and increased to 66.8 kt of CO_2eq by 2022, and finally, sulphur hexafluoride is estimated to remain constant.

Figure 2-4.
Eswatini inventory: total GHGs on a gas-by-gas basis (kt CO_2 eq), 1990 -2022



2.3. Description of trend for precursor gas emissions

Precursor gases emissions have not been estimated.

2.4. Description of trend for other substances that have an impact on climate

Not included in the analysis.

2.5. Description of trend for GHG intensity indicators

Indicators not included in analysis.

Chapter 3. ENERGY (CRT 1)

3.1. Overview of the sector

The energy sector is the leading contributor to Eswatini's GHG emissions excluding LULUCF. The sector contributes 55.5% of national emissions in the latest inventory and is followed by agriculture with a contribution of 38 % to national emissions. The leading activities are the Fuel Combustion Activities with the Transport sector, in particular Road transportation and Railways, leading in total emissions. The other significant contributors to the sector's emissions are energy used in Manufacturing Industries and Construction, and Other sectors (a combination of the residential sector and commercial/public sector).

3.1.1. Description of the sector

Eswatini's energy supply is made up of biomass (fuelwood, bagasse, woodchips and waste), bituminous coal, electricity and petroleum products. The energy is used in Manufacturing Industries and Construction (1.A.2), Transport (1.A.3) and Other Sectors (1.A.4). The use of primary energy in electricity generation for the national grid ceased in 2012 when the diesel power plant owned by the national power utility stopped operating. Primary energy (bagasse and woodchips) continues to be in use in manufacturing to produce electricity for own use. The inventory describes emissions from fuel combustion (1A) and fugitive emissions (1B). Eswatini's largest source of energy emissions is the Transport sector (1.A.3) followed by Manufacturing Industries and Construction (1.A.2), Other Sectors (1.A.4), and fugitive emissions (1.B.1 and 1.B.2). Only fugitive emissions from coal mining have been included in the estimate, with data still being sought to enable the estimation of fugitive emissions from fossil fuels distribution.

3.1.2. Trend in the sector's GHG

The total energy sector emissions estimate for the year 2022 are1265.6 kt of CO_2eq. The total energy sector emissions are made up mostly of fuel combustion activities, 1.A, contributing 1253.44 kt of CO_2eq and fugitive emissions contributing 12.11 kt of CO_2eq, i.e. 99.04% and 0.96%, respectively. Precursor gases have not been estimated due to insufficient data on the processes consuming fuel.

Table 3-1.
Energy Sector: emissions by GHG, category and subcategory (kt) for 2022.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_X	Total GHG emissions (1)
	(kt)							CO_2 equivalents (kt) (2)
Total Energy	1,123.29	3.70	0.15	NO	NO	NO	NO	1,265.55
1.A. Fuel combustion activities (sectoral approach)	1,111.18	3.70	0.15	NO	NO	NO	NO	1,253.44
1.A.1. Energy industries	NO	NO	NO	NE	NE	NE	NE	NO
1.A.1.a. Public electricity and heat production	NO	NO	NO	NE	NE	NE	NE	NO
1.A.1.b. Petroleum refining	NO	NO	NO	NE	NE	NE	NE	NO
1.A.1.c. Manufacture of solid fuels and other energy industries	NO	NO	NO	NE	NE	NE	NE	NO
1.A.2. Manufacturing industries and construction	224.63	0.38	0.05	NE	NE	NE	NE	249.02
1.A.2.a. Iron and steel	NO	NO	NO	NE	NE	NE	NE	NO
1.A.2.b. Non-ferrous metals	NO	NO	NO	NE	NE	NE	NE	NO
1.A.2.c. Chemicals	NO	NO	NO	NE	NE	NE	NE	NO
1.A.2.d. Pulp, paper and print	NO	NO	NO	NE	NE	NE	NE	NO
1.A.2.e. Food processing, beverages and tobacco	NO	NO	NO	NE	NE	NE	NE	NO
1.A.2.f. Non-metallic minerals	NO	NO	NO	NE	NE	NE	NE	NO
1.A.2.g. Other	224.63	0.38	0.05	NE	NE	NE	NE	249.02
1.A.3. Transport	848.22	0.18	0.05	NE	NE	NE	NE	867.22
1.A.3.a. Domestic aviation	0.86	0.00	0.00	NE	NE	NE	NE	0.87
1.A.3.b. Road transportation	816.99	0.18	0.04	NE	NE	NE	NE	832.83
1.A.3.c. Railways	30.37	0.00	0.01	NE	NE	NE	NE	33.53
1.A.3.d. Domestic navigation	NO	NO	NO	NE	NE	NE	NE	NO
1.A.3.e. Other transportation	NO	NO	NO	NE	NE	NE	NE	NO

1.A.4. Other sectors	38.33	3.13	0.04	NE	NE	NE	NE	137.21
1.A.4.a. Commercial/institutional	38.33	3.13	0.04	NE	NE	NE	NE	137.21
1.A.4.b. Residential	NO	NO	NO	NE	NE	NE	NE	NO
1.A.4.c. Agriculture/forestry/fishing	NO	NO	NO	NE	NE	NE	NE	NO
1.A.5. Other	NO	NO	NO	NO	NO	NO	NO	NO
1.A.5.a. Stationary	NO	NO	NO	NE	NE	NE	NE	NE
1.A.5.b. Mobile	NO	NO	NO	NO	NO	NO	NO	NO
1.B. Fugitive emissions from fuels	12.11	NO	NO	NE	NE	NE	NE	12.11
1.B.1. Solid fuels	12.11	NO	NE	NE	NE	NE	NE	12.11
1.B.1.a. Coal mining and handling	12.11	NO	NE	NE	NE	NE		12.11
1.B.1.b. Fuel transformation	NO	NO	NE	NE	NE	NE	NE	NO
1.B.1.c. Other	NO	NO	NE	NE	NE	NE	NE	NO
1.B.2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NE	NE	NE	NE	IE,NO
1.B.2.a. Oil	NO	NO	NO	NE	NE	NE	NE	NO
1.B.2.b. Natural gas	NO	NO			NE	NE	NE	NO
1.B.2.c. Venting and flaring	NO	NO	NO	NE	NE	NE	NE	IE,NE
1.B.2.d. Other	NO	NO	NO	NE	NE	NE	NE	NO
1.C. CO_2 Transport and storage	NO							NO
1.C.1. Transport of CO_2	NO							NO
1.C.2. Injection and storage	NO							NE
1.C.3. Other	NO							NO
1.D. Memo items: (3)								
1.D.1. International bunkers	14.88	0.00	0.00	NE	NE	NE	NE	14.90

1.D.1.a. Aviation	14.88	0.00	0.00	NE	NE	NE	NE	14.90
1.D.1.b.Navigation	NO	NO	NO	NE	NE	NE	NE	NO
1.D.2. Multilateral operations	NO	NO	NO	NE	NE	NE	NE	NO
1.D.3. CO_2 emissions from biomass	2,378.86							2,378.86
1.D.4. CO_2 captured	NO							NO
1.D.4.a. For domestic storage	NO							NO
1.D.4.b. For storage in other countries	NO							NO

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = not occurring; IE = included elsewhere; C = confidential.
Source: [], based on the **Table1** spreadsheet of the CRT.

The Transport sector (1A.3) is the main contributor to energy sector emissions, with 68.5% of the 2022 energy sector emissions estimate (1265.55 kt of CO_2eq). Other subsectors contribute as follows: 19.7% for manufacturing industries and construction (1.A.2), 10.8% for Other sectors (1.A.4) and 1% for fugitive emissions. The 2022 estimate of 1265.55 kt of CO_2eq is an increase of -1.22% and 35.7% from the 2018 and 1990 inventory estimates, respectively. The decline in the estimate between 2018 and 2022 is driven by the following changes: 1.A.2 15% change, 1.A.3 8.5% change, 1.A.4 -45.1% change and 1.B.1 -13.9% change. The increase in emissions between 1990 and 2022 is driven by the following changes: 1.A.2 -40.4 % change, 1.A.3 183.5% change, 1.A.4 -33.5% change and 1B.1 455.8% change.

Overall, the Transport sector drives the overall change in energy emissions due to its large contribution. While Transport sector emissions significantly increase from 1990, primarily due to increase in Road Transportation, the sector emissions increase gradually due to decreases in Manufacturing Industries and Construction, and Other sectors. It is noted that under Energy Industries, 1.A.1, a diesel power plant was operational until 2012. Eswatini's 1990-2022 energy sector estimates are summarized in Table 3-2 and Figure 3-1.

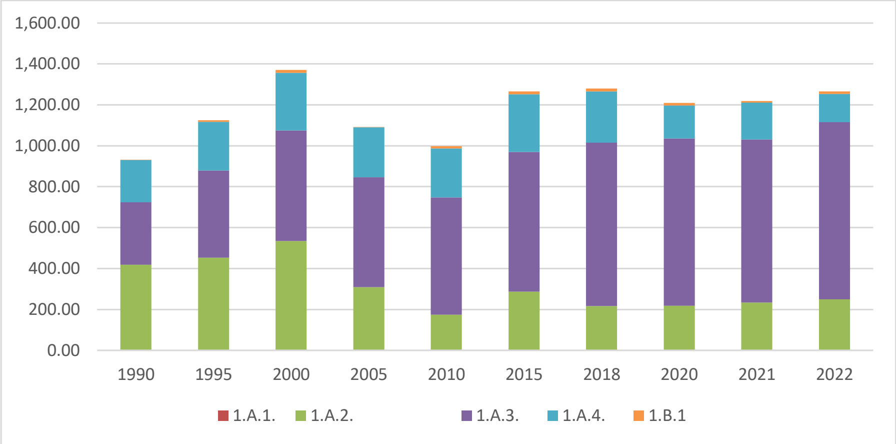
Table 3-2.

Energy sector: total GHG emissions by category or subcategory (kt CO_2 eq)

Category	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
1.A.1.	0.69	0.69	1.06	0.11	0.03	NO	NO	NO	NO	NO
1.A.2.	417.89	453.00	533.52	308.48	174.29	286.63	216.57	217.60	233.57	249.02
1.A.3.	305.88	425.58	540.13	537.23	572.98	683.44	799.35	817.43	796.90	867.22
1.A.4.	206.29	238.61	282.45	244.96	240.51	282.22	249.90	162.25	179.95	137.21
1.B.1	2.18	6.46	13.14	0.11	10.35	13.10	14.06	12.07	8.68	12.11
Total	**932.93**	**1,124.34**	**1,370.28**	**1,090.90**	**998.17**	**1,265.38**	**1,279.88**	**1,209.35**	**1,219.09**	**1,265.55**

Note:
Source: based on the **Table10s1** spreadsheet of the CRT.

Figure 3-1.
Energy sector: total GHG emissions by category or subcategory (kt CO_2eq), 1990-2022



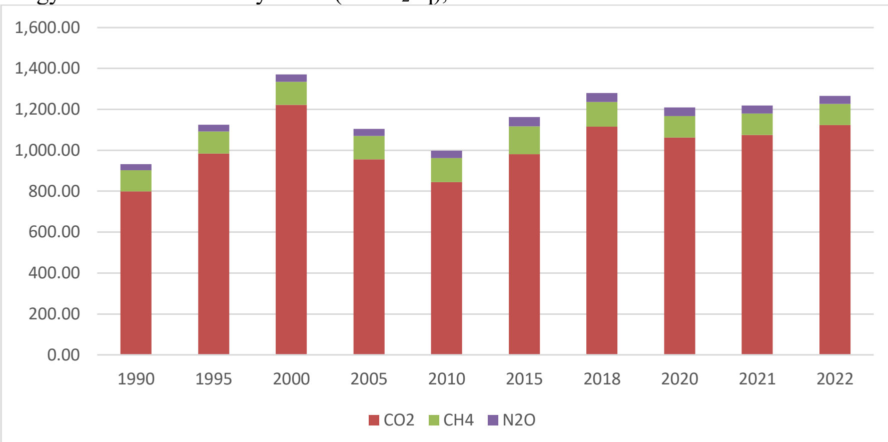
The 1265.55 kt of CO_2eq emissions estimate for 2022 in the energy sector is made up of 1123.29 kt of CO_2eq of carbon dioxide (88.6%), 103.58 kt of CO_2eq of methane (8.2%) and 38.69 kt of CO_2eq of nitrous oxide (3.2%). The changes in GHG emissions between 2022 and 2018 are as follows: carbon dioxide 0.75% change, methane -14.12% change and nitrous oxide -12.86% change. The changes in GHG emissions between 2022 and 1990 are as follows: carbon dioxide 40.55% change, methane -0.17% change and nitrous oxide 29% change.

The changes in carbon dioxide (gradual increase) are due to increases in road transportation. While the value for methane is almost constant when comparing 2022 to 1990, the values over the years fluctuate as a result of increase in methane from coal mining which are offset by decreases in manufacturing. Table 3-3 and Figure 3-2 summarizes the energy sector emissions by gas.

Table 3-3.
Energy sector: emissions by GHG (kt CO_2 eq)

GHG	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
CO_2	799.19	983.76	1,222.80	956.20	845.28	980.82	1,114.88	1,061.88	1,075.12	1,123.29
CH_4	103.75	107.75	111.70	113.89	116.67	135.66	120.60	105.44	104.74	103.58
N_2O	29.99	32.83	35.78	35.15	36.22	45.87	44.40	42.03	39.22	38.69
Total	932.93	1,124.34	1,370.28	1,105.24	998.17	1,162.35	1,279.88	1,209.35	1,219.09	1,265.55

Figure 3-2.
Energy sector: emissions by GHG (kt CO_2eq), 1990-2022



Precursor gasses have not been included in the inventory due to insufficient information on fuel combustion processes.

Other emissions that have an impact on the climate, such as short-lived climate pollutants and particulate matter have not been included in the inventory.

3.1.3. General methodological issues of the sector

IPCC guidelines were used in preparing the inventory. For the 1990-2018 period, the previous inventory was imported as is into the IPCC software, with changes resulting in changes in the GWPs of methane and nitrous oxide. For the 2019-2022 period, the inventory was prepared using data from the national energy balances produced by the Department of Energy of the Ministry of Natural Resources and Energy and vehicle data from the Road Transportation Department of the Ministry of Public Works and Transport. Tier 1 methodology was used for all subsectors in the energy sector inventory, with default emission factors from IPCC 2006 Guidelines. This is with the exception of the fugitive emissions where the emission factor was sourced from the mining company. It is also noted that the use of biomass is confined to own use in manufacturing industries.

3.2. Fuel combustion (CRT 1.A)

3.2.1. Description and trend of GHGs in the category

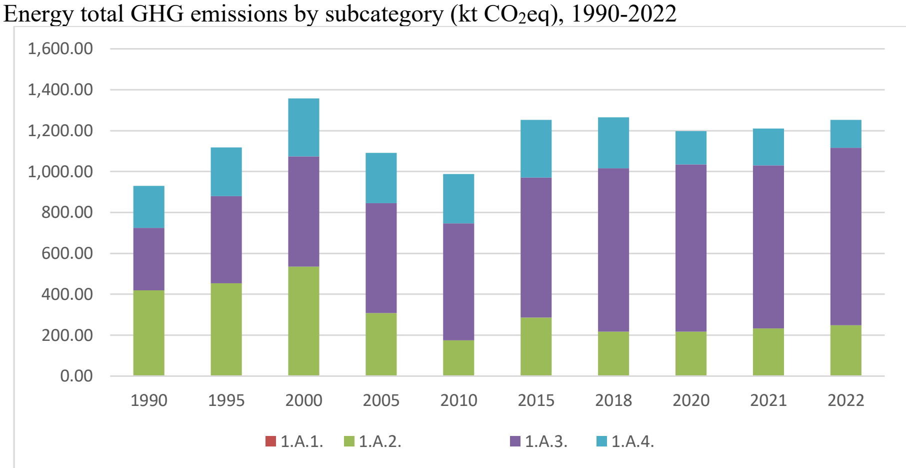
Fuel combustion is the main contributor to GHG emissions in the energy sector. It has four subcategories, namely: Energy Industries (1.A.1); Manufacturing Industries and Construction (1.A.2); Transport (1.A.3); and Other Sectors (1.A.5), which includes Commercial, Residential and Agriculture.

The emissions in 1.A are estimated at 930.8 kt of CO_2eq for 1990, increasing to 1265.8 kt of CO_2eq in 2018 and declining slightly to 1253.4 kt of CO_2eq in 2022. In the period between 2018 and 2022, emissions estimates indicate a decline in 2020, coinciding with the start of the COVID-19 pandemic, then begin to increase again, and in 2022, emissions are almost at the 2018 levels. Transport contributes most of the emissions in the fuels combustion sector, with a contribution of 69.2% in the 2022 estimate. The other subsectors contribute as follows: 19.9% for Manufacturing Industries and Construction and 10.9% for Other Sectors. The 2022 estimate represents an increase of 34.7% from the 1990 estimate and a 1% decline from the 2018 estimate. The increase from the 1990 estimate is driven by significant increases in Transport emissions. The Fuels combustion subsector's emissions are summarized in Table 3-6 and Figure 3-5.

Table 3-4.
1.A Fuel Combustion: total GHG emissions by subcategory (kt CO_2eq)

Category	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
1.A.1.	0.69	0.69	1.06	0.11	0.03	0.00	0.00	0.00	0.00	0.00
1.A.2.	417.89	453.00	533.52	308.48	174.29	286.63	216.57	217.60	233.57	249.02
1.A.3.	305.88	425.58	540.13	537.23	572.98	683.44	799.35	817.43	796.90	867.22
1.A.4.	206.29	238.61	282.45	244.96	240.51	282.22	249.90	162.25	179.95	137.21
Total	**930.75**	**1,117.88**	**1,357.15**	**1,090.79**	**987.82**	**1,252.28**	**1,265.82**	**1,197.28**	**1,210.42**	**1,253.44**

Figure 3-3.
Energy total GHG emissions by subcategory (kt CO_2eq), 1990-2022



3.2.2. Methodological issues of the category

Activity data was sourced from the previous inventory for the years up to 2018 and energy balances for fuel use data. The energy balance for 2019 did not have sufficient data as the data collection occurred to the lockdowns of 2020. Data filling was done using trend lines where possible and comparing with the 2018 value where there was no clear trend.

The emissions of the Transport subsector, as a key category, were estimated using Tier 2, just as in the previous inventory. Fuel sales in litres were converted to TJ using NCVs from South African Energy Statistics. Scrappage curves, and average fuel economies were taken from South African studies.[i,ii] Total fuel consumption was split into vehicle categories using vehicle numbers and fuel economies to calculate CO_2 emissions. Then the total vehicle-km of each category was estimated to calculate Tier 2 N_2O and CH_4 emissions. Default running hot emission factors for vehicles with oxidation catalysts were used, and emissions from cold starts assumed to be negligible.

3.2.2.1. Activity data of the category

1.A.1 Not occurring since 2012 when the only diesel power plant stopped operating but remains installed available capacity.
1.A.2 Data sourced from energy balances with fuel splits from the previous inventory maintained.
1.A.3 Annual Fuel Sales (petrol, diesel, IP), 2018-2022, from Energy Department, Ministry of Natural Resources and Energy. Vehicle registration database was obtained from Ministry of Public Works & Transport.

Table 3-5.
1.A Fuel Combustion: activity data by fuel or GHG source (TJ)

Year	*Coal (other bituminuos)*	*Diesel*	*Motor Gasolone*	*Other Kerosene*	*LPG*	*Jet Fuel (Civil Aviation)*	*Biomass*
1990	4346.83	2767.38	2228.59	272.74	83.56	6.49	21634.7
1991	3344.53	3051.89	2489.42	322.31	55.56	6.49	21759.76
1992	2732.59	3001.17	2439.68	306.28	59.55	6.49	21884.82
1993	1350.47	3332.48	3030.06	256.82	506.17	6.49	22009.88
1994	4958.76	3791.10	3147.03	315.64	223.38	6.49	22134.94
1995	4652.80	3791.10	3147.03	315.64	223.38	6.49	22260
1996	5201.43	3853.29	3138.43	314.76	222.78	6.49	22385.06
1997	5750.05	4099.17	3147.03	315.64	223.38	6.49	22510.12
1998	5750.05	4305.99	3147.03	315.64	223.38	6.49	22635.18
1999	5961.07	4701.15	3147.05	315.64	223.40	6.49	22760.24
2000	5433.54	5080.94	3147.97	312.53	238.19	6.49	22885.3
2001	5539.04	4481.56	3147.97	312.53	238.19	6.49	23010.36
2002	4979.86	3655.03	3147.97	312.53	238.19	6.49	23135.42
2003	4431.23	4571.60	3147.97	312.53	238.19	6.49	23260.49
2004	4304.63	4548.53	3147.97	312.53	238.19	6.49	23385.55
2005	2859.20	4839.92	3147.97	312.53	238.19	6.49	23510.61
2006	4178.02	4908.41	3264.57	408.48	457.08	6.49	23635.67
2007	4346.83	5090.26	4046.23	397.13	441.58	6.49	23760.73
2008	4473.44	4823.79	4177.26	437.98	490.09	6.49	23885.79
2009	3471.13	5208.20	4049.91	387.42	439.67	6.49	24010.85

2010	1283.22	5063.69	4183.43	292.87	394.00	6.49	24135.91
2011	1939.31	4886.12	4457.83	210.75	409.87	10.97	26705.28
2012	2499.00	5318.43	5492.35	175.14	362.00	9.86	25420.53
2013	2359.00	6209.22	4077.71	139.53	596.00	11.2	27110.34
2014	2448.60	6602.82	4265.96	180.04	431.27	11.2	25796.2
2015	1400.94	6472.09	4450.43	91.54	207.65	11.2	28077.72
2016	2105.12	7002.39	5190.53	177.39	84.90	11.2	26738.2
2017	1591.86	7051.79	5509.40	182.21	17.97	11.2	24563.28
2018	1584.29	7255.51	5714.98	168.31	190.92	11.2	25143.41
2019	1645.40	7255.51	6062.07	193.90	47.73	11.2	26578.02
2020	1564.19	7255.51	5443.68	165.38	234.88	5.02	28012.62
2021	1770.18	7255.51	5303.42	148.21	260.00	5.02	26207.27
2022	1973.24	7255.51	5091.99	136.91	154.91	5.86	24212.26

3.2.2.2. Emission factors applied in the category

Default emission factors were used in 1.A.

Table 3-6.
1.A Fuel Combustion: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Liquid fuels	CO_2	93.97	t/TJ
liquid fuels	CH_4	3.00	kg/TJ
Liquid fuels	N_2O	0.60	kg/TJ
Solid fuels	CO_2	94.60	t/TJ
Solid fuels	CH_4	10.00	kg/TJ
Solid fuels	N_2O	1.50	kg/TJ
Biomass	CO_2	100.00	t/TJ
Biomass	CH_4	30.00	kg/TJ
Biomass	N_2O	4.00	kg/TJ

Source: Table 1.A(a) in CRT

3.2.3. Comparison of the sectoral approach with the reference approach

3.2.3.1. Description and trend of CO_2 from the approach comparison

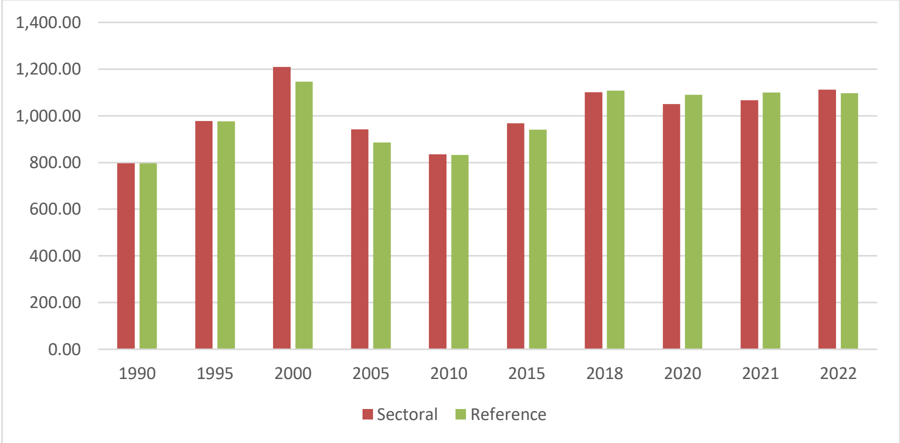
Eswatini uses the following liquid fuels in fuel burning activities: diesel, motor gasoline (petrol), liquified petroleum gases, jet fuel and kerosene. In addition, the country uses bituminous coal as the only solid fuel in burning activities. These fuels have been used in the reference approach. The fuel data in national energy balances, where it is extracted, is expressed in energy units as opposed to natural units. It is expected that the reference approach and sectoral should almost match since the are no intermediate conversions from natural units and emission factors in fuel burning activities are all default emission factors.

The CO_2 emissions from the reference approach are 1096.9 kt CO_2 in 2022, a decline of 1% from the 2018 estimate and an increase of 37.8% from the 1990 estimate. The 2018 value is driven primarily by consumption of diesel and motor gasoline. The increase between 1990 and 2022 is also driven by gradually increasing volumes of diesel and motor gasoline consumed in the country. There are differences exceeding 5% in some years which were are still making sense of but should be resolved eventual. The differences appear to be related to inconsistencies in handling of the data as the differences are consistently on a specific fuel at a given period. Table 3-7 and Figure 3-4 provide a summary of the CO_2 emissions estimated using the reference approach and a comparison of the reference approach to the sectoral approach.

Table 3-7.
Approach comparison: CO_2 emissions obtained using the sectoral approach and reference approach (kt CO_2)

Method	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
Sectoral	797.01	977.30	1,209.67	941.75	834.93	968.20	1,100.82	1,049.81	1,066.45	1,111.18
Reference	795.93	976.32	1,146.44	885.04	832.71	940.78	1,108.24	1,089.67	1,099.79	1,096.93
Difference	**-1.08**	**-0.98**	**-63.23**	**-56.70**	**-2.22**	**-27.42**	**7.42**	**39.87**	**33.34**	**-14.25**
Difference %	**-0.14%**	**-0.10%**	**-5.23%**	**-6.02%**	**-0.27%**	**-2.83%**	**0.67%**	**3.80%**	**3.13%**	**-1.28%**

Figure 3-4.
Approach comparison: CO_2 emissions obtained using the sectoral approach and reference approach (kt CO_2) and percentage difference, 1990-2022



3.2.3.2. Methodological issues of the reference approach

Data for fuel used in fuel burning activities was obtained from the previous inventory for the years 1990-2018 and the rest was extracted from national energy balances. Data gaps identified in the 2019 energy balance was filled using a trend analysis. The methodology for estimating emissions is Tier 1 with default emission factors from the 2006 IPCC Guidelines. Activity data is summarized according to fuel type and is in Table 3-8. Emission factors are summarized in Table 3-9.

Table 3-8.
Approach comparison: apparent consumption by fuel type (activity data unit)

Year	*Liquid fuel*	*Solid fuel*
1990	5,358.76	4,346.83
1991	5,925.66	3,344.53
1992	5,813.17	2,732.59
1993	7,132.02	1,350.47
1994	7,483.64	4,958.76
1995	7,483.64	4,652.80
1996	7,535.76	5,201.43
1997	7,791.71	5,750.05
1998	7,998.53	5,750.05
1999	8,393.73	5,961.07
2000	8,786.12	5,433.54
2001	8,186.74	5,539.04
2002	7,360.21	4,979.86
2003	8,276.79	4,431.23
2004	8,253.71	4,304.63
2005	8,545.11	2,859.20
2006	9,045.03	4,178.02
2007	9,981.68	4,346.83
2008	9,935.61	4,473.44
2009	10,091.68	3,471.13
2010	9,940.48	1,283.22
2011	9,975.54	1,939.31
2012	11,357.78	2,499.00
2013	11,033.66	2,359.00
2014	11,491.29	2,448.60
2015	11,232.91	1,400.94
2016	12,466.41	2,105.12
2017	12,772.57	1,591.86
2018	13,340.92	1,584.29

2019	13,570.40	1,645.40
2020	13,104.46	1,564.19
2021	12,972.16	1,770.18
2022	12,645.18	1,973.24

Table 3-9.
Approach comparison: CO_2 emission factor applied

GHG source		GHG	Value	Unit
Liquid fuels		CO2	93.97	t/TJ
Solid fuels		CO2	94.6	t/TJ

3.2.4. International bunkers

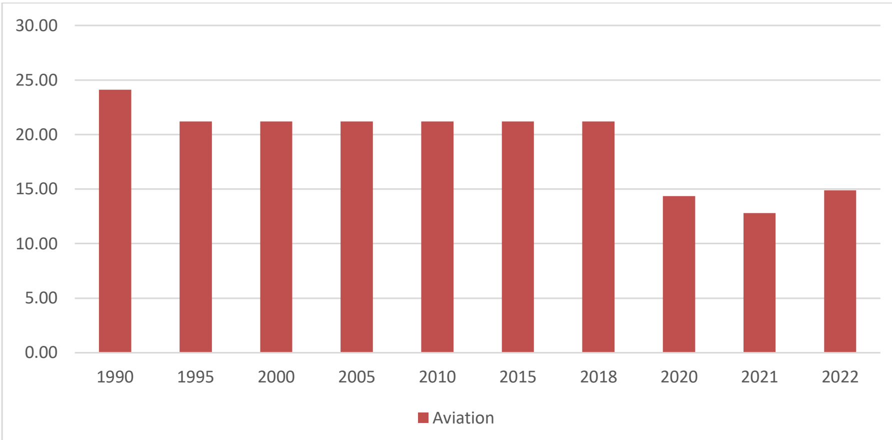
3.2.4.1. Description and trend of GHGs from international bunkers

Eswatini is a landlocked country with no access to sea, hence only international aviation contributes to international bunkers. The subsectors emissions are summarized Table 3-12 and Figure 3-7. The emissions estimate for 2022 is 14.90 kt of CO_2eq, a decline of 29.7 kt of CO_2eq from the 2018 emissions estimate and a decline of 38.2 kt of CO_2eq from the 1990 emissions estimate. International aviation was impacted by COVID-19 lockdowns and took much longer to rebound. Emissions for international bunkers are summarized in Table 3-10 and Figure 3-5.

Table 3-10.
International bunkers: aviation and marine bunker fuel GHG emissions (kt CO_2eq)

International transport	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
Aviation	24.10	21.20	21.20	21.20	21.20	21.20	21.20	14.37	12.81	14.90
Marine	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**24.10**	**21.20**	**21.20**	**21.20**	**21.20**	**21.20**	**21.20**	**14.37**	**12.81**	**14.90**

Figure 3-5.
International bunkers: aviation and marine bunker fuel GHG emissions (kt CO_2eq), 1990-2022



3.2.4.2. Methodological issues of international bunkers

The emissions were estimated using a Tier 1 methodology following the 2006 IPCC Guidelines. Emission factors are default values from 2006 IPCC guidelines.

Table 3-11.
International bunkers: activity data by fuel or GHG source (TJ)

Year	*Jet Fuel (International)*
1990	171.75
1991	179.00
1992	176.90
1993	161.27
1994	145.63
1995	130.00
1996	109.56
1997	89.13
1998	68.69
1999	48.25
2000	27.82
2001	27.82
2002	27.82
2003	27.82
2004	27.82
2005	27.82
2006	27.82
2007	28.80
2008	29.79
2009	26.42
2010	25.45
2011	22.63
2012	19.81
2013	16.98
2014	14.16
2015	11.34
2016	8.52

Year	Jet Fuel (International)
2017	41.80
2018	53.15
2019	14.16
2020	33.07
2021	11.03
2022	40.61

Table 3-12.
International bunkers: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Liquid fuels	CO2	93.97	t/TJ
liquid fuels	CH4	3.00	kg/TJ
Liquid fuels	N2O	0.60	kg/TJ

3.2.5. Feedstocks and no-energy use of fuels

Feedstock and non-energy use of fuels accounted for in Industrial processes.

3.2.6. Energy industries (CRT 1.A.1)

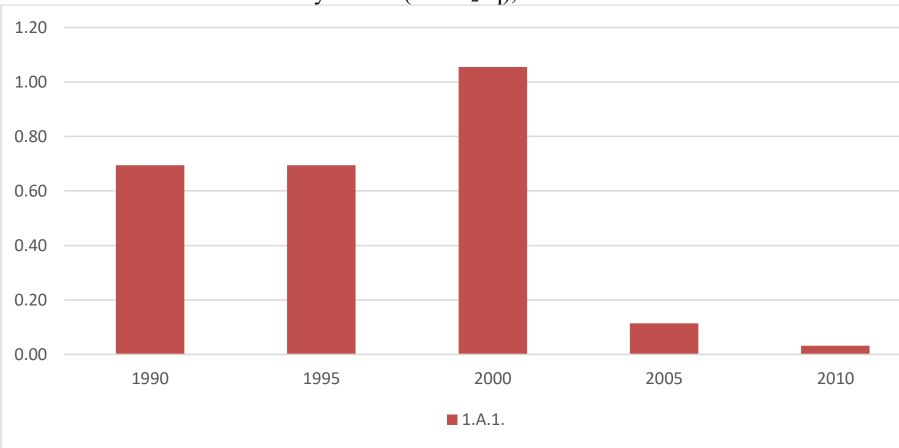
3.2.6.1. Description and trend of GHGs in the subcategory

Not occurring since 2013. Before 2013 the only source under this category was a diesel power plant operated by the power utility. The emissions up to 2013 are summarized in Table 3-13 and Figure 3-6.

Table 3-13.
1.A.1.a.i: total GHG emissions by GHG source (kt CO_2eq)

Category	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
1.A.1.a.i	0.69	0.69	1.06	0.11	0.03	NO	NO	NO	NO	NO

Figure 3-6.
1.A.1.a.i: total GHG emissions by source (kt CO_2eq), 1990-2022



3.2.6.2. Methodological issues of the subcategory

In the previous inventory data was obtained from the national power utility with default emission values for liquid fuels used.

3.2.6.2.1. Activity data of the subcategory

Table 3-14.
1.A.1.a.i: activity data by fuel or GHG source (TJ)

Year	*Diesel*
1990	9.34
1991	9.34
1992	9.34
1993	9.34
1994	9.34
1995	9.34
1996	22.19
1997	7.95
1998	17.83
1999	26.71
2000	14.2
2001	19.5
2002	16.42
2003	1.47
2004	1.58
2005	1.54
2006	0.99
2007	1.04
2008	1.97
2009	0.21
2010	0.43
2011	0.43
2012	7.99
2013	NO
2014	NO
2015	NO

Year	Diesel
2016	NO
2017	NO
2018	NO
2019	NO
2020	NO
2021	NO
2022	NO

3.2.6.2.2. Emission factors applied in the subcategory

Default emission factors for liquid fuels were used in the subcategory.

Table 3-15.
1.A.1.a.i: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Liquid fuels	CO2	93.97	t/TJ
liquid fuels	CH4	3.00	kg/TJ
Liquid fuels	N2O	0.60	kg/TJ

3.2.6.3. Description of any flexibility applied to the subcategory

No flexibility applied.

Table 3-16.
1.A.1.a.i: flexibility provisions applied

MPG flexibility provision	Gas	Description of the application of flexibility	Clarification of capacity constraint	Time frame for improvement	Progress made in addressing areas of improvement
	CO_2	NA			
	CH_4	NA			
	N_2O	NA			
	CO_2	NA			
	CH_4	NA			
	N_2O	NA			
	CO_2	NA			
	CH_4	NA			
	N_2O	NA			

Source: based on the **Flex_Summary** spreadsheet of the CRT.

3.2.6.4. Uncertainty assessment and time-series consistency of the subcategory

The subsector's emissions uncertainty for the different GHG's is as follows: carbon dioxide 7.9%, methane 228% and nitrous oxide 228%. The activity data was obtained directly from the power utility and hence is expected to be good data. The uncertainty is primarily from the emission factor.

3.2.6.5. Subcategory-specific QA/QC and verification

The data was obtained from the last inventory where sector stakeholders reviewed the energy inventory through sector-specific consultative meetings. For the additional time series, the team working on energy emissions worked closely with a government officer from the Department of Energy.

3.2.6.6. Subcategory-specific recalculations

No recalculations done.

3.2.6.7. Subcategory-specific planned improvements

No planned improvements.

3.2.7. Manufacturing industries and construction (CRT 1.A.2)

3.2.7.1. Description and trend of GHGs in the subcategory

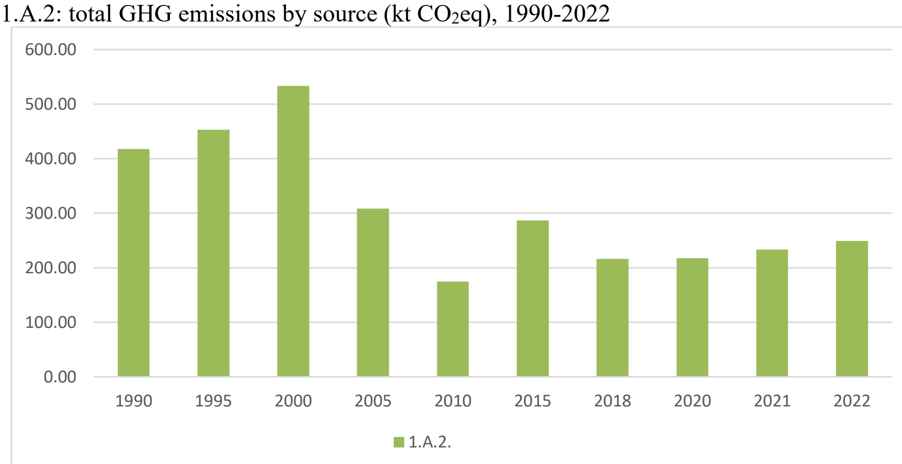
Eswatini's manufacturing industries are dominated by food, beverages and tobacco (1.A.2.e). There is significant construction (1.A.2.k), and textile and leather(1.A.2.l). The data for the this subsector is typically lumped together in the energy balance hence emissions for the sector are estimated in a similar manner. In this regard, the overview of the energy sector already provides details on emissions, however, a summary is provided by Table 3-20 and Figure 3-9. Emissions in this subsector are driven by the nature of industries at any given time. Industries come and go, hence the fluctuations in the emissions. We also note that Eswatini's manufacturing industry is dominated by sugar production and the sugar companies use a lot of biomass in their processes, whose emissions are a memo item.

The emissions estimate for 2022 is 249 kt of CO_2eq, an increase of 15% from the 2018 estimate and a decline of 40% from 1990 estimate. The decline in the trend is attributed to decline in coal used in manufacturing.

Table 3-17.
1.A.2: total GHG emissions by source (kt CO_2eq)

Category	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
1.A.2.	417.89	453.00	533.52	308.48	174.29	286.63	216.57	217.60	233.57	249.02

Figure 3-7.
1.A.2: total GHG emissions by source (kt CO_2eq), 1990-2022



3.2.7.2. Methodological issues of the subcategory

The previous inventory data was used as is, then data was sourced from energy balances for the 2018-2022 period. Issues with 2019 data are already noted in the 1.A methodological issues. Emissions were estimated using a Tier 1 method and default emission factors from the IPCC 2006 Guidelines. NCVs were obtained from IPCC 2006 Guidelines and the South African Energy Statistics.

3.2.7.2.1. Activity data of the subcategory

Activity data was sourced from energy balances.

Table 3-18.
1.A.2: activity data by fuel or GHG source (TJ)

Year	*LPG*	*Coal*	*Biomass*	*Other Kerosene*	*Diesel*
1990	0.84	3912.15	10817.35	55.96	275.80
1991	0.56	3010.07	10879.88	66.20	304.26
1992	0.60	2459.34	10942.41	62.87	299.18
1993	5.06	1215.42	11004.94	46.53	332.31
1994	2.23	4462.89	11067.47	64.35	378.18
1995	2.23	4187.52	11130.00	64.35	378.18
1996	2.23	4681.28	11192.53	85.65	383.11
1997	2.23	5175.05	11255.06	94.42	409.12
1998	2.23	5175.05	11317.59	98.11	428.82

1999	2.23	5364.96	11380.12	112.00	467.44
2000	2.38	4890.18	11442.65	110.51	506.67
2001	2.38	4985.14	11505.18	84.92	446.24
2002	2.38	4481.88	11567.71	77.21	363.86
2003	2.38	3988.11	11630.24	75.80	457.01
2004	2.38	3874.17	11692.77	73.34	454.69
2005	2.38	2573.28	11755.30	67.28	483.84
2006	4.57	3760.22	11817.83	68.65	490.74
2007	4.42	3912.15	11880.36	62.67	508.92
2008	4.90	4026.09	11942.89	48.57	482.18
2009	4.40	3124.02	12005.42	51.02	520.80
2010	3.94	1154.90	12067.96	48.24	506.33
2011	4.10	1745.38	13352.64	45.46	488.57
2012	3.62	2249.10	12710.27	39.50	531.04
2013	5.96	2123.10	13555.17	41.64	620.92
2014	4.31	2203.74	12898.10	39.46	660.28
2015	2.08	1260.85	14038.86	37.04	647.21
2016	0.85	1894.61	13369.10	36.89	700.24
2017	0.18	1432.67	12281.64	39.25	705.18
2018	1.91	1425.86	12571.70	37.98	725.55
2019	0.48	1480.86	13289.01	37.98	725.55
2020	2.35	1407.77	14006.31	37.98	725.55
2021	2.60	1593.16	13103.64	37.98	725.55
2022	1.55	1775.91	12106.13	37.98	725.55

3.2.7.2.2. Emission factors applied in the subcategory

Default emission factors for liquid and solid fuels were used in the subcategory.

Table 3-19.
1.A.2: emission factors applied by GHG source

GHG source	*GHG*	*Value*	*Unit*
Liquid fuels	CO_2	93.97	t/TJ
liquid fuels	CH_4	3.00	kg/TJ
Liquid fuels	N_2O	0.60	kg/TJ
Solid fuels	CO_2	94.60	t/TJ
Solid fuels	CH_4	10.00	kg/TJ
Solid fuels	N_2O	1.50	kg/TJ
Biomass	CO_2	100.00	t/TJ

Biomass	CH_4	30.00	kg/TJ
Biomass	N_2O	4.00	kg/TJ

3.2.7.3. Description of any flexibility applied to the subcategory

No flexibility applied for the subcategory.

3.2.7.4. Uncertainty assessment and time-series consistency of the subcategory

The subcategory's time-series was confirmed to be consistent with the previous inventory. Uncertainty for carbon dioxide emissions are as follows: 7.9% for liquid fuels, 13.4% for solid fuels and 18.3% for biomass. Uncertainty for methane emissions are as follows: 228% for liquid fuels, 200% for solid fuels and 222% for biomass. Uncertainty for nitrous oxide emissions are as follows: 228% for liquid fuels, 222% for solid fuels and 275% for biomass.

3.2.7.5. Subcategory-specific QA/QC and verification

The data was obtained from the last inventory where sector stakeholders reviewed the energy inventory through sector-specific consultative meetings. For the additional time series, the team working on energy emissions worked closely with a government officer from the Department of Energy.

3.2.7.6. Subcategory-specific recalculations

No recalculations in the subcategory.

3.2.7.7. Subcategory-specific planned improvements

There are currently no planned improvements that are directly emanating from the inventory, however, planned energy statistics will benefit the calculations under the subcategory.

3.2.8. Transport (CRT 1.A.3)

3.2.8.1. Description and trend of GHGs in the subcategory

Eswatini's transport sector is comprised of civil aviation (1.A.3.a), road transport (1.A.3.b) and railways (1.A.3.c). Road transportation has been increasing quite rapidly over the last three decades as more people began to own cars. This sector has been driving the increase in the subcategory's emissions.

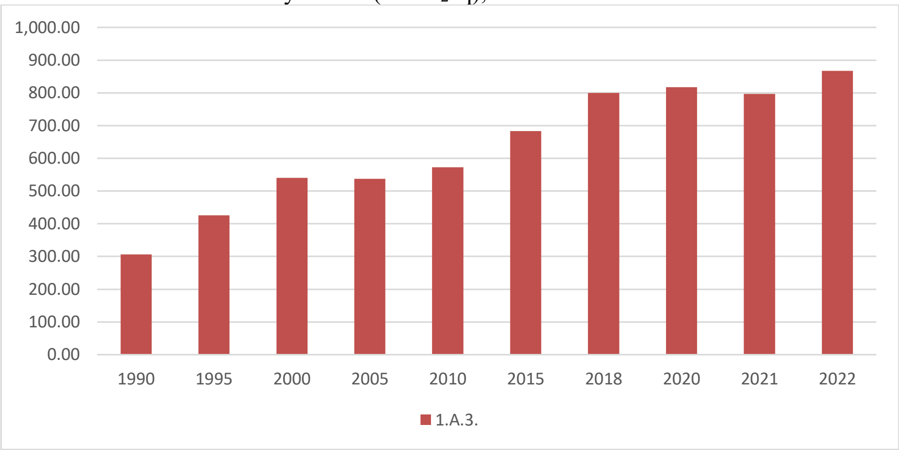
Transport emissions estimate for 2022 is 867.2 kt of CO_2eq, an increase of 8.5% from the 2018 estimate and an increase of 183.5% from the 1990 estimate. The primary driver of the increase is road transportation. Table 3-20 and Figure 3-10 summarizes the emissions of the subcategory.

Table 3-20.
1.A.3: total GHG emissions by source (kt CO_2 eq)

Category	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
1.A.3.	305.88	425.58	540.13	537.23	572.98	683.44	799.35	817.43	796.90	867.22
Total	**305.88**	**425.58**	**540.13**	**537.23**	**572.98**	**683.44**	**799.35**	**817.43**	**796.90**	**867.22**

Note:
Source:

Figure 3-8.
1.A.3: total GHG emissions by source (kt CO_2eq), 1990-2022



Note:
Source:

3.2.8.2. Methodological issues of the subcategory

The emissions of the Road Transport subsector, as a key category, were estimated using Tier 2, just as in the previous inventory. Fuel sales in litres were converted to TJ using NCVs from South African Energy Statistics. Scrappage curves, and average fuel economies were taken from South African studies. Total fuel consumption was split into vehicle categories using vehicle numbers and fuel economies to calculate CO_2 emissions. Then the total vehicle-km of each category was estimated to calculate Tier 2 N_2O and CH_4 emissions. Default running hot emission factors for vehicles with oxidation catalysts were used, and emissions from cold starts assumed to be negligible.

3.2.8.2.1. Activity data of the subcategory

Fuel sales data was sourced from the Department of Energy and energy balances for overall fuel imports. Vehicle data was sourced from the Ministry of Public Works and Transport. The subsector consumes two fuels, moto gasoline and diesel.

Table 3-21.
1.A.3: activity data by fuel or GHG source (TJ)

Year	Motor Gasoline	Diesel	Jet Fuel
1990	2228.59	4218.59	6.49
1991	2489.42	4480.42	6.49
1992	2439.68	4431.68	6.49
1993	3030.06	5023.06	6.49
1994	3147.03	5141.03	6.49
1995	3147.03	5142.03	6.49
1996	3256.90	5252.90	6.49
1997	3366.78	5363.78	6.49
1998	3439.71	5437.71	6.49
1999	3893.18	5892.18	6.49
2000	3801.00	5801.00	6.49
2001	3339.06	5340.06	6.49
2002	4256.72	6258.72	6.49
2003	3671.89	5674.89	6.49
2004	3795.65	5799.65	6.49
2005	3932.43	5937.43	6.49
2006	3825.06	5831.06	6.49
2007	3905.25	5912.25	6.49
2008	3794.10	5802.10	6.49
2009	4493.65	6502.65	6.49
2010	4260.19	6270.19	6.49
2011	4270.16	6281.16	10.97
2012	4207.78	6219.78	9.86
2013	4373.67	6386.67	11.2
2014	4606.44	6620.44	11.2
2015	4884.18	6899.18	11.2
2016	5244.81	7260.81	11.2
2017	5558.59	7575.59	11.2
2018	5754.95	7772.95	11.2
2019	5867.13	7886.13	11.2
2020	5981.07	8001.07	5.02
2021	6096.55	8117.55	5.02
2022	6214.47	8236.47	5.86

Note:
Source:

3.2.8.2.2. Emission factors applied in the subcategory

Default emission factors of the *2006 IPCC Guidelines* were used in the subcategory.

Table 3-22.
1.A.3: emission factors applied by GHG source

GHG source	*GHG*	*Value*	*Unit*
Liquid fuels	CO2	93.97	t/TJ
liquid fuels	CH4	3.00	kg/TJ
Liquid fuels	N2O	0.60	kg/TJ

Note:
Source:

3.2.8.3. Description of any flexibility applied to the subcategory

No flexibility was applied to the subcategory.

Table 3-23.
1.A.3: flexibility provisions applied

MPG flexibility provision	*Gas*	*Description of the application of flexibility*	*Clarification of capacity constraint*	*Time frame for improvement*	*Progress made in addressing areas of improvement*
	CO_2	NA			
	CH_4	NA			
	N_2O	NA			
	CO_2	NA			
	CH_4	NA			
	N_2O	NA			
	CO_2	NA			
	CH_4	NA			
	N_2O	NA			

Note:
Source: [], based on the **Flex_Summary** spreadsheet of the CRT.

3.2.8.4. Uncertainty assessment and time-series consistency of the subcategory

MPG: provisions 26, 27, 29 and 44. Provision 29 offers flexibility to countries that may need it.

The use of default emission factors is the main contributor of uncertainty in the transport sector. Uncertainty by subcategory and GHG is summarized in Table 3-24:

Table 3-24.
1.A.3 Transport: uncertainty in the transport sector.

2006 IPCC subcategory	Gas	Uncertainty 1990(%)	Uncertainty 2022 (%)
1.A.3a.i	CO_2	11.3	11.3
	CH_4	173	173

	N_2O	259	259
1.A.3.a.ii	CO_2	11.3	11.3
	CH_4	173	173
	N_2O	259	259
1.A.3.b.i	CO_2	5.7	5.7
	CH_4	244	244
	N_2O	209	209
1.A.3.b.ii	CO_2	5.7	5.7
	CH_4	244	244
	N_2O	209	209
1.A.3.b.iii	CO_2	6.1	6.1
	CH_4	346	346
	N_2O	297	297
1.A.3.c	CO_2	5.4	5.4
	CH_4	150	150
	N_2O	200	200

3.2.8.5. Subcategory-specific QA/QC and verification

The data was obtained from the last inventory where sector stakeholders reviewed the energy inventory through sector-specific consultative meetings. For the additional time series, the team working on energy emissions worked closely with a government officer from the Department of Energy.

3.2.8.6. Subcategory-specific recalculations

No recalculations have been done in the subcategory.

3.2.8.7. Subcategory-specific planned improvements

The planned improvement under this subcategory is in the collection of additional data on vehicle distances travelled. This will eliminate the need for use of fuel economy statistics and fuel used to estimate vehicle kilometres.

3.2.9. Other sectors (CRT 1.A.4)

3.2.9.1. Description and trend of GHGs in the subcategory

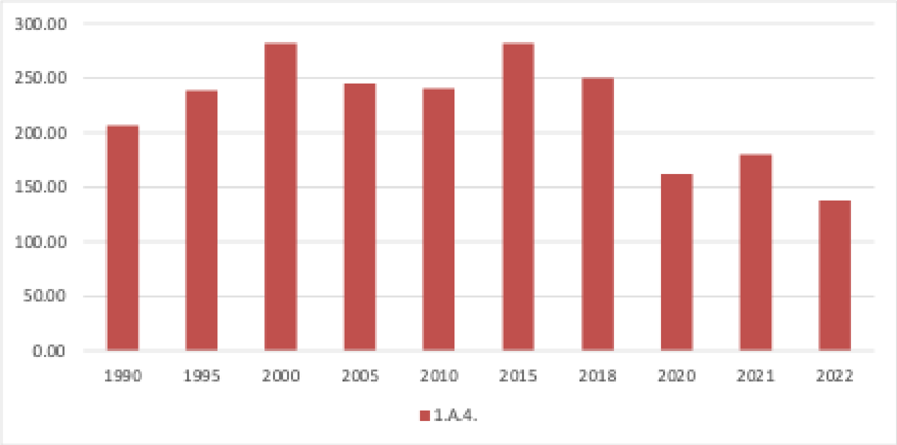
The Other sectors subcategory accounts for emissions from commercial buildings, public buildings and the residential sector. While the commercial and public buildings consume mostly modern energy forms (electricity, LPG), the residential sector has a significant consumption of biomass as fuel wood.

Other sectors emissions estimate for 2022 is 137.2 kt of CO_2eq, a decline of 45% from the 2018 estimate and a decline of 33% from the 1990 estimate. The shift is primarily due to fuel switching from LPG and kerosene to electricity. Table 3-25 and Figure 3-8 provide a summary of the emissions.

Table 3-25.
1.A.4: total GHG emissions by source (kt CO_2eq)

Category	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
1.A.4.	206.29	238.61	282.45	244.96	240.51	282.22	249.90	162.25	179.95	137.21
Total	**206.29**	**238.61**	**282.45**	**244.96**	**240.51**	**282.22**	**249.90**	**162.25**	**179.95**	**137.21**

Figure 3-9.
1.A.4: total GHG emissions by source (kt CO_2eq), 1990-2022



3.2.9.2. Methodological issues of the subcategory

The data is lumped together and not separated into the residential and commercial/institutional because of lack of properly desegregated fuel data and statistics on energy usage. The methodology is the Tier 1 and default 2006 IPCC guidelines emission factors are used in estimating emissions.

3.2.9.2.1. Activity data of the subcategory

Activity data was sourced from the previous inventory for the years up to 2018, and from energy balances for the period up to 2022.

Table 3-26.
Other Sectors: activity data by fuel or GHG source (activity data unit)

Year	LPG	Coal	Biomass	Gas/Diesel Oil	Other Kerosene

1990	82.73	434.68	10817.35	551.6082	223.8386
1991	55.00	334.45	10879.88	608.5113	264.8194
1992	58.95	273.26	10942.41	598.3667	251.4842
1993	501.11	135.05	11004.94	664.6284	186.1317
1994	221.15	495.88	11067.47	756.3529	257.4099
1995	221.15	465.28	11130	756.3529	257.4099
1996	220.56	520.14	11192.53	766.2197	342.5936
1997	221.15	575.01	11255.06	818.2444	377.6752
1998	221.15	575.01	11317.59	857.6318	392.4256
1999	221.17	596.11	11380.12	934.8894	447.9996
2000	235.81	543.35	11442.65	1013.349	442.0505
2001	235.81	553.90	11505.18	892.4819	339.6716
2002	235.81	497.99	11567.71	727.7202	308.8442
2003	235.81	443.12	11630.24	914.0278	303.2007
2004	235.81	430.46	11692.77	909.3895	293.3451
2005	235.81	285.92	11755.3	967.6769	269.127
2006	452.51	417.80	11817.83	981.4842	274.6103
2007	437.16	434.68	11880.36	1017.843	250.6666
2008	485.19	447.34	11942.89	964.3638	194.2627
2009	435.28	347.11	12005.42	1041.597	204.09
2010	390.06	128.32	12067.96	1012.65	192.96
2011	405.77	193.93	13352.64	977.139	181.83
2012	358.38	249.90	12710.27	1062.088	158.01
2013	590.04	235.90	13555.17	1241.844	166.56
2014	426.96	244.86	12898.1	1320.564	157.83
2015	205.57	140.09	14038.86	1294.418	148.14
2016	84.05	210.51	13369.1	1400.477	147.57
2017	17.79	159.19	12281.64	1410.358	156.9836
2018	189.01	141.00	12571.7	1451.102	151.9241
2019	47.72	0.00	6061.88	1507.24	0
2020	147.21	0.77	10430.7	548.09	163.3
2021	260.00	0.00	10430.7	736.58	132.96
2022	154.88	0.77	10430.7	0	134

3.2.9.2.2. Emission factors applied in the subcategory

Default 2006 IPCC guidelines emission factors were used in the subcategory.

Table 3-27.
1.A.4: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Liquid fuels	CO_2	93.97	t/TJ
liquid fuels	CH_4	3.00	kg/TJ
Liquid fuels	N_2O	0.60	kg/TJ
Solid fuels	CO_2	94.60	t/TJ
Solid fuels	CH_4	10.00	kg/TJ
Solid fuels	N_2O	1.50	kg/TJ
Biomass	CO_2	100.00	t/TJ
Biomass	CH_4	30.00	kg/TJ
Biomass	N_2O	4.00	kg/TJ

3.2.9.3. Description of any flexibility applied to the subcategory

No flexibility was applied for this sub-sector.

3.2.9.4. Uncertainty assessment and time-series consistency of the subcategory

The lumping of all the subcategory's leads to significant uncertainty as the residential, especially rural households, will tend to use fuels using older appliances yet the commercial subsector will tend to advance relatively quickly to advanced equipment. The uncertainty in liquid fuels is 7.95% for carbon dioxide, 200% for methane and 228% for nitrous oxide. For solid fuels, the uncertainty is 13% for carbon dioxide, 200% for methane and 217% for nitrous oxide. Lastly, for biomass, the uncertainty is 18% for carbon dioxide, 200% for methane and 250% for nitrous oxide.

3.2.9.5. Subcategory-specific QA/QC and verification

The data was obtained from the last inventory where sector stakeholders reviewed the energy inventory through sector-specific consultative meetings. For the additional time series, the team working on energy emissions worked closely with a government officer from the Department of Energy.

3.2.9.6. Subcategory-specific recalculations

No recalculations.

3.2.9.7. Subcategory-specific planned improvements

No planned improvements for this subcategory.

3.2.10. Other (not specified elsewhere) (CRT 1.A.5)

Not applicable

3.3. Fugitive emissions from fuels (CRT 1.B)

3.3.1. Description and trend of GHGs in the category

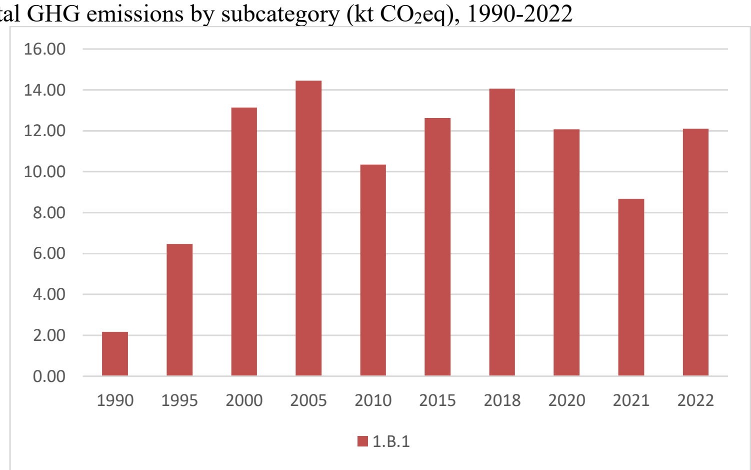
Eswatini has coal mining and distribution of petroleum products as the only two sources for fugitive emissions. In the current and previous inventory, emissions from coal mining are considered. Additional data required for estimating fugitive emissions from distribution of petroleum products is still not available. There is also insufficient data for abandoned mines.

The emissions estimate in this subsector for 2022 is 12.11 kt of CO_2eq, a decrease of 14 % from the 2018 estimate and an increase of 456% from the 1990 estimate. Emissions in this subcategory are driven by output of the single coal mine in operation up to 2022. Table 3-28 and Figure 3-10 summarizes the emissions for the subcategory.

Table 3-28.
1.B: total GHG emissions by subcategory (kt CO_2eq)

Category	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
1.B.1	2.18	6.46	13.14	14.45	10.35	13.10	14.06	12.07	8.68	12.11
Total	**2.18**	**6.46**	**13.14**	**14.45**	**10.35**	**13.10**	**14.06**	**12.07**	**8.68**	**12.11**

Figure 3-10.
1.B: total GHG emissions by subcategory (kt CO_2eq), 1990-2022



3.3.2. Methodological issues of the category

A Tier 2 methodology was used in the category with the emission factor sourced from the mining company.

3.3.2.1. Activity data of the category

Activity data was sourced from the mining company.

Table 3-29.
1.B: activity data by GHG source (tonne)

Year	*Cool mining*
1990	160000
1991	123125
1992	100500
1993	49750
1994	182250
1995	171250
1996	129375
1997	341180.5
1998	341180.5
1999	441828.7
2000	348249.7
2001	450000
2002	509805.5
2003	410510
2004	443350
2005	383086
2006	432047
2007	413011
2008	280283
2009	256407
2010	274463
2011	270024
2012	367622
2013	342032
2014	347244
2015	334711
2016	298814
2017	330312
2018	372625
2019	285000

2020	320000
2021	230000
2022	321000

3.3.2.2. Emission factors applied in the category

Emission factor for methane emissions in the coal mine were obtained from the mine. The mine provided a 2004 study which contains the measured emission factor for methane during the compilation of the previous inventory.

Table 3-30.
1.B.1: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Coal mining	CH_4	18	m^3/t

3.3.3. Solid fuels (CRT 1.B.1)

3.3.3.1. Description and trend of GHGs in the subcategory

Summary provided under the overall 1.B category.

3.3.4. Oil and natural gas and other emissions from energy production (CRT 1.B.2)

Emissions for this category are not occurring in Eswatini.

3.4. CO_2 transport and storage (CRT 1.C)

This category is not occurring in Eswatini.

Chapter 4. INDUSTRIAL PROCESSES AND PRODUCT USE (CRT 2)

4.1. Overview of the sector

4.1.1. Description of the sector

Eswatini does not have most of the manufacturing industries that are reported under the IPPU sector. Under the minerals Industry, only ceramic production is reported on and it also goes to 2017 as the company eventually closed. The country also has a glass recycling company but it uses 100% recycled glass and hence no emissions from this subcategory. A summary of the emission estimates in the IPPU sector is provided in the Table 4-1 below.

Eswatini has several industries that utilize various chemicals, some of which lead to both direct and indirect emissions of greenhouse gases into the atmosphere. These industries include the minerals sector, non-energy products derived from fuels and solvent use, product applications as substitutes for ozone-depleting substances, other product manufacturing and use, as well as additional industries classified according to IPCC guidelines. Data sources for this sector included the industries themselves, the Eswatini Environment Authority (EEA), the Eswatini Revenue Service (ERS), and information from the previous inventory reported in the Third National Communication, depending on the specific industry. Emissions estimates were primarily based on the 2006 IPCC guidelines for most calculations.

The country has done a few studies that have helped generate country specific data such as the waste characterisation done in 2021, as well as the recent inventory of ODS and HFCs that informed the Kigali Implementation Plan (KIP).

4.1.2. Trend in the sector's GHG

For the IPPU, the subcategories that contributed to the sectors emissions for the year 2022 include emissions from non-energy products from fuel and solvents (mainly lubricant use (2.D.1) and Paraffin wax use (2.D.2)), product uses as substitutes for ozone depleting substances (ODS, refrigeration and air-conditioning (2.F.1) and other product manufacture and use (electrical equipment, 2.G.1). **Table 4.1** give a summary of the 2022 emissions.

There has been a noticeable increase in emissions for the sector from 1990 to 2022, primarily attributed to the use of HFCs, which were introduced in the mid-1990s for refrigeration and air-conditioning applications. Currently, refrigerant recovery is not widely practiced in the country, resulting in the release of refrigerants into the atmosphere when equipment reaches the end of its life. This is particularly evident in the spike in emissions in 2010, coinciding with the end-of-life phase for many pieces of equipment and the subsequent release of HFCs, approximately 15 years after their introduction, which aligns with the assumed lifespan of these devices.

Table 4-1.

IPPU Sector: emissions by GHG, category and subcategory (kt) for 2022

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs [1]	PFCs [1]	Unspecified mix of HFCs and PFCs [1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_X	Total GHG emissions [2]
	(kt)			CO_2eq (kt) [3]			(kt)						CO_2eq (kt) [3]
2. Total industrial processes	4.09	NA,NO	0.00	66.79	NO	NO	0.00	NO	NO	NO	NO	NO	72.15
2.A. Mineral industry	NA,NO	NO	NO						NE	NE	NE	NE	NA,NO
2.A.1. Cement production	NE											NO	NE
2.A.2. Lime production	NO												NO
2.A.3. Glass production	NA												NA
2.A.4. Other process uses of carbonates	NO	NO	NO						NO	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.B.1. Ammonia production	NO	NO	NO						NO	NO	NO	NO	NO
2.B.2. Nitric acid production			NO						NO				NO
2.B.3. Adipic acid production	NO		NO						NO	NO	NO		NO
2.B.4. Caprolactam, glyoxal and glyoxylic acid production	NO		NO								NO	NO	NO
2.B.5. Carbide production	NO	NO							NO	NO	NO	NO	NO
2.B.6. Titanium dioxide production	NO												NO
2.B.7. Soda ash production	NO												NO
2.B.8. Petrochemical and carbon black production	NO	NO							NO	NO	NO	NO	NO
2.B.9. Fluorochemical production				NO	NO	NO	NE	NO					NO
2.B.10. Other	NO	NO	NO	NO	NO	NO	NE	NO	NO	NO	NO	NO	NO
2.C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.1. Iron and steel production	NO	NO							NO	NO	NO	NO	NE
2.C.2. Ferroalloys production	NO	NO							NO	NO	NO	NO	NE
2.C.3. Aluminium production	NO				NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.4. Magnesium production	NO			NO	NO	NO	NO		NO	NO	NO	NO	NO
2.C.5. Lead production	NO								NO	NO	NO	NO	NE
2.C.6. Zinc production	NO								NO	NO	NO	NO	NE
2.C.7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use [4]	4.09	NO	NO						NE	NE	NE	NE	4.09
2.D.1. Lubricant use	4.06	NO	NO						NE	NE	NE	NE	4.06
2.D.2. Paraffin wax use	0.04	NO	NO						NE	NE	NE	NE	0.04
2.D.3. Other	NO	NO	NO						NO	NO	NO	NO	NA
2.E. Electronics industry			NO	NO	NO	NO	NO	NO					NO
2.E.1. Integrated circuit or semiconductor			NO	NO	NO	NO	NO	NO					NO
2.E.2. TFT flat panel display			NO	NO	NO	NO	NO	NO					NO
2.E.3. Photovoltaics				NO	NO	NO	NO	NO					NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs [1]	PFCs [1]	Unspecified mix of HFCs and PFCs [1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_X	Total GHG emissions [2]
	(kt)			CO_2eq (kt) [3]			(kt)						CO_2eq (kt) [3]
2.E.4. Heat transfer fluid				NO	NO	NO	NO	NO					NO
2.E.5. Other			NO	NO	NO	NO	NO	NO					NO
2.F. Product uses as substitutes for ODS				66.79	NO	NO		NO					66.79
2.F.1. Refrigeration and air conditioning				66.79	NO	NO		NO					66.79
2.F.2. Foam blowing agents				NO	NO	NO		NO					NO
2.F.3. Fire protection				IE	NO	NO		NO					NO
2.F.4. Aerosols				NO	NO	NO		NO					NO
2.F.5. Solvents				NO	NO	NO		NO					NO
2.F.6. Other applications				NO	NO	NO		NO					NO
2.G. Other product manufacture and use	NO	NO	0.00	NO	NO	NO	0.00	NO	NO	NO	NO	NO	1.26
2.G.1. Electrical equipment				NO	NO	NO	0.00	NO					1.22
2.G.2. SF_6 and PFCs from other product use					NO		NO						NO
2.G.3. N_2O from product uses			0.00										0.04
2.G.4. Other	NO	NO	N	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H. Other [5]	NE	NE	NE						NO	NO	NO	NO	NO
2.H.1. Pulp and paper	NO	NO	NO						NE	NE	NE	NE	NE
2.H.2. Food and beverages industry	NO	NO	NO						NE	NE	NE	NE	NE
2.H.3. Other *(please specify)*													

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = not occurring; IE = included elsewhere; C = confidential.
Source: [], based on the **Table2(I)** spreadsheet of the CRT.

Commented [DN2]: There is a lot of use of NA. Should it not be NO, given that Not Applicable means activities under a given category that do occur within the Party but do not result in emissions or removals of a specific gas. I suppose it would apply for gases related to the glass industry though.

In Eswatini, there are generally few subcategories that apply for the IPPU sector. Under the Mineral industry, (only glass production applied but it does not result in emissions as all glass products are produced from recycled glass hence CO_2 emissions are not applicable. For ceramics (2.A.4.a), they used to be produced in the country until 2017 when the company closed. For 2022, this subcategory does not contribute to IPPU emissions. All the other subcategories under 2.A are not occurring.

Other non-occurring categories include the chemical industry (2.B), metal industry (2.C) and the electronics industry (2.E). In Eswatini there is no manufacturing processes for any of these. For 2.D, lubricant use, paraffin wax use and solvent use are all applicable. But solvent use was not estimated as the available data had huge uncertainties as well as difficulty in getting NMVOC emission estimates using the IPCC software. Sub-category 2.D.4 is also not occurring.

For product uses as substitutes of Ozone Depleting Substances (ODS), the available data was not segregated and hence it was not possible to separate use of refrigerants between domestic refrigeration, mobile air-conditioning, firefighting, etc. The refrigerant use was therefore all reported under refrigeration and air-conditioning (2.F.1.a), hence all other relevant subcategories under 2.F were reported under 2.F.1.a.

For 2.G category, which is other product manufacture and use, the manufacture of these products is not applicable in Eswatini, hence sub-category 2.F.1.b was reported. For 2.G.2, this is not applicable in the country as this information is not available. For N_2O from product use, the data was also not segregated and hence it was all reported under 2.G.3.b and this covers medical applications (2.G.3.a).

NMVOCs under 2.H were not estimated due to lack of data as well as lack of capacity to use IPCC tool to generate these emissions using available data.

The IPPU sector contributes a total of 72.15 kt of CO_2eq which is equivalent to about 3.16% of the country's GHG emissions (2281.95 kt CO_2eq). The total change in emissions from the IPPU sector was almost 740% between 1990 and 2022. This is because the major contributor to the IPPU emissions are the HFCs in 2.F which were not available in 1990 until 1995. These have high GWPs and hence their emission contributes significantly to the sector emissions. Since the introduction of HFCs, they have seen a gradual increase until the equipment reaches their end of life (assumed to be 15 years) where all the gas is released to the environment. This can be seen from the year 2010.

It must be noted that data on lubricant and paraffin wax consumption was extrapolated from previous inventory data and the activity data of both lubricants and paraffin waxes fluctuated and hence based on the extrapolations, the activity data was slightly lower for 2022 compared to 2018 resulting in a reduction of 2% and 3% for lubricants and paraffin wax, respectively.

The HFC emissions increased by about 38% when comparing 2018 and 2022 emissions. This is due to the increase used of HFCs in the refrigeration and air-conditioning sector. These HFCs were used to substitute ODS under the Montreal Protocol and their use is still increasing even though the Protocol has introduced the Kigali amendment which aims to phase down the use of HFCs over time. HFCs therefore account for 92% of the emissions from the IPPU sector.

For SF_6, the amount used on an annual basis was assumed to be equal to emissions for that year and this amount has been consistent over the past years. Hence the emissions from this sector were consistent across the time series.

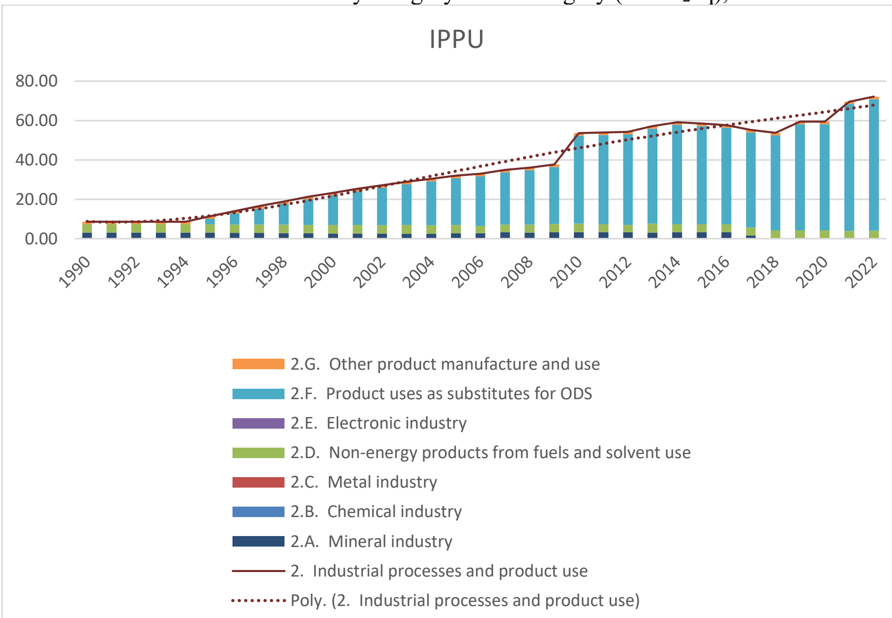
Table 4-2.
IPPU Sector: total GHG emissions by category (kt CO_2eq)

	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
2. Industrial processes and product use	**8.59**	**11.39**	**23.29**	**31.95**	**53.58**	**58.39**	**53.74**	**59.45**	**69.56**	**72.15**
2.A. Mineral industry	3.18	3.1	2.69	2.73	3.28	3.22	NO	NO	NO	NO
2.B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D. Non-energy products from fuels and solvent use	4.19	4.19	4.24	4.26	4.36	4.17	4.17	4.23	3.99	4.09
2.E. Electronic industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.F. Product uses as substitutes for ODS	NO	2.87	15.14	23.69	44.69	49.74	48.30	53.95	64.31	66.79
2.G. Other product manufacture and use	1.22	1.22	1.22	1.27	1.25	1.26	1.26	1.26	1.26	1.26
2.H. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Source: based on the **Table10s1** spreadsheet of the CRT.

Figure 4-1 shows a graphic presentation of the sector emissions.

Figure 4-1.
IPPU Sector: total GHG emissions by category or subcategory (kt CO_2eq), 1990-2022



The trend generally shows an increasing trend mainly from the HFCs. The HFCs are generally increasing due to the phase out date for HCFC which is 2030. Most of the domestic refrigeration sector has transitioned to climate friendly refrigerants while for the other sectors using refrigerants have just moved to HFCs and/or are still transitioning hence equipment containing climate friendly alternative refrigerants is not readily available.

The main contributing subcategory is the product use of substituents of ODS and these are mainly HFCs. This is also shown in Table 4-3 which shows emissions by GHG. It must be noted that HFC125 is the highest contributor. This HFC is not used individually but used in blends such as R410A, R404A, R407C and R507A, all of which are used in the country.

Table 4-3.
IPPU sector: emissions by GHG (kt CO_2eq)

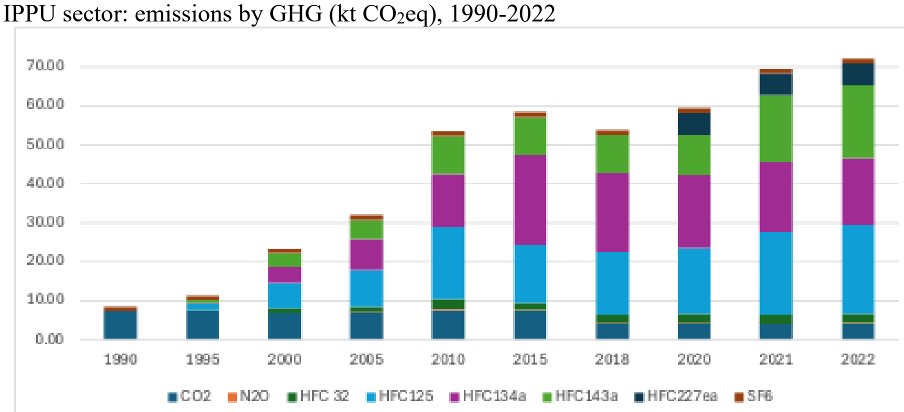
GHG	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
CO_2	7.37	7.29	6.93	7.00	7.64	7.39	4.17	4.23	3.99	4.09
CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
N_2O				0.04	0.03	0.04	0.04	0.04	0.04	0.04
HFC 32	0.00	0.24	1.03	1.43	2.78	1.98	2.21	2.30	2.35	2.50
HFC125	0.00	1.58	6.77	9.37	18.54	14.92	16.05	16.98	21.12	22.81

GHG	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
HFC134a	0.00	0.24	3.88	8.08	13.53	23.07	20.30	18.70	17.98	17.15
HFC143a	0.00	0.81	3.47	4.81	9.83	9.78	9.74	10.45	17.34	18.80
HFC227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.53	5.53	5.53
SF6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
PFC	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total	**8.59**	**11.39**	**23.30**	**31.95**	**53.58**	**58.40**	**53.73**	**59.44**	**69.57**	**72.15**

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = not occurring; IE = included elsewhere; C = confidential.
Source: Source: based on the **Table10s5** spreadsheet of the CRT.

Figure 4.2 gives a summary of the IPPU emissions by gas.

Figure 4-2
IPPU sector: emissions by GHG (kt CO_2eq), 1990-2022



Due to capacity constraints, precursors and other substances that have an impact on climate are not reported.

4.1.3. General methodological issues of the sector

The GHGs included in the IPPU sector are CO_2, HFCs, SF_6 and N_2O. The industries covered in this sector include mineral industry (ceramics), non-energy products from fuels and solvent use (lubricants and paraffin wax) and product uses as substitutes for ozone depleting substances (use of HFCs in the manufacture and servicing of refrigerators and air-conditioning), Other Product Manufacture and Use (electrical equipment) and other (N_2O from Product Uses).

For most of the emissions, Tier 1 approach was used as there is lack of local emission factors. **Table 4-1** summarizes the industries that were included in the GHG inventory for this sector, the gases emitted from each category as well as information on key categories.

Activity data was mainly obtained from the previous inventory, national reports, the industries responsible, and expert judgement based on information gathered from discussions with national stakeholders. Other sources of data were the Eswatini Environment Authority (EEA), especially for HFC data.

4.2. Mineral industry (CRT 2.A)

4.2.1. Description and trend of GHGs in the category

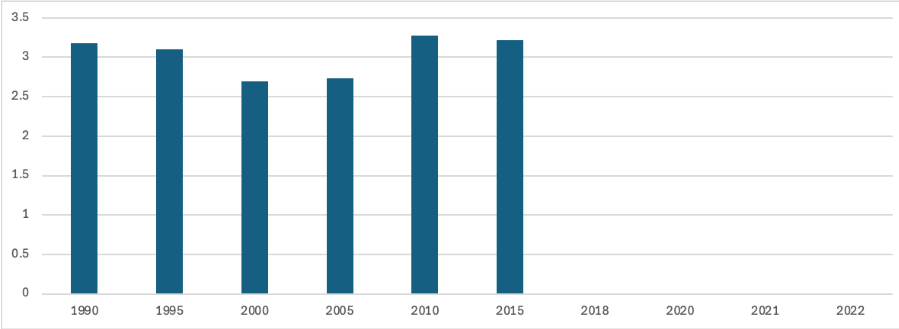
Langa Bricks was the only company in the ceramics sector, producing red bricks since 1990. It utilized clay that likely contained limestone and dolomite. The company ceased operations in 2018, which eliminated emissions from Langa Bricks and the ceramics sector, as there are no other ceramic manufacturers in the country. This category therefore does not contribute any GHGs for the inventory year (2022) as shown in Table 4-6. In the years that the company was still operational, contributions from this category were less than 1% of the total sector emissions.

Table 4-64.
Mineral Industry: total GHG emissions by source (kt CO_2eq)

Subcategory	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
2.A.4 a Ceramics	3.182	3.101	2.695	2.734	3.276	3.216	0	0	0	0
Total	**3.182**	**3.101**	**2.695**	**2.734**	**3.276**	**3.216**	**0**	**0**	**0**	**0**

Figure 4-5 gives a summary of the emissions from this category.

Figure 4-53.
Mineral Industry: total GHG emissions by source (kt CO_2eq), 1990-2022



This category does not contribute to GHG emissions since 2018 as the company that was using clay closed.

4.2.2. Methodological issues of the category

The activity data was based on the amount of bricks produced (tonnes) per year (obtained from the previous inventory), the clay consumed (Production – consumption loss factor of 1.1) and mass of carbonates consumed (10%). These were based on default values from the IPCC guidelines as there was no specific data from the company. The equation below demonstrates the calculation methods employed.

$$CO_2\ Emissions = \sum(M_i \bullet EF_i \bullet F_i)$$

Where:

CO_2 Emissions:	Emissions of CO_2 from other process uses of carbonates, tonnes
M_i:	Mass of the carbonate *i* consumed, tonnes
EF_i:	Emission factor for the carbonate *i*, tonnes CO_2/tonne carbonate
F_i:	Fraction calcination achieved for the particular carbonate *i*, fraction. Where the fraction calcination achieved for the particular carbonate is not known it can be assumed that the fraction calcination is equal to 1.00.
i :	One of the carbonates uses

4.2.2.1. Activity data of the category

To estimate the emissions, Tier 1 was applied, utilizing default emission factors from the IPCC guidelines (2006 GL, Vol 3, Ch 2, Table 2.1) for both limestone (0.43971) and dolomite (0.47732). These factors were used to estimate the CO_2 emissions associated with the clay utilized in the brick production process, given the lack of country-specific data regarding clay quality. The following assumptions were made:

- The company was already operational in 1990
- It closed in November 2018
- Production halved in 2017 before the closure in 2018

Table 4-5.
Mineral Industry: activity data by GHG source (activity data unit)

Year	brick production (tonnes)	Production-consumption loss factor	Clay consumed (tonnes)	Carbonate content	mass of carbonate consumed (tonnes)
1990	65,792.00	1.10	72,371.20	10%	7,237.12
1991	65,792.00	1.10	72,371.20	10%	7,237.12
1992	65,792.00	1.10	72,371.20	10%	7,237.12
1993	65,792.00	1.10	72,371.20	10%	7,237.12

Year	*brick production (tonnes)*	*Production-consumption loss factor*	*Clay consumed (tonnes)*	*Carbonate content*	*mass of carbonate consumed (tonnes)*
1994	65,792.00	1.10	72,371.20	10%	7,237.12
1995	64,112.00	1.10	70,523.20	10%	7,052.32
1996	62,431.00	1.10	68,674.10	10%	6,867.41
1997	60,751.00	1.10	66,826.10	10%	6,682.61
1998	59,071.00	1.10	64,978.10	10%	6,497.81
1999	57,390.00	1.10	63,129.00	10%	6,312.90
2000	55,710.00	1.10	61,281.00	10%	6,128.10
2001	55,549.00	1.10	61,103.90	10%	6,110.39
2002	55,330.00	1.10	60,863.00	10%	6,086.30
2003	51,235.00	1.10	56,358.50	10%	5,635.85
2004	51,855.00	1.10	57,040.50	10%	5,704.05
2005	56,528.00	1.10	62,180.80	10%	6,218.08
2006	55,972.00	1.10	61,569.20	10%	6,156.92
2007	68,515.00	1.10	75,366.50	10%	7,536.65
2008	63,368.00	1.10	69,704.80	10%	6,970.48
2009	67,164.00	1.10	73,880.40	10%	7,388.04
2010	67,724.00	1.10	74,496.40	10%	7,449.64
2011	66,851.00	1.10	73,536.10	10%	7,353.61
2012	65,978.00	1.10	72,575.80	10%	7,257.58
2013	65,792.00	1.10	72,371.20	10%	7,237.12
2014	66,066.00	1.10	72,672.60	10%	7,267.26
2015	66,398.00	1.10	73,037.80	10%	7,303.78
2016	66,489.00	1.10	73,137.90	10%	7,313.79
2017	33,244.00	1.10	36,568.40	10%	3,656.84
2018	0.00	1.10	0.00	10%	0.00
2019	0.00	1.10	0.00	10%	0.00
2020	0.00	1.10	0.00	10%	0.00
2021	0.00	1.10	0.00	10%	0.00
2022	0.00	1.10	0.00	10%	0.00

The activity data for this sector was calculated from the bricks produced and that data was multiplied by 1.1 to accommodate the loss factor and this gave the amount of clay consumed. The carbonate content was assumed to be 10% of the clay consumed.

4.2.2.2. Emission factors applied in the category

The default emission factors were obtained from the IPCC guidelines (2006 GL, Vol 3, Ch 2, Table 2.1) for both limestone (0.43971) and dolomite (0.47732).

Table 4-6.
Mineral Industry: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Ceramics Dolomite limestone	CO_2	0.43971 0.47732	tonnes CO_2/tonne carbonate
N/A	CH_4	0	N/A
N/A	N_2O	0	N/A
N/A	CO_2	0	N/A
N/A	CH_4	0	N/A
N/A	N_2O	0	N/A
N/A	CO_2	0	N/A
N/A	CH_4	0	N/A
N/A	N_2O	0	N/A

4.2.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

4.2.4. Uncertainty assessment and time-series consistency of the category

Uncertainties in this category stem from the incomplete data across the entire time series, which necessitated data filling from the previous inventory. For instance, data from 1990 to 1994 was extrapolated, 1994 to 2000 was interpolated, and data from 2013 to 2018 was also extrapolated. Utilizing Tier 1 emission factors introduces additional uncertainties due to the absence of country-specific values. Furthermore, there was no means to verify the data from the previous inventory. For this inventory, these uncertainties which applied to the previous inventory are still valid for this inventory as well

4.2.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations as well as comparing the values with the previous inventory.

4.2.6. Category-specific recalculations

There were no recalculations for this category.

4.2.7. Category-specific planned improvements

There are no planned improvements for this category.

4.3. Chemical industry (CRT 2.B)

Eswatini does not have chemical manufacturing industries hence this category is not applicable.

4.4. Metal industry (CRT 2.C)

There are no metal processing industries in the country, hence no emissions were estimated for this category.

4.5. Non-energy products from fuels and solvent use (CRT 2.D)

4.5.1. Description and trend of GHGs in the category

Lubricants and greases are utilized across various sectors, including transportation, but are all imported into the country since there is no local production. While there is a candle manufacturing company, Swazi Candles, in Eswatini, most of the candles burned locally, which contribute to emissions, are typically imported. Swazi Candles primarily produces candles for tourists and a few local consumers, so the data related to paraffin wax from this company does not accurately represent emissions from candle burning. Consequently, data on lubricants and paraffin wax were sourced from the previous inventory due to challenges in obtaining updated information.
To estimate the emissions, the amount of lubricants consumed were multiplied by the carbon content, oxidisable fraction during use. The IPCC default values were used as there is no country specific data.

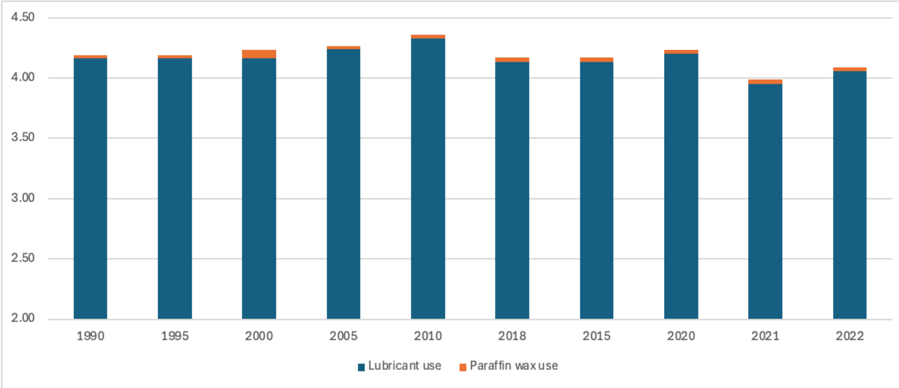
This category contributes about 0.3% to the sector emissions most of which is coming from lubricant use, with the paraffin wax use contributing only 1% of the 0.3% for 2022. The emissions from this category did not vary much over the whole time series as observed in Table 4-21.

Table 4-7.
Non-energy products from fuels and solvent use: total GHG emissions by subcategory (kt CO_2eq)

Subcategory	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
Lubricant use	4.17	4.17	4.17	4.24	4.33	4.14	4.14	4.20	3.95	4.06
Paraffin wax use	0.03	0.03	0.07	0.03	0.04	0.04	0.04	0.03	0.04	0.04
Total	**4.19**	**4.19**	**4.24**	**4.26**	**4.36**	**4.17**	**4.17**	**4.24**	**3.99**	**4.09**

An illustration of the emissions from this category is shown in Figure 4-8.

Figure 4-4.
Non-energy products from fuels and solvent use: total GHG emissions by source (kt CO_2eq), 1990-2022



4.5.2. Methodological issues of the category

To estimate the CO_2 emissions for this category, it is necessary to have data on the quantity of lubricant used (converted into energy units, TJ), the carbon content factor (CCF), and the fraction of fossil fuel carbon that is oxidized during use (ODU). These values can then be utilized to calculate emissions using the equation below.

$$CO_2 Emissions = \sum(NEU_i \times CC_i \times ODU_i) \times 44/12$$

Where:CO_2 : Emissions from non-energy product uses, tonne CO_2
NEU_i: non-energy use of fuel *i*, TJ
CC_i: specific carbon content of fuel *i*, tonne C/TJ (=kg C/GJ)
ODU_i: ODU factor for fuel *i*, fraction
44/22: mass ration of CO_2/C

4.5.2.1. Activity data of the category

The data used for this inventory was obtained from the previous inventory without alterations. The data was extrapolated for the years 2018-2022. The data for this subcategory is difficult to obtain as most of the data custodians are private distribution companies. Data from ERS is not usable to estimate the amounts of lubricants and paraffin wax or candles imported into the country, hence data from previous inventory was used (Table 4-22).

Table 4-8.
Non-energy products from fuels and solvent use: activity data by GHG source (activity data unit)

Year	Amount of lubricant consumed (tonnes)	Amount of lubricant consumed (TJ)	Amount of paraffin wax consumed (tonnes)	Amount of paraffin wax consumed (TJ)
1990	7061.38	283.87	42	1.6884
1991	7061.38	283.87	42	1.6884
1992	7061.38	283.87	42	1.6884
1993	7061.38	283.87	42	1.6884
1994	7061.38	283.87	42	1.6884
1995	7061.38	283.87	42	1.6884
1996	7061.38	283.87	42	1.6884
1997	7061.38	283.87	120	4.824
1998	7061.38	283.87	120	4.824
1999	7061.38	283.87	120	4.824
2000	7061.38	283.87	120	4.824
2001	7061.38	283.87	120	4.824
2002	7061.38	283.87	120	4.824
2003	7549.00	303.47	120	4.824
2004	7403.00	297.60	42	1.6884
2005	7200.00	289.44	42	1.6884
2006	6494.00	261.06	42	1.6884
2007	6600.00	265.32	42	1.6884
2008	6800.00	273.36	42	1.6884
2009	7100.00	285.42	60	2.412
2010	7345.00	295.27	60	2.412
2011	6878.50	276.52	60	2.412
2012	6412.00	257.76	60	2.412
2013	7490.00	301.10	60	2.412
2014	7024.68	282.39	60	2.412
2015	7024.68	282.39	60	2.412
2016	7024.68	282.39	60	2.412
2017	7024.68	282.39	60	2.412
2018	7024.68	282.39	60	2.412
2019	7125.45	286.44	61	2.447
2020	6703.45	269.48	57	2.302
2021	6879.45	276.55	59	2.362

Year	Amount of lubricant consumed (tonnes)	Amount of lubricant consumed (TJ)	Amount of paraffin wax consumed (tonnes)	Amount of paraffin wax consumed (TJ)
2022	6964.75	279.98	59	2.391

4.5.2.2. Emission factors applied in the category

Emissions in this category are based on the amount of lubricants, greases and paraffin wax used, in energy units (TJ). For calculating CO_2 emissions, the total amount of lubricants lost during use is assumed to be fully combusted and these emissions are directly reported as CO_2 emissions instead of NMVOC. Since there is no country-specific statistics available on the fates and composition of lubricants, motor oils and greases in the country, Tier 1 was used. This tier assumes that 90 percent of the mass of lubricants is oil and 10 percent is grease, and when applied to ODU factors for oils and greases yields an overall ODU factor of 0.2 which was used (Table 5.2 - ODU factors in IPCC guidelines) and section 5.3.2.2. for paraffin wax. These are shown in Table 4-23.

Table 4-9.
Non-energy products from fuels and solvent use: emission factors applied by GHG source

GHG source	Factor	GHG	Value	Unit
Lubricant use	Oxidised during use (ODU) factor	CO_2	0.20	factor
	Carbon content	CO_2	20.00	kg C/GJ
	Net Calorific Value (NCV)	CO_2	40.20	TJ/Gg
	Mass ratio of CO2	CO_2	3.67	factor
Paraffin wax use	Oxidised during use (ODU) factor	CO_2	0.20	factor
	Carbon content	CO_2	20.00	kg C/GJ
	Net Calorific Value (NCV)	CO_2	40.20	TJ/Gg
	Mass ratio of CO2	CO_2	3.67	factor

Note:
Source:

4.5.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

4.5.4. Uncertainty assessment and time-series consistency of the category

Uncertainties in this category arose from the incomplete data across the entire time series, necessitating the application of data filling techniques, as was done in the previous inventory. The reliance on Tier 1 emission factors also introduces uncertainties due to the lack of country-specific values. There are still major gaps in the data as it is currently estimated. The main barrier is that importers of lubricants and candles are not obliged to report their imports except their declarations with customs. Data from customs is not meant for inventory use but for revenue collection, hence it is not usable. The calculations were done using the same method and data sets for every year in the time series.

4.5.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations to ensure errors are eliminated.

4.5.6. Category-specific recalculations

There are no recalculations as this is the first BTR.

4.5.7. Category-specific planned improvements

There is need to improve the quality of activity data especially lubricants and paraffin waxes as they contribute directly to GHG emissions. This will improve the quality of the activity data.

4.6. Electronic industry (CRT 2.E)

This category is not applicable to Eswatini.

4.7. Product uses as substitutes for ODS (CRT 2.F)

4.7.1. Description and trend of GHGs in the category

Eswatini is home to a refrigerator manufacturing company, along with several businesses and individuals who service refrigerators and install air conditioning units. The refrigeration manufacturing company currently does not use any HFCs as they have been phased out. Most of the refrigerators manufactured by this company are exported, primarily to South Africa, while the majority of refrigerators used locally are imported. This was the case even when they were using HFCs. All refrigerants utilized for both manufacturing and servicing are imported, as there is no local production of refrigerants. Several blends have been identified as being used in the country, including R-404A, R-407C, R-408A, R-410A, and R-507A. These blends contain varying proportions of HFCs such as HFC-134A, R-125, R-143A, and R-32.

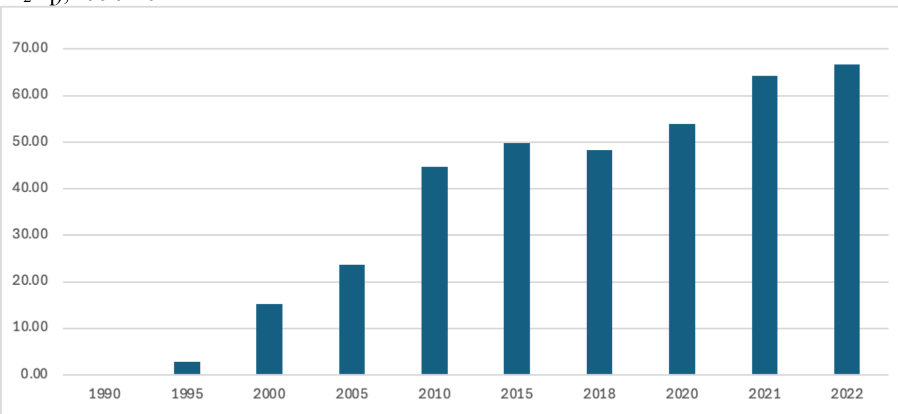
The use of these refrigerants could not be segregated to specific subcategories as that data is not available. Hence all information of product uses as substitutes of ODS are reported under refrigeration and stationary air-conditioning (2.F.1a).
The emissions from this subcategory contribute about 5% of the total emissions of this sector for the year 2022. These emissions are due to the phase out of ODS which should be phased out by 2030. Most of the equipment that are now being imported into the country are charged with HFCs. This also increase HFCs used for servicing the same equipment. The emissions from this sector have therefore been increasing since the introduction of HFCs in the market as shown in Table3-31.

Table 4-10.
Products uses as substituents and air conditioning: total GHG emissions by subcategory (kt CO_2eq)

Subcategory	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
2.F.1.a Refrigeration and stationary air-conditioning	0.00	2.88	15.14	23.69	44.69	49.74	48.30	53.95	64.31	66.79
Total	**0.00**	**2.88**	**15.14**	**23.69**	**44.69**	**49.74**	**48.30**	**53.95**	**64.31**	**66.79**

Figure 4-10 shows a graphical presentation of the emissions from this category over the time series.

Figure 4-5.
Products uses as substituents and air conditioning: total GHG emissions by source (kt CO_2eq), 1990-2022



4.7.2. Methodological issues of the category

Data for the bulk importation of ODS alternatives was obtained from the previous inventory. In that inventory, activity data was obtained from a survey done by EEA for ODS alternatives which covered a four-year period between 2012 and 2015. Another survey for HFCs has been recently completed by EEA which was done to inform the Kigali Implementation Plan (KIP). This covered from 2016 – 2022 Extrapolations were made for the years before this period based on the assumption that these F-gases were introduced in the early 1990s, where 1995 was assumed to be the year of their introduction in Eswatini. The amount used for manufacturing new refrigerators was obtained from Palfridge which is the manufacturing company, even though this is not applicable anymore as the fridge factory phased out the use of HFCs.
The emissions were calculated using the equation below:

$$Annual\ Emissions = Net\ Consumption \bullet Composite\ EF$$

Where:

Net Consumption = net consumption for the application

Composite EF = composite emission factor for the application

4.7.2.1. Activity data of the category

Activity data for this category was obtained from previous HFC inventories done by EEA under the Montreal protocol. The data covered from 2012 – 2022. It includes data for pure HFCs as well as their blends as shown in Table 4-32.

Table 4-11.
Products uses as substituents and air conditioning: activity data by GHG source (activity data unit)

Year	*HFC 134A (imported & in Banks)*	*R410A (imported & in Banks)*	*R404A (imported & in Banks)*	*R407C (imported & in Banks)*	*R407A (imported & in Banks)*	*HFC227ea (imported & in Banks)*
1990	0.0000	0.0000	0.0000	0.0000	0.00	0.00
1991	0.0000	0.0000	0.0000	0.0000	0.00	0.00
1992	0.0000	0.0000	0.0000	0.0000	0.00	0.00
1993	0.0000	0.0000	0.0000	0.0000	0.00	0.00
1994	0.0000	0.0000	0.0000	0.0000	0.00	0.00
1995	0.4686	0.0000	0.0000	0.0000	0.00	0.00
1996	0.9371	0.3000	0.0000	0.0000	0.00	0.00
1997	1.4057	0.4801	0.0651	0.0000	0.00	0.00
1998	1.8742	0.6666	0.1106	0.0000	0.00	0.00
1999	2.3428	0.8403	0.1302	0.0000	0.00	0.00
2000	2.8113	1.0270	0.1499	0.0000	0.00	0.00
2001	3.2932	1.2011	0.1699	0.0000	0.00	0.00
2002	3.7627	1.3821	0.1903	0.0000	0.00	0.00
2003	4.2315	1.5707	0.3415	0.0000	0.00	0.00
2004	4.7001	1.7484	0.3905	0.0000	0.00	0.00
2005	5.1682	1.9434	0.4431	0.0000	0.00	0.00
2006	5.6434	2.1338	0.5026	0.0000	0.00	0.00
2007	6.1028	2.3540	0.5763	0.0000	0.00	0.00
2008	6.5690	2.6015	0.6390	0.0000	0.00	0.00
2009	7.0368	2.9250	0.8685	0.0000	0.00	0.00
2010	7.5008	3.5165	1.1065	0.0000	0.00	0.00
2011	7.9549	4.5000	1.6020	0.0000	0.00	0.00
2012	8.4220	5.6165	2.5670	0.0000	0.00	0.00
2013	10.7040	7.3365	3.3495	0.0000	0.00	0.00
2014	9.8950	9.4565	4.3585	0.0000	0.00	0.00

Year	HFC 134A (imported & in Banks)	R410A (imported & in Banks)	R404A (imported & in Banks)	R407C (imported & in Banks)	R407A (imported & in Banks)	HFC227ea (imported & in Banks)
2015	7.8640	4.9295	5.1450	0.0000	0.00	0.00
2016	7.4000	8.0565	3.4295	0.0000	1.40	0.00
2017	7.4000	8.3205	3.4100	0.0000	0.00	0.00
2018	7.4000	10.1565	3.5205	0.8000	0.00	0.00
2019	6.3000	8.6715	4.6660	0.4000	0.00	11.00
2020	6.8200	7.5065	4.2790	0.3000	1.20	0.00
2021	7.8600	8.2755	19.7670	0.0000	0.18	0.00
2022	9.0100	10.2300	6.0000	0.0000	0.53	0.00

4.7.2.2. Emission factors applied in the category

The following assumptions were made:

- ODS alternatives were introduced in the early 1990s in Eswatini, around 1995.
- Their use increased gradually from then until recently were it has slowed down.
- Most of the use of these alternatives imported are for servicing already in-use equipment as the refrigeration company has reduced the amount of ODS alternatives used.
- For air-conditioning (mobile and stationary) and industrial refrigeration, equipment imported is still dominantly charged with HFC blends.
- The life span of both refrigerators and air-conditioners was assumed to be 15 years.

Since the data could not be segregated to different sub-applications, a composite emission factor of 15% was used as per the IPCC guidance.

4.7.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

4.7.4. Uncertainty assessment and time-series consistency of the category

Uncertainties are based on the assumptions made including the percentage of refrigerators and air-conditioners charged with ODS is not known. The emission factor used was also the composite emission factor which is not use specific.

Future inventories may have improvements as the data collection for imports of HFCs is being strengthened through legal instruments meant to improve the enforcement of the Montreal Protocol. To ensure time-series consistency, the same method was applied across the time-series as well as the activity data used was the same.

4.7.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations.

4.7.6. Category-specific recalculations

There are no recalculations as this is the first BTR.

4.7.7. Category-specific planned improvements

To improve the inventory, it is important to gather data on imports of equipment charged with F-gases, especially for years to come, as this may not be possible for past years.

4.8. Other product manufacture and use (CRT 2.G)

4.8.1. Description and trend of GHGs in the category

The electrical distribution network necessitates the installation of circuit breakers at all substations. These circuit breakers contain SF_6 gas, which leak over time. The Eswatini Electricity Company (EEC) replenishes this gas as needed during their maintenance activities. This gas is imported into the country for EEC's use. The data from EEC indicated the amount of SF_6 purchased or used to service the circuit breakers annually, which was assumed to serve as a proxy for emissions for that same year.

Different products that are charged with N_2O are used in the country. These include use of N_2O in medical applications and as a propellant in aerosol products. These are not manufactured locally hence emissions come from product use. The data used was obtained from the previous inventory and extrapolated for the later years.

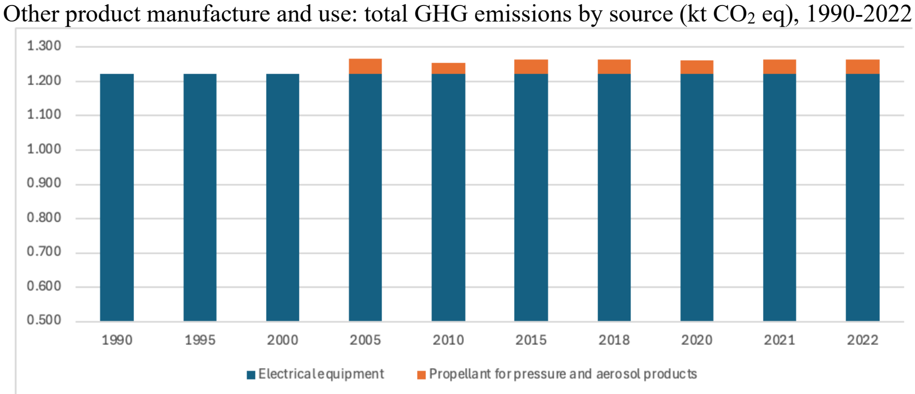
This category contributes 2% of the emissions from IPPU where most of the emissions originate from SF_6. The amount of SF_6 is consistent throughout the time series. The contribution from N_2O products is very low at 0.06% of total emissions in 2022.

Table 4-12.
Other product manufacture and use: total GHG emissions by subcategory (kt CO_2eq)

Subcategory	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
Electrical equipment	1.222	1.222	1.222	1.222	1.222	1.222	1.222	1.222	1.222	1.222
Propellant for pressure and aerosol products	0.000	0.000	0.000	0.045	0.033	0.042	0.042	0.040	0.042	0.042
Total	**1.222**	**1.222**	**1.222**	**1.267**	**1.255**	**1.264**	**1.264**	**1.262**	**1.264**	**1.264**

Figure 4-11 shows the emissions from this category which are predominately from electrical equipment.

Figure 4-6.
Other product manufacture and use: total GHG emissions by source (kt CO_2 eq), 1990-2022



4.8.2. Methodological issues of the category

The data for both subcategories was obtained from the previous inventory. For SF_6, the source was EEC which gave the amount of SF_6 purchased or used to service circuit breakers per year and this was assumed as a proxy for emissions in the same year. This basically means that even though the data on the actual amount refilled could not be ascertained, but it was confirmed that 52 kg of SF_6 was purchased on an annual basis. It was therefore assumed that 52 kg escaped from the system to the atmosphere annually. The equations used to calculate the emissions are given below.

For SF_6:

Equipment use emissions = SF_6 retro-filled x emission factor

For N_2O:

$$E_{N2O}(t) = \sum_i \{ [0.5 \bullet A_i(t) + 0.5 \bullet A_i(t-1)] \bullet EF_i \}$$

Where:

$E_{N2O}(t)$ = emissions of N_2O in year *t*, tonnes
$A_i(t)$ = total quantity of N_2O supplied in year *t* in application type *i*, tonnes
$A_i(t\text{-}1)$ = total quantity of N_2O supplied in year *t*-1 in application type *i*, tonnes
EF_i = emission factor for application type *i*, fraction

4.8.2.1. Activity data of the category

The activity data for SF_6 consisted of the annual amount procured, which was assumed to serve as a proxy for emissions for that same year. The source of the N_2O data from the previous inventory, with extrapolations applied for subsequent years due to the lack of better available data.

Table 4-13.
Other products manufacture and use: activity data by GHG source (activity data unit)

Year	*SF_6 quantity (kg)*	*N_2O from Product Uses (kg)*
1990	52	0
1991	52	0
1992	52	0
1993	52	0
1994	52	0
1995	52	0
1996	52	0
1997	52	0
1998	52	0
1999	52	0
2000	52	0
2001	52	0.2352
2002	52	0.3392
2003	52	0.3392
2004	52	0.2352
2005	52	0.3392
2006	52	0.2352
2007	52	0.3392
2008	52	0.2352
2009	52	0.2352
2010	52	0.248
2011	52	0.3552
2012	52	0.3152
2013	52	0.3168
2014	52	0.3168
2015	52	0.3168
2016	52	0.3168
2017	52	0.3168
2018	52	0.3168
2019	52	0.3213
2020	52	0.3023
2021	52	0.3103
2022	52	0.3141

4.8.2.2. Emission factors applied in the category

The emission factors are summarised in Table 4-38. For SF_6, an emission factor of 1 was used based on the fact that the activity data is of procured gas which was assumed to be equivalent to emitted SF_6.

Table 4-14.
Other products manufacture and use: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Electrical equipment	SF_6	1	
Propellant for pressure and aerosol products	N_2O	1	

4.8.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

4.8.4. Uncertainty assessment and time-series consistency of the category

Uncertainties are based on the activity data as well as the use of Tier 1 for both SF_6 and N_2O. The activity data is the amount of SF_6 imported annually which is assumed to be equivalent to the SF_6 emissions.

4.8.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentation of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations.

4.8.6. Category-specific recalculations

There were no recalculations as this is the first BTR.

4.8.7. Category-specific planned improvements

There is need to get more data from other electricity generating companies as well as improve data collection for amount of N_2O from product use

4.9. Other (specify) (CRT 2.H)

These were not included in this inventory but will be considered as improvements in the next inventory.

Chapter 5. AGRICULTURE (CRT 3)

5.1. Overview of the sector

5.1.1. Description of the sector

The agricultural sector in Eswatini plays a central role in the livelihoods of over 70% of the population, serving as a key source of income, employment, and food security[3]. It is broadly divided into two categories: subsistence and commercial agriculture. Subsistence farming, predominantly practiced by rural households, relies primarily on rain-fed systems and is characterized by low productivity and minimal investment. In contrast, commercial agriculture is highly mechanized and resource-intensive, with irrigation systems enabling the production of high-value crops such as sugarcane, citrus, and forestry products, particularly on Title Deed Land (TDL). Smallholder farmers, who make up over 75% of rural households, often engage in mixed farming, combining crop cultivation with livestock rearing, mainly on communally held Swazi Nation Land (SNL).

Land tenure in Eswatini is categorized into three main types: Swazi Nation Land (SNL), Title Deed Land (TDL), and Crown Land (CL)[4]. SNL, which constitutes 75% of the land, is held in trust by the King and allocated by chiefs to community members for cultivation and grazing. TDL, comprising 24% of the land, is privately owned and includes highly productive commercial farms and plantations. Crown Land, at 1%, is government-owned and includes protected areas and commercially managed forestry operations. These land tenure systems influence agricultural practices and investment levels, with TDL characterized by high productivity and SNL often associated with low-input, subsistence farming.

The agricultural landscape is dominated by maize, which accounts for 84% of the rain-fed cropped area, followed by cotton (7%) and groundnuts (6%). Other significant crops include sorghum, sweet potatoes, and grain legumes. Livestock production is widespread, with goats, cattle, sheep, pigs, and poultry being the primary types. The sector also shows a growing interest in fish farming. Grazing lands cover approximately 60% of the country, mostly on SNL, while the Highveld, with its shallow soils, is used predominantly for commercial forest plantations. Notably, irrigated sugarcane is Eswatini's leading cash crop, occupying 45,000 hectares and consuming over 80% of the country's surface water resources.

From a greenhouse gas (GHG) perspective, Eswatini's agricultural sector contributes to emissions through activities such as livestock rearing, manure management, and the application of nitrogen-based fertilizers. Following the 2006 IPCC Guidelines[5], emissions from this sector are classified into two major categories: livestock (Category 3A) and aggregated sources and non-CO_2 emissions on land (Category 3C). Livestock-related emissions include enteric fermentation (3A1) and manure management (3A2). Land-based emissions encompass practices such as biomass burning (3C1), liming (3C2), urea application (3C3), and direct and indirect N_2O emissions from managed soils (3C4 and 3C5).

[3] IPC Acute Food Insecurity Analysis, June 2023
[4] https://www.undp.org/eswatini/publications/third-state-environment-report-kingdom-eswatini
[5] https://www.ipcc-nggip.iges.or.jp/public/2006gl/

However, certain categories, such as rice cultivation, are excluded due to their insignificance and lack of data in the country.

5.1.2. Trend in the sector's GHG

The results for greenhouse gas (GHG) emissions in the agriculture sector for 2022 (Table 5-1) indicate significant contributions from specific sources while highlighting areas where emissions were either not occurring or not applicable within the country. Total GHG emissions for the sector amounted to 866.05 kt CO_2eq, driven by emissions of CO_2, CH_4, and N_2O. Carbon dioxide (CO_2) emissions were measured at 99.38 kt, with crop residues as the only identified source. Methane (CH_4) emissions totalled 18.14 kt, predominantly arising from enteric fermentation in livestock. The largest contributors to CH_4 emissions were non-dairy cattle (14.78 kt) and goats (2.62 kt). Nitrous oxide (N_2O) emissions were recorded at 0.98 kt, primarily linked to agricultural soils.

Enteric fermentation was the dominant source of CH_4 emissions, with cattle contributing the largest share. Other livestock, including goats, horses, and poultry, also added to the emissions, though to a lesser extent. The subcategories for manure management showed minimal emissions, except for small contributions from indirect N_2O emissions and other livestock. Categories like field burning of agricultural residues and specific practices such as dolomite application contributed negligible emissions.

Table 5-1.

Agriculture sector: emissions by GHG, category and subcategory (kt) for 2022

Code	GHG source categories	CO_2 (kt)	CH_4 (kt)	N_2O (kt)	NO_x (kt)	CO (kt)	NMVOC (kt)	SO_X (kt)	Total GHG (kt CO_2 eq)
3.	**Agriculture**	99.38	18.14	0.98	NA,NO	NA,NO	IE,NA,NO	NO	866.05
3.A.	Enteric fermentation		17.52						490.56
3.A.1.	Cattle		14.78						413.81
3.A.1.a.	Dairy cattle								
3.A.1.b.	Non-dairy cattle		14.78						413.80
3.A.2.	Sheep		0.26						7.27
3.A.3.	Swine		14.52						406.53
3.A.4.	Other livestock		NA						NA
3.A.4.a.	Buffalo		NA						NA
3.A.4.b.	Camels		0.08						2.32
3.A.4.c.	Deer		0.04						1.14
3.A.4.d.	Goats		2.62						73.30
3.A.4.e.	Horses		0.62	0.08			IE,NO		37.69
3.A.4.f.	Mules and asses		0.47	0.00			IE		13.28
3.A.4.g.	Poultry								
3.A.4.h.	Other		0.47	0.00			IE		13.28
3.B.	Manure management		0.01	0.00			IE		0.17
3.B.1.	Cattle		0.47	NE			IE		13.11
3.B.1.a.	Dairy cattle		NA	NA			IE		NA
3.B.1.b.	Non-dairy cattle						IE		
3.B.2.	Sheep		0.00	0.00			NO		0.48
3.B.3.	Swine		0.04	NE			NO		1.14
3.B.4.	Other livestock		0.10	0.06			NO		18.53
3.B.4.a.	Buffalo			0.02					
3.B.4.b.	Camels		NE				NO		NE
3.B.4.c.	Deer		NA	0.90	NA	NA	NA		238.42
3.B.4.d.	Goats			0.79					210.67
3.B.4.e.	Horses			0.00					0.02
3.B.4.f.	Mules and asses			0.11					29.59
3.B.4.g.	Poultry			0.66					174.76
3.B.4.h.	Other			0.02					6.30
3.B.5.	Indirect N_2O			NE					NE
3.C.	Rice cultivation			NO					NO
3.C.1.	Irrigated			NO					NO
3.C.2.	Rain-fed			0.10					27.74
3.C.3.	Deep water		NO	NO	NE	NE	NE	NE	NO
3.C.4.	Other (please specify)		NE	NE	NE	NE	NE	NE	NE
3.D.	Agricultural soils	1.94							1.94
3.D.1.	Direct N_2O emissions from agricultural soils	97.43							97.43
3.D.1.a.	Inorganic fertilizers	NA							NA
3.D.1.b.	Organic fertilizers	NO	NO	NO	NO	NO	NO	NO	NO
3.D.1.c.	Urine and dung deposited by grazing animals	NO	NO	NO	NO	NO	NO	NO	NO
3.D.1.d.	Crop residues	99.38	18.14	0.98	NA,NO	NA,NO	IE,NA,NO	NO	866.05
3.D.1.e.	Mineralization associated with soil organic matter		17.52						490.56
3.D.1.f.	Cultivation of organic soils (histosols)		14.78						413.81
3.D.1.g.	Other (please specify)								

Commented [DN3]: Aren't the grey areas where there should be no data?

Commented [SM4R3]: It is so Director, however NMVOCs are not applicable for the Agriculture sector, we report on CH4 and N2O.

Commented [DN5]: NA means the activity is there but leads to no emissions in the country. Why does the country's deers population result in no CH4 and NMVOCemissions.

Commented [SM6R5]: We do not have deer this end of the globe director, only imported ones as exotic. That said, our inventory does not include wildlife as such data is not easily accessible from reserves, for reasons including security (and profits).

Code	GHG source categories	CO_2 (kt)	CH_4 (kt)	N_2O (kt)	NO_x (kt)	CO (kt)	NMVOC (kt)	SO_X (kt)	Total GHG (kt CO_2 eq)
3.D.2.	Indirect N_2O emissions from agricultural soils		14.78						413.80
3.D.2.a.	Atmospheric deposition		0.26						7.27
3.D.2.b.	Leaching and run-off		14.52						406.53
3.E.	Prescribed burning of savannahs		NA						NA
3.F.	Field burning of agricultural residues		NA						NA
3.F.1.	Wheat		0.08						2.32
3.F.2.	Pulses		0.04						1.14
3.F.3.	Tubers and roots		2.62						73.30
3.F.4.	Sugar cane		0.62	0.08			IE,NO		37.69
3.F.3.	Other (please specify)		0.47	0.00			IE		13.28
3.G.	Liming								
3.G.1.	Limestone		0.47	0.00			IE		13.28
3.G.2.	Dolomite		0.01	0.00			IE		0.17
3.H.	Urea application		0.47	NE			IE		13.11
3.I.	Other carbon-containing fertilizers		NA	NA			IE		NA
3.J.	Other (please specify)						IE		

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = n ot occurring; IE = included elsewhere; C = confidential.
Source: [], based on the **Table3** spreadsheet of the CRT.

The agriculture sector's greenhouse gas (GHG) emissions from 1990 to 2022 show a decreasing trend overall (Table 5-2 and Figure 5-1), with 1990 serving as the base year. In 1990, total emissions were 1,099.89 kt CO_2 equivalent, which declined to 866.03 kt CO_2 equivalent in 2022, representing a reduction of approximately 21%.

Enteric fermentation, the largest contributor, accounted for 672.69 kt CO_2eq in 1990, decreasing steadily to 490.56 kt CO_2eq by 2022. This decline reflects reduced livestock emissions over time, which has been as a result of reduced livestock numbers over the years, especially since the drought that was experienced nationally in the years 2015-2016. Manure management emissions showed relatively minor variations, increasing slightly from 35.38 kt CO_2eq in 1990 to 37.69 kt CO_2eq in 2022, with peaks and troughs in intermediate years.

Table 5-2.

Agriculture sector: total GHG emissions by category (kt CO_2eq)

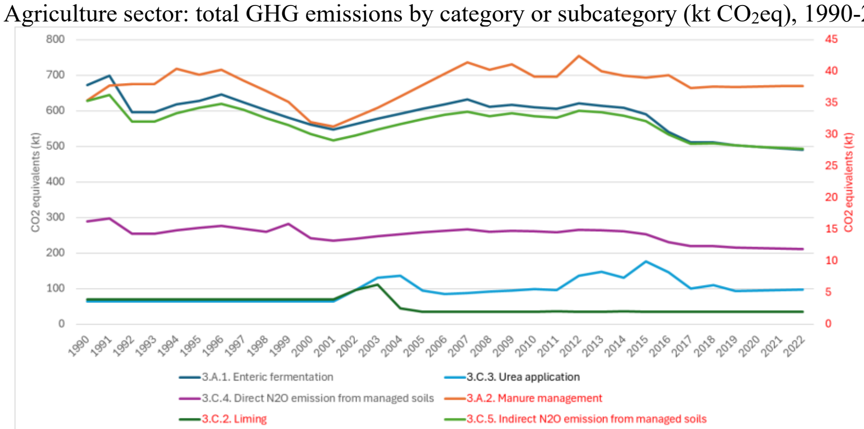
Category	1990	1995	2000	2005	2010	2015	2020	2021	2022
3.A.1. Enteric fermentation	672.69	628.09	561.84	604.97	610.01	590.64	499.04	494.85	490.56
3.A.2. Manure management	35.38	39.43	31.98	37.83	39.18	38.96	37.57	37.63	37.69
3.C.2. Liming	3.89	3.89	3.89	1.94	1.96	1.96	1.94	1.94	1.94
3.C.3. Urea application	64.09	64.09	64.09	93.92	98.44	176.86	94.37	95.90	97.43
3.C.4. Direct N2O emission from managed soils	288.54	270.30	242.28	258.05	260.55	252.85	214.23	212.48	210.67
3.C.5. Indirect N2O emission from managed soils	35.30	34.22	30.10	32.40	32.92	32.11	28.08	27.91	27.74
Total	1099.89	1040.02	934.18	1029.11	1043.06	1093.38	875.23	870.71	866.03

Source: based on the **Table10s1** spreadsheet of the CRT.

Liming emissions remained constant at 3.89 kt CO_2eq until 2005, after which they declined to 1.94 kt CO_2eq and stabilized. Similarly, urea application emissions rose sharply after 2000, reaching a peak of 176.86 kt CO_2eq in 2015, before settling at 97.43 kt CO_2eq in 2022. This suggests changes in fertilizer use intensity or efficiency over the years.

Direct N_2O emissions from managed soils also declined significantly, from 288.54 kt CO_2eq in 1990 to 210.67 kt CO_2eq in 2022, reflecting improved management practices. Indirect N_2O emissions followed a similar downward trend, dropping from 35.30 kt CO_2eq in 1990 to 27.74 kt CO_2eq in 2022.

Figure 5-1.
Agriculture sector: total GHG emissions by category or subcategory (kt CO_2eq), 1990-2022



The emissions of greenhouse gases (GHGs) in the agriculture sector from 1990 to 2022 demonstrate distinct trends for CO_2, CH_4, and N_2O (Table 5-3). Total emissions increased from 94.08 kt CO_2eq in 1990 to a peak of 201.79 kt CO_2eq in 2015, followed by a decline to 118.50 kt CO_2eq in 2022.

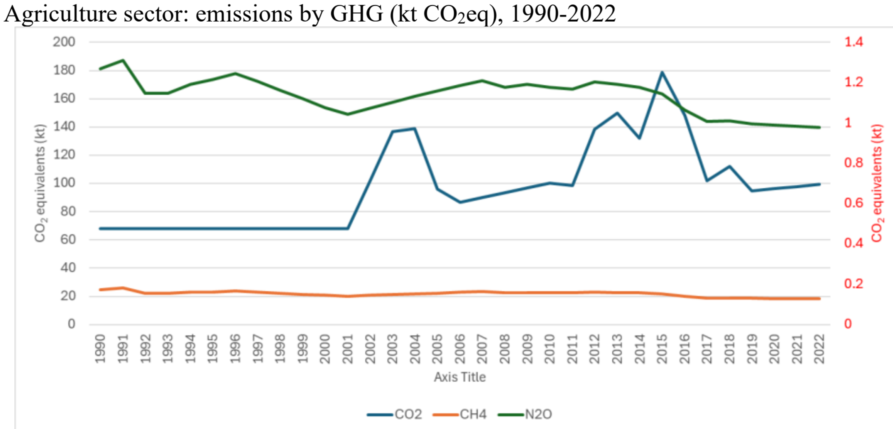
Carbon dioxide (CO_2) emissions rose significantly over the period, from 67.98 kt in 1990 to 99.38 kt in 2022. The sharpest increase occurred between 2000 and 2015, with emissions nearly doubling to 178.82 kt in 2015, reflecting higher contributions from agriculture inputs. However, after 2015, CO_2 emissions decreased possibly due to the 2015/16 El Nino, stabilizing at around 99 kt from 2020 onward, attributed to the recovery from the El Nino.

Methane (CH_4) emissions, on the other hand, exhibited a gradual decline throughout the GHG inventory period. Starting at 24.83 kt in 1990, emissions fell to 18.14 kt in 2022, with reductions evident in livestock-related activities such as enteric fermentation. This trend highlights improvements in livestock management or reductions in livestock populations, mainly driven by reductions in livestock, contributing to lower CH_4 levels, which is attributed to reduced livestock numbers national since the 2015/16 drought years. Nitrous oxide (N_2O) emissions showed a relatively stable pattern, decreasing slightly from 1.27 kt in 1990 to 0.98 kt in 2022.

Table 5-3.
Agriculture sector: emissions by GHG (kt CO_2eq)

GHG	1990	1995	2000	2005	2010	2015	2020	2021	2022
CO_2	67.98	67.98	67.98	95.87	100.4	178.82	96.31	97.84	99.38
CH_4	24.83	23.2	20.76	22.35	22.53	21.83	18.45	18.3	18.14
N_2O	1.27	1.22	1.07	1.16	1.18	1.14	0.99	0.98	0.98
Total	94.08	92.40	89.81	119.38	124.11	201.79	115.75	117.12	118.50

Figure 5-2.
Agriculture sector: emissions by GHG (kt CO_2eq), 1990-2022



Note:
Source:

Table 5-4. (NA, NO)
Agriculture sector: emissions by precursor (kt)

Precursor	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2020*	*2021*	*2022*
NO_x									
CO									
NMVOC									
SO_X									
Total									

Note:
Source:

Figure 5-3. (NA, NO)

Table 5-5. (NA, NO)
Agriculture sector: emissions of other substances that have an impact on climate (kt)

Substance	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2020*	*2021*	*2022*
Total									

Note:
Source:

Figure 5-4. (NA, NO)

5.1.3. General methodological issues of the sector

5.2. Enteric fermentation (CRT 3.A)

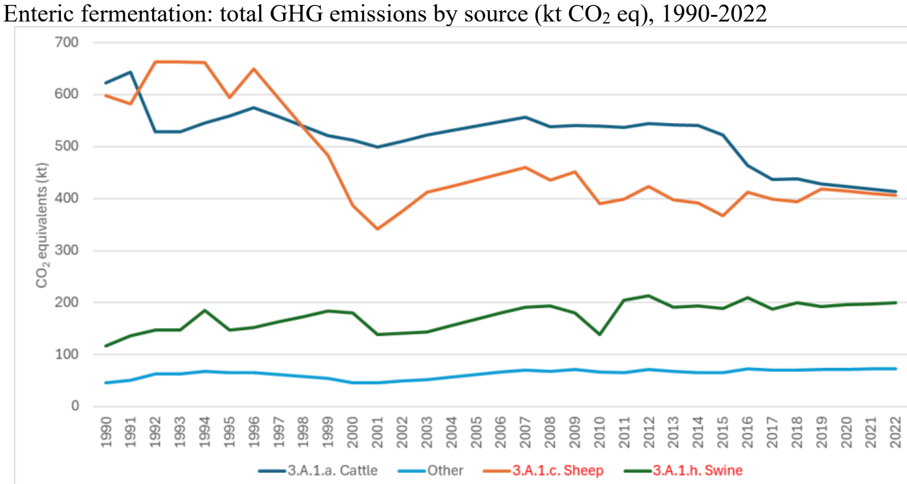
5.2.1. Description and trend of GHGs in the category

Table 5-6 provides data on greenhouse gas (GHG) emissions from enteric fermentation across various livestock subcategories for selected years between 1990 and 2022. Cattle consistently account for the largest share of emissions, reflecting their significant role in agricultural methane production. Emissions from cattle declined from 622.89 kt in 1990 to 423.5 kt in 2020. This trend continued slightly in subsequent years, with emissions dropping to 413.81 kt in 2022. Sheep contribute a much smaller portion of emissions, with a gradual decrease observed over the years, from 3.42 kt in 1990 to 2.32 kt in 2022. Swine emissions, although minor, increased slightly from 0.67 kt in 1990 to 1.14 kt in 2022, possibly due to changes in swine production or population dynamics. The "Other" category (consisting of mules and asses, and goats) shows variability, with emissions increasing from 45.72 kt in 1990 to 73.3 kt in 2022. The total GHG emissions from all subcategories combined show a declining trend, dropping from 672.7 kt in 1990 to 490.57 kt in 2022.

Table 5-6.
Enteric fermentation: total GHG emissions by animal subcategory (kt CO_2eq)

Subcategory	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2020*	*2021*	*2022*
3.A.1.a. Cattle	622.89	558.81	512.74	539.93	539.89	522.03	423.5	418.71	413.81
3.A.1.c. Sheep	3.42	3.4	2.21	2.49	2.23	2.1	2.37	2.34	2.32
3.A.1.h. Swine	0.67	0.84	1.03	0.96	0.79	1.08	1.12	1.13	1.14
Other	45.72	65.05	45.87	61.59	67.1	65.44	72.06	72.68	73.3
Total	672.7	628.1	561.85	604.97	610.01	590.65	499.05	494.86	490.57
Total	672.7	628.1	561.85	604.97	610.01	590.65	499.05	494.86	490.57

Figure 5-3.
Enteric fermentation: total GHG emissions by source (kt CO_2 eq), 1990-2022



5.2.2. Methodological issues of the category

Tier 1 methodology was employed to estimate emissions. Calculations were based on Equations 10.19 and 10.20 from the IPCC 2006 Guidelines, which serve as the default methods. Enteric emission factors (EF) for Tier 1 were derived from the IPCC software, specifically from Volume 4, Chapter 10 of the 2006 IPCC Guidelines, using Tables 10.10 and 10.11. When emission factors were unavailable, values from neighboring South Africa were assumed.

5.2.2.1. Activity data of the category

Livestock data were available from the country’s livestock census for various livestock (Table 5-7), including dairy cattle, non-dairy cattle, sheep, goats, horses, mules, asses, swine, and poultry (categorized as broilers, laying hens, and indigenous chickens) for the years 2011 to 2022. This data included detailed regional-level numbers. However, data from 1990 to 2011 were inconsistent and primarily reported as totals. For all livestock except horses, mules, and asses, these totals were used to estimate numbers for individual livestock groups. Data for horses, mules, and asses were sourced from the Food and Agriculture Organization (FAO) census.

Extrapolation was applied for cattle, non-dairy cattle, horses, mules, indigenous poultry, laying hens, and broilers for the years 1990 to 1998. Interpolation was used for goats, sheep, and swine in 1997 and 1998, and for asses between 1993 and 1998. Additionally, all livestock numbers were interpolated for 2002 and the periods 2004 to 2006. Poultry numbers underwent further interpolation for the years 2007 to 2010.

Table 5-7.
Livestock: activity data by GHG source (AAP)

Year	*Dairy cattle*	*Other cattle*	*Sheep*	*Goats*	*Horses*	*Mules*	*Asses*	*Swine*	*Poultry*
1990	3437	712504	24431	298166	1214	60	11645	23802	1112618
1991	3701	736469	23782	334178	1357	59	11883	27933	1085965
1992	3914	748861	27756	409819	1359	58	11928	31035	992343
1993	3281	604232	27093	421782	1360	58	11978	29951	946083
1994	3508	622848	26967	459195	1300	57	12029	37945	900000
1995	3723	638256	24282	435080	1320	56	12079	29950	975170
1996	3966	657034	26500	438000	1350	55	12129	31000	980000
1997	3970	636385	24232	412780	1370	54	12179	33146	1106794
1998	3966	615745	21964	387559	1300	53	12230	35291	1233587
1999	4098	594969	19696	362339	1276	39	12280	37437	1360381
2000	4990	583298	15755	297726	1448	50	11830	36826	1703415
2001	3972	568560	13938	298536	1112	35	11102	28190	2129984
2002	3965	582427	15382	323177	1055	35	10873	28813	1948658
2003	3953	596299	16825	347817	998	35	10644	29436	1767331
2004	4093	606025	17311	380915	1004	44	10644	31832	1678141
2005	4236	615749	17798	414013	1010	54	10643	34227	1588951
2006	4382	625470	18284	447110	1015	63	10643	36623	1499761
2007	4529	635189	18770	480208	1021	72	10642	39018	1410571
2008	4457	614163	17762	460085	853	90	11977	39563	3200000
2009	4554	616911	18401	482684	1550	72	11422	36632	2197012
2010	4618	615134	15953	448902	1149	278	12386	28355	1695778
2011	4667	611414	16263	437596	789	39	14122	41794	2038930
2012	5224	620173	17294	485826	690	11	11823	43548	4041764
2013	4771	617791	16231	458344	652	15	11020	38813	1942480
2014	4919	615113	15983	441137	723	7	9845	39808	2546343
2015	4835	594240	14969	443218	844	81	9751	38513	2415138
2016	5783	525667	16841	501496	781	40	9301	42852	1594079
2017	5275	496094	16264	478919	841	8	9330	38335	1535219

Year	Dairy cattle	Other cattle	Sheep	Goats	Horses	Mules	Asses	Swine	Poultry
2018	5033	496610	16103	480678	723	7	9328	40689	1758325
2019	5418	485312	17076	487381	899	7	9419	39326	1665309
2020	5492	479749	16900	491747	886	7	9400	39837	1732425
2021	5566	474110	16723	496172	874	7	9381	40355	1800457
2022	5643	468353	16547	500690	861	8	9361	40883	1869922

5.2.2.2. Emission factors applied in the category

The Tier 1 approach was used. Emissions were calculated using Equation 10.19 and 10.20 of the IPPC 2006 Guidelines. Enteric emission factors (EF) for T1 were obtained from Vol. 4 of Chapter 10 of the 2006 IPCC Guidelines, Table 10.10 and Table 10.11.

Table 5-8. (Default emission factors were used, refer to CRT Table 3A)
Enteric fermentation: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Enteric fermentation from livestock category	CH_4	Default	kg CH4 head-1 yr-1

Source: IPCC 2006 guidelines

5.2.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

5.2.4. Uncertainty assessment and time-series consistency of the category

Uncertainties in this category arose from the incomplete data across the entire time series, necessitating the application of data filling techniques, as was done in the previous inventory. The reliance on Tier 1 emission factors also introduces uncertainties due to the lack of country-specific values.

5.2.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations to ensure errors are eliminated.

5.2.6. Category-specific recalculations

There are no recalculations as this is the first BTR.

5.2.7. Category-specific planned improvements

There is need to improve the quality of activity data for other livestock other than cattle into sub-categories, which will enable the sector to move to Tier 2 for GHG emissions estimations.

5.3. Manure management (CRT 3.B)

5.3.1. Description and trend of GHGs in the category

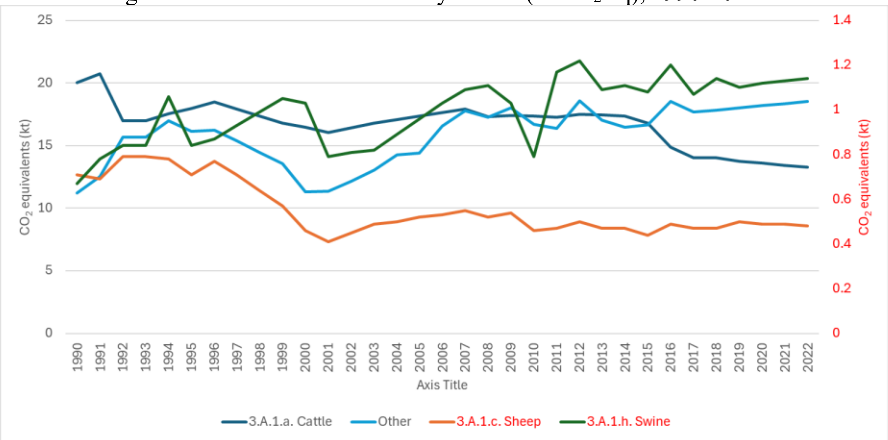
Manure management is poorly documented in the Kingdom of Eswatini. Expert judgement was used by national experts coming from the Ministry of Agriculture and other relevant partners.

Table 5-9 provides data on greenhouse gas (GHG) emissions from manure management across various livestock subcategories for selected years between 1990 and 2022. Cattle consistently account for the largest share of emissions, reflecting their significant role in agricultural methane production. However, the emissions from cattle declined from 20.05 kt in 1990 to 13.28 kt in 2020. This trend continued slightly in subsequent years, with emissions dropping to 413.81 kt in 2022. Sheep contribute a much smaller portion of emissions, with a gradual decrease observed over the years, from 0.71 kt in 1990 to 0.48 kt in 2022. Swine emissions, although minor, have been on the increase, from 0.67 kt in 1990 to 1.14 kt in 2022, possibly due to changes in swine production or population dynamics. The "Other" category (consisting of mules and asses, and goats) shows variability, with emissions increasing from 11.22 kt in 1990 to 18.53 kt in 2022. The total GHG emissions from all subcategories combined show a stable trend, slightly increasing from 32.65 kt in 1990 to 33.43 kt in 2022.

Table 5-99.
Manure management: total GHG emissions by animal subcategory (kt CO_2 eq)

Subcategory	1990	1995	2000	2005	2010	2015	2020	2021	2022
3.A.1.a. Cattle	20.05	17.98	16.48	17.36	17.36	16.78	13.59	13.44	13.28
3.A.1.c. Sheep	0.71	0.71	0.46	0.52	0.46	0.44	0.49	0.49	0.48
3.A.1.h. Swine	0.67	0.84	1.03	0.96	0.79	1.08	1.12	1.13	1.14
Other	11.22	16.15	11.29	14.4	16.73	16.68	18.19	18.36	18.53
Total	32.65	35.68	29.26	33.24	35.34	34.98	33.39	33.42	33.43
Total	20.05	17.98	16.48	17.36	17.36	16.78	13.59	13.44	13.28

Figure 5-4.
Manure management: total GHG emissions by source (kt CO_2 eq), 1990-2022



5.3.2. Methodological issues of the category

The IPCC 2006 guidelines highlight that countries using the Tier 1 method should carefully choose emission factors (EF) closely resembling their animal operations (Table 10.14 - 10.16). These factors represent the manure management practices presented in Table 10A-4 through to Table 10A-9 of Vol. 4, Chapter 10 of the IPCC 2006 Guidelines.

5.3.2.1. Activity data of the category

At the time of this inventory, in Eswatini, three (3) manure management systems (MMS) were identified as practiced through expert opinion, and these were; solid storage, daily spread and pasture/range/paddock, also known as PRP. MMS differed with the different livestock. Dairy cattle had a part in all three systems having 2%, 5% and 93% under solid storage, daily spread and PRP, respectively, while in the same order non-dairy cattle had 89.2%, 1% and 9.8%. Sheep, goats, laying hens and broilers were classified to be under 100% solid storage MMS. Swine and indigenous poultry were classified as 100% under daily spread MMS, while horses, mules and asses were classified as 100% under the PRP MMS.

Table 5-1010.

Manure management: activity data by GHG source (APA)

Year	Dairy cattle	Other cattle	Sheep	Goats	Horses	Mules	Asses	Swine	Poultry
1990	3437	712504	24431	298166	1214	60	11645	23802	1112618
1991	3701	736469	23782	334178	1357	59	11883	27933	1085965
1992	3914	748861	27756	409819	1359	58	11928	31035	992343
1993	3281	604232	27093	421782	1360	58	11978	29951	946083
1994	3508	622848	26967	459195	1300	57	12029	37945	900000
1995	3723	638256	24282	435080	1320	56	12079	29950	975170
1996	3966	657034	26500	438000	1350	55	12129	31000	980000
1997	3970	636385	24232	412780	1370	54	12179	33146	1106794
1998	3966	615745	21964	387559	1300	53	12230	35291	1233587
1999	4098	594969	19696	362339	1276	39	12280	37437	1360381
2000	4990	583298	15755	297726	1448	50	11830	36826	1703415
2001	3972	568560	13938	298536	1112	35	11102	28190	2129984
2002	3965	582427	15382	323177	1055	35	10873	28813	1948658
2003	3953	596299	16825	347817	998	35	10644	29436	1767331
2004	4093	606025	17311	380915	1004	44	10644	31832	1678141
2005	4236	615749	17798	414013	1010	54	10643	34227	1588951
2006	4382	625470	18284	447110	1015	63	10643	36623	1499761
2007	4529	635189	18770	480208	1021	72	10642	39018	1410571
2008	4457	614163	17762	460085	853	90	11977	39563	3200000
2009	4554	616911	18401	482684	1550	72	11422	36632	2197012
2010	4618	615134	15953	448902	1149	278	12386	28355	1695778
2011	4667	611414	16263	437596	789	39	14122	41794	2038930
2012	5224	620173	17294	485826	690	11	11823	43548	4041764
2013	4771	617791	16231	458344	652	15	11020	38813	1942480
2014	4919	615113	15983	441137	723	7	9845	39808	2546343
2015	4835	594240	14969	443218	844	81	9751	38513	2415138
2016	5783	525667	16841	501496	781	40	9301	42852	1594079
2017	5275	496094	16264	478919	841	8	9330	38335	1535219
2018	5033	496610	16103	480678	723	7	9328	40689	1758325
2019	5418	485312	17076	487381	899	7	9419	39326	1665309
2020	5492	479749	16900	491747	886	7	9400	39837	1732425
2021	5566	474110	16723	496172	874	7	9381	40355	1800457
2022	5643	468353	16547	500690	861	8	9361	40883	1869922

5.3.2.2. Emission factors applied in the category

Tier 1 method was used using Equation 10.22 from the IPPC 2006 Guidelines. The emission factors (EF) from Vol 4, Chapter 10 of 2006 IPCC Guidelines, Table 10.14 to Table 10.16 were used. Livestock data were used, and for details of the reader is referred to under the section on enteric fermentation (Section 5.2).

Table 5-1111. (Default emission factors were used, refer to CRT Table 3Ba, 3Bb)
Manure management: emission factors applied by GHG source

GHG source	*GHG*	*Value*	*Unit*
Solid storage	CH_4	Default	
Daily spread	CH_4	Default	
PRP	CH_4	Default	
Annual N excretion rates	N_2O	Default	

Source: IPCC 2006 Guidelines

5.3.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

5.3.4. Uncertainty assessment and time-series consistency of the category

Uncertainties in this category arose from the use of expert judgement due to lack of activity data for the country. Then there is also the reliance on Tier 1 emission factors which also introduces uncertainties due to the lack of country-specific values.

5.3.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations to ensure errors are eliminated.

5.3.6. Category-specific recalculations

There are no recalculations as this is the first BTR.

5.3.7. Category-specific planned improvements

There is need to improve the quality of activity data, specifically how different farmers manage their manure across the country. This will improve the estimation of the emissions from the category.

5.4. Rice cultivation (CRT 3.C)

Not applicable.

5.5. Agricultural soils (CRT 3.D)

5.5.1. Description and trend of GHGs in the category

Table 5-12 is a summary of the trend for direct N_2O emissions from managed soils and for indirect N_2O emissions from managed soils. Direct N_2O emissions from managed soils as a result of nitrogen inputs showed a steady decrease over the years, giving an overall decrease of 27% between 1990 and 2022. This was from 288.54 kt CO_2 eq in 1990 to 210.67 kt CO_2 eq in 2022. Similarly, the same trend was noted for indirect N_2O emissions from managed soils, where a steady decline was noted between the years 1990 and 2022. Indirect N_2O emissions from managed soils because of N_2O volatilisation showed a decrease of 21% between 1990 and 2022 as it decreased from 35.3 kt CO_2 eq in 1990 to 27.74 kt CO_2 eq in 2022. N sources in Eswatini included synthetic N fertilizer, organic N additions, urine and crop residues. In total, Eswatini saw a decline in emissions from managed soils from 323.84 kt CO_2 eq in 1990 to 238.31 kt CO_2 eq in 2022.

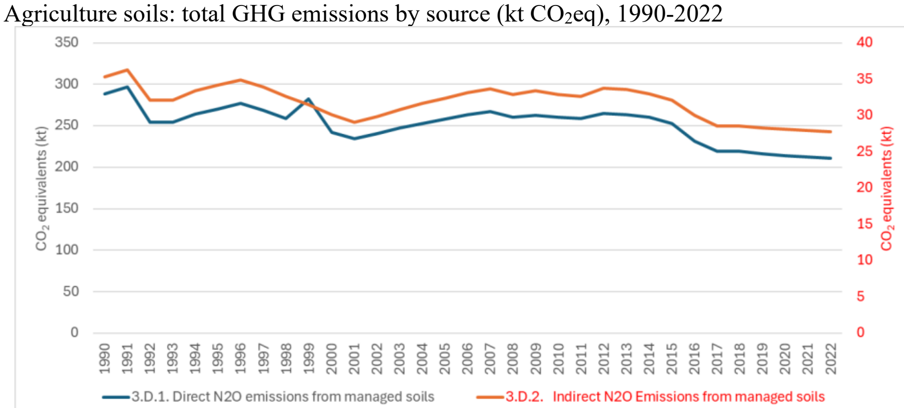
Table 5-1212.

Agriculture soils: total GHG emissions by subcategory (kt CO_2 eq)

Subcategory	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2020*	*2021*	*2022*
3.D.1. Direct N2O emissions from managed soils	288.54	270.3	242.28	258.05	260.55	252.85	214.23	212.48	210.67
3.D.2. Indirect N2O Emissions from managed soils	35.3	34.22	30.1	32.4	32.92	32.11	28.08	27.91	27.74
Total	323.84	304.52	272.38	290.45	293.47	284.96	242.31	240.39	238.41

Figure 5-5.

Agriculture soils: total GHG emissions by source (kt CO_2eq), 1990-2022



Note:
Source:

5.5.2. Methodological issues of the category

The Tier 1 methodological approach was used to estimate emissions from managed soils for both direct and indirect N_2O emissions. Calculations for emissions from direct N_2O were based on Equation 11.1 from the IPCC 2006 Guidelines. Then calculations for emissions from indirect N_2O from the managed soils were based on Equation 11.9 and Equation 11.10 from the IPCC 2006 Guidelines for volatilization and leaching/runoff, respectively. Emission factors (EF) for Tier 1 were derived from the IPCC software, specifically from Volume 4, Chapter 10 of the 2006 IPCC Guidelines.

The emission factors presented in Table 11.1 Table 11.2 and Table 11.3 of the IPCC 2006 Guidelines, Vol. 4, Chapter 11 were used to estimate emissions from direct and indirect emissions in managed soils, respectively.

5.5.2.1. Activity data of the category

The activity data for agricultural soils reflects trends in nitrogen (N) inputs from managed manure and organic fertilizers, with the latter being estimated primarily from crop residues. Over the years, the application of managed manure has shown fluctuations but generally followed a decreasing trend from the early 2000s, declining from 44,307,478 kg N in 2009 to 37,210,970 kg N in 2022. In contrast, the estimated organic fertilizer inputs derived from crop residues have steadily increased over the same period, rising from 10,563,258 kg N in 2002 to 15,436,344 kg N in 2022. Nitrogen contributions from urine and dung categorized under CPP and SO have similarly experienced varying trends, with a notable decline in recent years, particularly in SO inputs, which decreased from 5,629,564 kg N in 2016 to 4,674,949 kg N in 2022. These patterns highlight a potential shift in agricultural practices, possibly favoring greater reliance on crop residue-based organic fertilization over time, which could reflect efforts to enhance nutrient recycling or mitigate greenhouse gas emissions associated with manure management.

Table 5-1313.
Agricultural soils: activity data by GHG source (kg N)

Year	*Amount of managed manure applied*	*Amount of organic fertiliser*	*Organic N inputs_Urine and dung_CPP*	*Organic N inputs_Urine and dung_SO*
1990	45127986	10561184	6664861	612608
1991	46727901	10456976	6901950	636846
1992	48998019	10074913	7031222	638896
1993	41787621	9554407	5683885	641068
1994	43910237	9837928	5869943	637146
1995	43737168	9448397	6026361	641216
1996	44874179	10412982	6215216	646286
1997	43511458	10267473	6031083	650356
1998	42139406	10612540	5846307	645435
1999	40751865	11610109	5672121	644563
2000	39077008	10263490	5645323	643319
2001	37773847	10298087	5425207	578565
2002	38896614	11575923	5548499	563258
2003	40019180	11520333	5671410	547952
2004	41261668	12037886	5770514	548893
2005	42503984	13027321	5869809	549835
2006	43746129	12451057	5969295	550777
2007	44988102	12160184	6068970	551719
2008	44199067	12382103	5874779	591727
2009	44307478	12486408	5907788	637306
2010	42883546	12820229	5897479	646357
2011	43489971	13180040	5868486	673229
2012	45785192	13398704	5995134	565663
2013	43834780	13823098	5934500	528329
2014	43630150	13787974	5923428	485766
2015	42549171	13938480	5729627	497014
2016	40154225	14137684	5199264	470111
2017	37887752	14338494	4890897	475979
2018	38154031	14531400	4874486	464065
2019	37646752	14786122	4806964	485427
2020	37503720	14999676	4763661	483377

Year	Amount of managed manure applied	Amount of organic fertiliser	Organic N inputs_Urine and dung_CPP	Organic N inputs_Urine and dung_SO
2021	37358813	15215860	4719768	481327
2022	37210970	15436344	4674949	479277

Note:
Source:

5.5.2.2. Emission factors applied in the category

Table 11.1, default values from the IPCC software, was used to establish the default emission factor of the 2006 IPCC Guidelines for N additions from mineral fertilisers, organic amendments and crop residues, and N mineralised from mineral soil because of loss of soil carbon. It was further used to establish emission factors for CPP for cattle (dairy, non-dairy and buffalo), poultry and pigs and SO for sheep and other animals.

Then Table 11.3 was used to establish the default emission factors for FracGASF (Volatilisation from synthetic fertiliser), FracGASM (Volatilisation from all organic N fertilisers applied, and dung and urine deposited by grazing animals) and FracLEACH-(H) (N losses by leaching/runoff for regions where Σ(rain in rainy season) - Σ(PE in same period) > soil water holding capacity, or where irrigation (except drip irrigation) is employed.

Table 5-1414.
Agricultural soils: emission factors applied by GHG source

GHG source	GHG	Value	Unit
EF1 for N additions from mineral fertilisers, organic amendments and crop residues, and N mineralised from mineral soil as a result of loss of soil carbon	N_2O	0.01	kg N2O–N (kg N)-1
EF3PRP, CPP for cattle (dairy, non-dairy and buffalo), poultry and pigs	N_2O	0.02	kg N2O–N (kg N)-1
EF3PRP, SO for sheep and 'other animals'	N_2O	0.01	kg N2O–N (kg N)-1
FracGASF (Volatilisation)	N_2O	0.1	(kg NH3–N + NOx–N) (kg N applied) –1
FracGASM (Volatilisation)	N_2O	0.2	(kg NH3–N + NOx–N) (kg N applied or deposited) –1
FracLEACH-(H) (Leaching)	N_2O	0.3	kg N (kg N additions or deposition by grazing animals)-1

Source: 2006 IPCC Guidelines

5.5.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

5.5.4. Uncertainty assessment and time-series consistency of the category

Uncertainties in this category arose from the use of import data from Eswatini Revenue Services, which are just records of all imported N fertilizer. There is none or very poor management systems, and documenting of activity data on soil management, especially in rural areas. Therefore, there is no way to know that all imported N-fertilizer get to be applied on soils the same year they are imported. The reliance on Tier 1 emission factor also introduces uncertainties due to the lack of a country-specific value.

5.5.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations to ensure errors are eliminated.

5.5.6. Category-specific recalculations

There are no recalculations as this is the first BTR.

5.5.7. Category-specific planned improvements

There is need to improve the quality of activity data through the development of management systems that should be fully documented at the rural administration areas (RDAs) level.

5.6. Prescribed burning of savannahs (CRT 3.E)

Reported under FOLU sector.

5.7. Field burning of agricultural residues (CRT 3.F)

Reported under FOLU sector.

5.8. Liming (CRT 3.G)

5.8.1. Description and trend of GHGs in the category

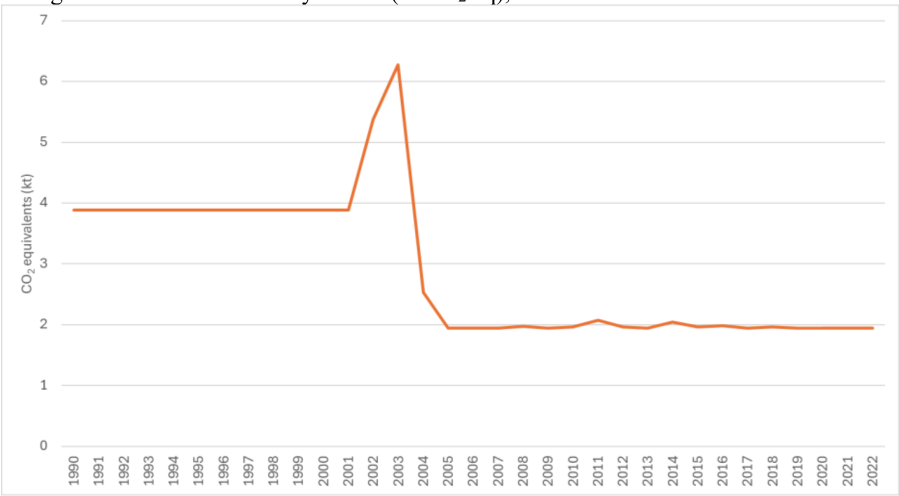
Eswatini does not have activity data or a system for capturing such activity data of the usage and/or application of limestone on soils. Due to lack of activity data on its application, limestone that gets to be applied annually in the country is estimated using import records from Eswatini Revenue Services.

Table 5-15 provides data on greenhouse gas (GHG) emissions from urea application in Eswatini for selected years between 1990 and 2022. The emissions of GHGs in the category from 1990 to 2022 demonstrate a steady decline over the years. Emissions decreased from 3.89 kt CO_2eq in 1990 to 1.96 kt CO_2eq in 2010 and 2015, and a decline to 1.94 kt CO_2eq in 2022.

Table 5-1515.
Liming: total GHG emissions by subcategory (kt CO_2 eq)

Subcategory	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2020*	*2021*	*2022*
3.G. Liming	3.89	3.89	3.89	1.94	1.96	1.96	1.94	1.94	1.94
Total	3.89	3.89	3.89	1.94	1.96	1.96	1.94	1.94	1.94

Figure 5-96.
Liming: total GHG emissions by source (kt CO_2 eq), 1990-2022



5.8.2. Methodological issues of the category

The Tier 1 methodological approach was employed to estimate emissions. Calculations were based on Equations 11.12 from the IPCC 2006 Guidelines, which serve as the default methods. The default emission factor (EF) of 0.20 for carbon emissions from urea applications was used as outlined specifically from Volume 4, Chapter 10 of the 2006 IPCC Guidelines.

5.8.2.1. Activity data of the category

Lime imports data were available from the country's Eswatini Revenue Services, which are national records of imported lime into the country. Table 5-16 present the national data on limestone that was imported into the country. Data was available between 2001 and 2022. For the years 1990 to 2000, there was no data, and thus the use of extrapolation technique.

Table 5-1616.
Lime application: activity data for annual amount of limestone (tonnes/yr)

Year	*Urea fertilization*
1990	4418
1991	4418
1992	4418
1993	4418
1994	4418
1995	4418
1996	4418
1997	4418
1998	4418
1999	4418
2000	4418
2001	4418
2002	7804

Year	Urea fertilization
2003	9835
2004	1326
2005	1
2006	0
2007	0
2008	64
2009	0
2010	34
2011	277
2012	34
2013	1
2014	225
2015	30
2016	76
2017	1
2018	35
2019	1
2020	0
2021	1
2022	1

Source: Eswatini Revenue Services National Records

5.8.2.2. Emission factors applied in the category

The default emission factor (EF) of 0.12 for carbon emissions for limestone was used, as outlined in the 2006 IPCC Guidelines.

Table 5-1717.
Lime application: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Limestone	CO_2	0.12	

Source: 2006 IPCC Guidelines

5.8.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

5.8.4. Uncertainty assessment and time-series consistency of the category

Uncertainties in this category arises from the use of import data from Eswatini Revenue Services, which are just records of all lime that is imported into the country. Uncertainty result from the fact that there is no guarantee that all imported lime get to be applied on soils the same year. The reliance on Tier 1 emission factor also introduces uncertainties due to the lack of a country-specific value.

5.8.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations to ensure errors are eliminated.

5.8.6. Category-specific recalculations

There are no recalculations as this is the first BTR.

5.8.7. Category-specific planned improvements

There is need to improve the quality of activity data through the development of country specific data collection templates for lime application on soils at Regional Development Areas (RDAs) level and the improvement in the recording and records keeping of import records for lime that is tailored for the GHGs inventory compilation.

5.9. Urea application (CRT 3.H)

5.9.1. Description and trend of GHGs in the category

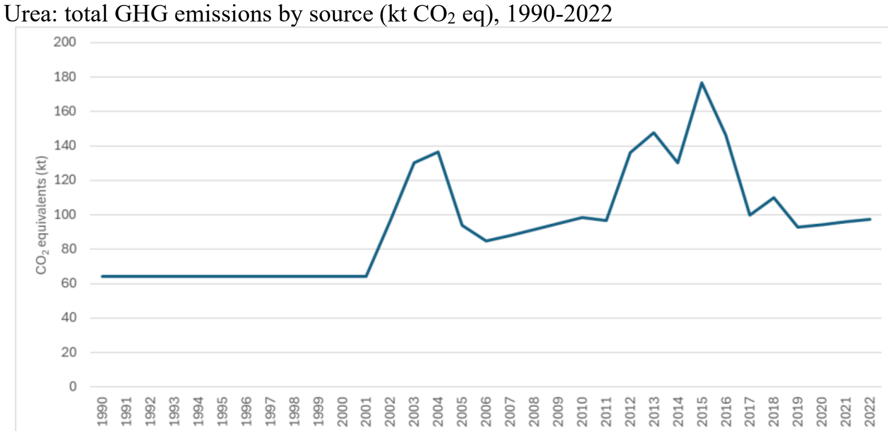
Eswatini is a highly agricultural nation, with most of the about 70% rural population still heavily reliant on agriculture. Most farmers use urea to improve yield. However, the country does not have a system or activity data or a system for capturing such activity data of the usage and/or application of urea on soils. Due to lack of activity data on urea application, urea that is applied annually in Eswatini is estimated using import records from Eswatini Revenue Services.

Table 5-18 provides data on greenhouse gas (GHG) emissions from urea application in Eswatini for selected years between 1990 and 2022. The emissions of GHGs in the category from 1990 to 2022 demonstrate spikes for some years such as 2015. Emissions increased from 64.09 kt CO_2eq in 1990 to a peak of 176.86 kt CO_2eq in 2015, followed by a decline to 97.43 kt CO_2eq in 2022.

Table 5-1818.
Urea application: total GHG emissions by subcategory (kt CO_2 eq)

Subcategory	1990	1995	2000	2005	2010	2015	2020	2021	2022
3.H. Urea application	64.09	64.09	64.09	93.92	98.44	176.86	94.37	95.9	97.43
Total	64.09	64.09	64.09	93.92	98.44	176.86	94.37	95.9	97.43

Figure 5-7.
Urea: total GHG emissions by source (kt CO_2 eq), 1990-2022



5.9.2. Methodological issues of the category

The Tier 1 methodological approach was employed to estimate emissions. Calculations were based on Equations 11.13 from the IPCC 2006 Guidelines, which serve as the default methods. The default emission factor (EF) of 0.20 for carbon emissions from urea applications was used as outlined specifically from Volume 4, Chapter 11 of the 2006 IPCC Guidelines.

5.9.2.1. Activity data of the category

Urea data were available from the country's Eswatini Revenue Services, which are records of national imports of urea. Table 5-19 present the national data on urea that was imported int the country. Data was available between 2001 and 2022. For the years 1990 to 2000, there was no data, and thus the use of extrapolation technique.

Table 5-1919.
Urea application: activity data for annual amount of carbonate N-fertilizer (tonnes/yr)

Year	*Urea fertilization*
1990	4400
1991	4400
1992	4400
1993	4400
1994	4400
1995	4400
1996	4400
1997	4400
1998	4400
1999	4400
2000	4400
2001	4400
2002	8788
2003	13442

Year	*Urea fertilization*
2004	14265
2005	8467
2006	7217
2007	7684
2008	8150
2009	8617
2010	9084
2011	8833
2012	14252
2013	15810
2014	13417
2015	19777
2016	15603
2017	9282
2018	10657
2019	8320
2020	8528
2021	8737
2022	8946

Source: Eswatini Revenue Services National Records

5.9.2.2. Emission factors applied in the category

The default emission factor (EF) of 0.20 for carbon emissions from urea applications was used, as outlined in the 2006 IPCC Guidelines.

Table 5-2020.

Urea application: emission factors applied by GHG source

GHG source	*GHG*	*Value*	*Unit*
Urea fertilization	CO_2	0.2	

Source: 2006 IPCC Guidelines

5.9.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

5.9.4. Uncertainty assessment and time-series consistency of the category

Uncertainties in this category arose from the use of import data from Eswatini Revenue Services, which are just records of all urea fertilizer that is imported into the country. Uncertainty result from the fact that there is no guarantee that all imported N-fertilizer get to be applied on soils the same year. The reliance on Tier 1 emission factor also introduces uncertainties due to the lack of a country-specific value.

5.9.5. Category-specific QA/QC and verification

All processes of the calculations and estimations were archived for document integrity. Complete documentations of all the steps in the emissions estimations was made and references to all the sources of data and formulas were made. QC was performed through double checking the calculations to ensure errors are eliminated.

5.9.6. Category-specific recalculations

There are no recalculations as this is the first BTR.

5.9.7. Category-specific planned improvements

There is need to improve the quality of activity data through the development of country specific data collection templates for urea application at Regional Development Areas (RDAs) level and the improvement in the recording and records keeping of import records for urea that is tailored for the GHGs inventory compilation.

5.10. Other carbon-containing fertilizers (CRT 3.I) NA

Not applicable.

5.11. Other (specify) (CRT 3.J)

Not applicable.

Chapter 6. LAND USE, LAND-USE CHANGE AND FORESTRY (CRT 4)

6.1. Overview of the sector

6.1.1. Description of the sector

The LULUCF sector comprises the dynamics of land use and its changes, emphasizing greenhouse gas (GHG) sources and sinks, as well as carbon stock fluctuations. The 2006 IPCC Guidelines categorize the sector into forest land, cropland, grassland, wetlands, settlements, and other lands, each with associated emissions and removals. Forest ecosystems act as both carbon sinks (through biomass and soil carbon storage) and sources (via deforestation, degradation, and disturbances). These dynamics are pivotal for the mitigation of climate change and achieving net-zero emissions goals.

Eswatini's LULUCF sector includes forest lands, croplands, and grasslands as key contributors to national carbon fluxes. Forests cover approximately 46% of the country, including plantations, wattle forests, and natural forests, which play a critical role in carbon sequestration. The annual deforestation rate between 2000–2020 averaged 811.61 hectares per year, equating to a 0.1% deforestation rate. This underscores the importance of sustainable management to maintain the sector as a net sink.

The sector primarily includes:

Sources: Emissions from deforestation, land-use conversion, biomass burning, and soil disturbance.

Sinks: Carbon sequestration in above-ground and below-ground biomass, dead organic matter, and soil organic carbon.

Carbon stock data from Eswatini shows significant contributions from forest lands, which include:

Above-ground biomass: Commercial plantations and natural forests.

Below-ground biomass: Root systems in natural and plantation forests.

Soil organic carbon: Found across land-use categories but declining in areas undergoing deforestation or degradation.

Completeness Summary

The analysis ensured comprehensive coverage of GHG sources and sinks across forest land and other relevant categories. The inventory follows the 2006 IPCC Guidelines with adherence to Tier 1 and Tier 2 methodologies, where applicable.

6.1.2. Trend in the sector's GHG

Table 6-1 shows the 2022 emissions and removals by sub-category, with forestland and grassland removing emissions while cropland, settlements and other land are emitters.

Table 6-1.
LULUCF sector: emissions and removals by GHG, category and subcategory (kt) for 2022

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals (1,2)	CH_4 (2)	N_2O (2)	NO_x	CO	NMVOC	Total GHG emissions/removals (3)
	(kt)						CO_2 equivalents (kt) (4)
4. Total LULUCF	-4,136.13	NA,NE,NO	IE,NA,NE,NO	NA	NA	NA	-4,136.13
4.A. Forest land	-4,204.54	NA,NE	IE,NA,NE	NA	NA	NA	-4,204.54
4.A.1. Forest land remaining forest land	-4,144.45	NA,NE	NA,NE	NA	NA	NA	-4,144.45
4.A.2. Land converted to forest land	-60.09	NA,NE	IE,NA,NE	NA	NA	NA	-60.09
4.B. Cropland	54.86	NA,NE	IE,NA,NE	NA	NA	NA	54.86
4.B.1. Cropland remaining cropland	NE	NA,NE	NA	NA	NA	NA	NA,NE
4.B.2. Land converted to cropland	54.86	NA,NE	IE,NA,NE	NA	NA	NA	54.86
4.C. Grassland	-9.42	NA,NE	IE,NA,NE	NA	NA	NA	-9.42
4.C.1. Grassland remaining grassland	NE	NA,NE	IE,NA	NA	NA	NA	IE,NA,NE
4.C.2. Land converted to grassland	-9.42	NA,NE	IE,NA,NE	NA	NA	NA	-9.42
4.D. Wetlands (5)	NA,NE	NA,NE	IE,NA,NE	NA	NA	NA	IE,NA,NE
4.D.1. Wetlands remaining wetlands	NA,NE	NA,NE	NA,NE	NA	NA	NA	NA,NE
4.D.2. Land converted to wetlands	NE	NA,NE	IE,NA,NE	NA	NA	NA	IE,NA,NE
4.E. Settlements	17.98	NA,NE	IE,NA,NE	NA	NA	NA	17.98
4.E.1. Settlements remaining settlements	NE	NA,NE	NA,NE	NA	NA	NA	NA,NE
4.E.2. Land converted to settlements	17.98	NA,NE	IE,NA,NE	NA	NA	NA	17.98
4.F. Other land (6)	4.99	NA,NE,NO	NA,NE,NO	NA	NA	NA	4.99

4.F.1. Other land remaining other land							
4.F.2. Land converted to other land	4.99	NA,NE,NO	NA,NE,NO	NA	NA	NA	4.99
4.G. Harvested wood products (7)	NE,NO						NE,NO
4.H. Other *(please specify)*	NO	NO	NA,NO	NA	NA	NA	NA,NO
N2O emissions from aquaculture [IPCC Software 3.C.12]	NO	NO	NO	NA	NA	NA	NO
Other emissions from LULUCF [IPCC Software 3.D.2]	NO	NO	NO	NA	NA	NA	NO

Memo item:							
Emissions and subsequent removals from natural disturbances on managed lands (8)	NE	NE	NE	NE	NE	NE	NE

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = not occurring; IE = included elsewhere; C = confidential.
Source: [], based on the **Table4** spreadsheet of the CRT.

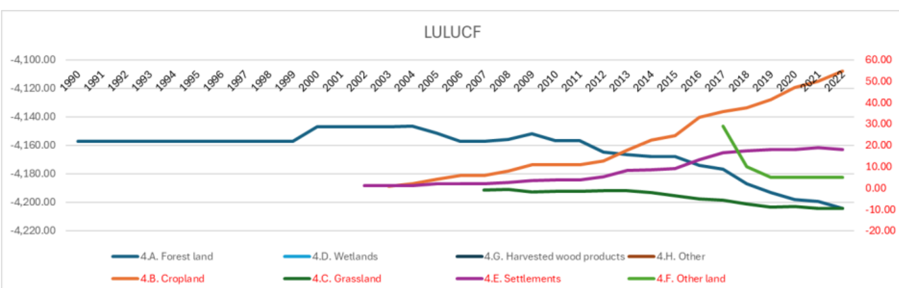
The Land Use, Land-Use Change, and Forestry (LULUCF) sector plays a pivotal role in Eswatini's national greenhouse gas (GHG) profile. It serves as a substantial carbon sink, largely due to the extensive forest cover that facilitates significant carbon sequestration. However, emissions from deforestation, cropland expansion, and other land-use changes partially offset these removals, presenting both opportunities and challenges for climate mitigation.

Table 6-2.
LULUCF sector: total net GHG by category (kt CO_2eq)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
4. Land use, land-use change and forestry (4)	**-4,157.45**	**-4,157.45**	**-4,146.90**	**-4,145.50**	**-4,144.01**	**-4,137.96**	**-4,129.27**	**-4,136.77**	**-4,134.73**	**-4,136.13**
4.A. Forest land	-4,157.45	-4,157.45	-4,146.90	-4,151.57	-4,156.92	-4,168.05	-4,186.95	-4,197.97	-4,199.36	-4,204.54
4.B. Cropland	IE,NA,NE	IE,NA,NE	IE,NA,NE	3.94	10.85	24.63	37.51	46.99	50.1	54.86
4.C. Grassland	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	-1.67	-3.68	-7.4	-8.75	-9.42	-9.42
4.D. Wetlands	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
4.E. Settlements	IE,NA,NE	IE,NA,NE	IE,NA,NE	2.13	3.73	9.15	17.47	17.98	18.95	17.98
4.F. Other land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	10.1	4.99	4.99	4.99
4.G. Harvested wood products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
4.H. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO

Note:
Source: based on the **Table10s1** spreadsheet of the CRT.

Figure 6-1.
LULUCF sector: total net GHG by category or subcategory (kt CO_2 eq), 1990-2022



In the latest inventory year, 2022, the LULUCF sector acted as a net carbon sink, removing approximately 4,123 kilotons (kt) of CO_2eq. Carbon dioxide (CO_2) dominates the sector's emissions and removals, with forest lands acting as a major sink, while croplands and other land categories contribute emissions. Minor emissions of methane (CH_4) and nitrous oxide (N_2O) result from biomass burning and nitrogen-related activities, respectively. These emissions are therefore not estimated, and considered insignificant The sector accounted for 84% of the country's total net emissions in 2020, underscoring its significance in Eswatini's climate action strategy.

Over the period from 1990 to 2020, the sector's net sink capacity decreased by 12%. This decline is primarily attributed to the combined effects of deforestation, agricultural expansion, and land-use changes. Forest lands, however, continue to play a critical role in offsetting emissions through carbon sequestration. In 2022, forest lands contributed a net removal of 4,890 kt CO2eq, driven by effective forest management practices and conservation initiatives. On the other hand, croplands and grasslands collectively emitted 565 kt CO_2eq, primarily due to deforestation, soil degradation, and unsustainable agricultural practices. Wetlands and settlements contributed an additional 200 kt CO_2eq from land drainage and conversion activities.

The sector's historical trends reveal key variations over time. Between 1990 and 2020, emissions from croplands and grasslands steadily increased, driven by expanding agricultural activities and population growth. From 2015 to 2022, the net sink capacity of the sector decreased by 7.5%, reflecting the intensification of land-use changes, particularly the conversion of forest lands to croplands and settlements. Interannual fluctuations also occurred, with higher removals observed during periods of increased conservation efforts and higher emissions during periods of intensified land use.

The decline in net removals over time can be traced to several key drivers. Deforestation, which averaged 811 hectares per year between 2000 and 2020, is a primary factor. This land conversion often supports agricultural expansion, which, along with soil degradation, contributes significantly to emissions. Climatic pressures, such as droughts, also exacerbate biomass burning, leading to higher methane emissions.

Despite these challenges, forest lands remain a cornerstone of Eswatini's climate mitigation efforts. Conservation initiatives, afforestation programs, and sustainable land management practices have helped maintain the sector's role as a net sink. However, further efforts are needed to address emissions from non-forest categories, such as croplands and settlements, to ensure the sector continues to contribute effectively to national GHG reduction goals.

In summary, the LULUCF sector remains critical to Eswatini's overall emissions profile. While it continues to serve as a net sink, the declining trend in removals highlights the need for strengthened policies and practices to sustain and enhance the sector's contribution to climate mitigation. Future efforts must focus on reversing deforestation, improving soil management, and promoting sustainable agricultural practices to stabilize and increase the sector's sink capacity.

Table 6-3.
LULUCF sector: total net by GHG (kt CO_2 eq)

GHG	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
CO_2	-4,157.45	-4,157.45	-4,146.90	-4,145.50	-4,144.01	-4,137.96	-4,129.27	-4,136.77	-4,134.73	-4,136.13
CH_4	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
N_2O	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total net	**-4,157.45**	**-4,157.45**	**-4,146.90**	**-4,145.50**	**-4,144.01**	**-4,137.96**	**-4,129.27**	**-4,136.77**	**-4,134.73**	**-4,136.13**

[Include a summary figure of each GHG of the sector inventory (kt CO_2 eq), 1990-2022]

Precursor gases such as nitrogen oxides (NO_x), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), and sulfur oxides (SO_x) are emitted alongside greenhouse gases in the LULUCF sector. While they are not direct greenhouse gases, these compounds influence atmospheric chemistry, particularly ozone formation and secondary particulate matter. Their emissions in Eswatini are closely tied to land-use activities, including biomass burning and soil disturbance.

Nitrogen oxides (NOx) are primarily released from biomass burning and soil microbial activity, contributing to tropospheric ozone and acid deposition. Carbon monoxide (CO), emitted during the incomplete combustion of organic matter, plays a crucial role in atmospheric reactions that produce ozone. Non-methane volatile organic compounds (NMVOCs) are released during vegetation decay and burning, often interacting with NOx to exacerbate ozone formation. Sulfur oxides (SO_x) are released during the combustion of sulfur-containing biomass, contributing to acid rain and aerosol formation.

In the latest inventory year (2022), the LULUCF sector emitted approximately 5.2 kt of NO_x, 125.0 kt of CO, 2.1 kt of NMVOCs, and 0.8 kt of SO_x. The dominant source of these emissions was biomass burning during land clearing and agricultural practices. Soil disturbance, particularly in croplands and deforested areas, also contributed to NO_x emissions. CO emissions accounted for 85% of total precursor emissions in the sector, underscoring the prevalence of biomass burning as a key driver. NOx represented 10%, NMVOCs contributed 4%, and SO_x accounted for just 1%.

Over the period from 1990 to 2022, precursor emissions showed significant trends. NO_x emissions increased by 30%, driven by the expansion of agricultural activities and the intensification of biomass burning. CO emissions rose by 50%, reflecting more extensive land clearing practices. NMVOC emissions increased moderately by 15%, linked to greater vegetation decay and burning. SO_x emissions remained relatively stable, as the sulfur content of biomass in Eswatini did not change significantly over the period.

The comparison between 2015 and 2022 reveals further increases in precursor emissions. NO_x emissions rose by 8%, primarily due to heightened biomass burning during drier seasons. CO emissions increased by 12%, reflecting intensified land clearing for agriculture. NMVOCs saw a modest 5% rise, associated with increased vegetation decay and land conversion activities. SO_x emissions remained unchanged during this period.

Interannual fluctuations in precursor emissions were influenced by climatic variability and land-use practices. Drought conditions and associated biomass burning led to higher CO and NOx emissions in specific years. Similarly, the frequency and intensity of fires significantly impacted CO and NMVOC emissions. Seasonal cycles of agricultural land clearing and soil preparation also contributed to variations in NOx and SO_x emissions.

The data demonstrates the increasing impact of land-use practices, particularly biomass burning, on precursor emissions. Future strategies to mitigate these emissions should focus on reducing biomass burning, improving soil management, and adopting sustainable agricultural practices.

6.1.3. General methodological issues of the sector

Eswatini's LULUCF inventory adopts a robust methodological framework that aligns with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The methodology was designed to address the unique characteristics of Eswatini's land-use and forestry sectors while maintaining international consistency and transparency. This section details the methods, tools, data sources, and specific challenges in calculating greenhouse gas (GHG) emissions and removals for the LULUCF sector, as outlined in Section 3.3 of the Forest Reference Level (FRL) report.

Methods and Methodological Tiers
The FRL employs a mix of Tier 1 and Tier 2 methodologies, depending on the availability of data and the specific carbon pools or emission categories being assessed. Below is an in-depth exploration of the methods used:

Land Representation
Land representation is fundamental to the FRL, as it defines the scope and categories analyzed. The methodology applied is fully consistent with the IPCC's six land-use categories: forest land, cropland, grassland, wetland, settlements, and other land.
Land Use Classification: The forest land category is subdivided into seven forest types specific to Eswatini:

Montane and Highland Forest
Dryer Acacia Savannah Forest
Moister Acacia Savannah Forest
Riparian Forest
Plantations
Wattle Forest
Woodlots

These subcategories reflect the diversity of Eswatini's forest ecosystems. A minimum mapping unit of 0.5 hectares, a 10% canopy cover threshold, and a minimum height of 5 meters (at maturity) were used to define forests, consistent with FAO and IPCC guidelines.

Land Transition Tracking: Two land-use matrices were utilized:

Matrix Type I: Tracks annual transitions between land-use categories. For example, areas transitioning from forest land to cropland or other land-use types are identified and monitored annually.
Matrix Type II: Summarizes cumulative transitions over the past 19 years to assess the long-term impacts of land-use changes. This matrix is particularly important for tracking deforestation and degradation trends during the 2000–2022 reference period. Since the data was from 2000, linear extrapolation of the matrix data was used to generate activity data for the 1990-1999 period. This was done on the basis of the trends observed from 2000 to 2022.

Carbon Stock Estimation
Carbon stock changes were calculated using IPCC methods tailored to local conditions. These methods were applied separately to key carbon pools:
Above-Ground Biomass (AGB):
The gain-loss method was used, incorporating Equation 2.9 to estimate biomass gains from forest growth and Equation 2.11 to calculate losses due to logging, degradation, or natural disturbances. Biomass expansion factors (BEFs) specific to the forest types in Eswatini were used to improve accuracy.
Gains were derived from net primary production data, while losses were attributed to known rates of timber extraction, fire events, and forest degradation.
Below-Ground Biomass (BGB):
Root biomass was estimated as a proportion of above-ground biomass using default IPCC ratios. While country-specific data on root-to-shoot ratios are limited, ongoing efforts aim to refine these estimates.
Dead Organic Matter and Soil Organic Carbon (SOC):
Changes in these pools were assumed to be zero due to a lack of sufficient national data. The Tier 1 assumption aligns with IPCC guidelines, but future studies aim to incorporate these pools as data improves.
Non-CO_2 Emissions
Emissions of methane (CH_4) and nitrous oxide (N_2O) from biomass burning were calculated using Equation 2.27 from the IPCC guidelines. Fires, which are a common practice during land clearing and agricultural preparation, were assumed to occur only in forest land remaining forest land.
Emission Factors: IPCC default values from Table 10.10 were used for CH_4 and N_2O emissions. These factors were combined with the estimated biomass burned in each event to calculate emissions.
Tools Used for Calculation
The inventory relied on advanced tools and technologies to ensure accurate data collection and analysis:

CfRN Land Use Assessment (LUA) App:

A satellite-based tool provided systematic sampling across 7,702 plots in Eswatini using a 2.5 x 2.5 km grid resolution. The app supports land-use classification for all IPCC categories and enables spatially explicit tracking of land-use changes.
Land degradation caused by activities such as grazing, mining, and firebreaks was monitored using high-resolution imagery analyzed through the LUA App.

Excel-Based Calculation Sheets:
Custom Excel workbooks were developed to process data from the LUA App. These sheets included multiple tabs for defining terms, calculating carbon stock changes, analyzing random errors, and organizing data by land-use transitions.

Remote Sensing and GIS Tools:
Remote sensing data from Landsat (30m resolution) and MODIS were used to classify land use and detect transitions. QGIS was utilized for mapping, overlay analysis, and validating spatial data.

Activity Data Sources
The inventory draws upon comprehensive and diverse sources of activity data:

Land-Use Data Collection:
Field surveys conducted by a technical team from the Ministry of Tourism and Environmental Affairs (MTEA) during June–October 2023 provided ground-truthing data for land-use classification.
Historical data spanning the reference period (2000–2020) was incorporated to ensure a robust dataset.

Carbon Stock Data:
Above-ground biomass carbon stocks were estimated using Eswatini's National Greenhouse Gas Inventory for 2020 and extrapolated data from South African studies conducted in 2015. These values were cross-verified against IPCC defaults.

Emission Factor Sources
Emission factors were sourced from both IPCC guidelines and local studies:

Country-Specific EFs:
Local data were used for above-ground biomass, leveraging field measurements of tree species common to Eswatini's forests. These factors account for the variation in carbon density between forest types.

IPCC Default EFs:
Default values were used for below-ground biomass, SOC, and non-CO_2 gases, as national data are not yet available for these pools.
Challenges and Limitations
The FRL highlights several challenges that limit the application of higher-tier methods:

Data Gaps:
National data on soil organic carbon, dead organic matter, and the proportions of roundwood versus fuelwood extraction remain insufficient.
Remote Sensing Limitations:
Cloud cover and low spatial resolution in certain regions reduced the accuracy of satellite-based assessments.
Uncertainty Analysis:

While the inventory report acknowledges uncertainties, the propagation of uncertainty was not fully implemented due to data constraints.
Quality Assurance and Control (QA/QC)
A rigorous QA/QC process was implemented:

Consistency Checks: Data was cross-verified with the 2020 National Greenhouse Gas Inventory and other independent sources.
Stakeholder Engagement: Input from government agencies, universities, and international experts ensured methodological transparency.
Documentation: Detailed records of all calculations, assumptions, and data sources were maintained.

Conclusions and Future Directions
Eswatini's LULUCF inventory represents a comprehensive and methodologically sound approach to emissions and removals estimation. Future plans include:

- Expanding country-specific emission factors to include soil organic carbon and dead organic matter.
- Refining land-use matrices to improve the accuracy of activity data.
- Incorporating uncertainty propagation into future submissions.
- By addressing these challenges, Eswatini aims to enhance the accuracy and credibility of its emissions reporting while fulfilling its commitments to international climate goals.

6.2. Land-use definitions and land representation approaches

The methodologies for land representation in Eswatini's LULUCF inventory are designed to align with the 2006 IPCC Guidelines while capturing the country's unique land-use characteristics. All six IPCC land-use categories were assessed during data collection, but the FRL primarily focuses on the forest land category. This section outlines the detailed definitions, classifications, and land representation approaches used in Eswatini's inventory.

6.2.1 Forest Land Definition

The forest land category follows the FAO definition of forest, which refers to all land with woody vegetation that meets the following criteria:

- **Minimum Mapping Unit (MMU):** 0.5 hectares.
- **Minimum Tree Cover:** 10%.
- **Minimum Potential Height at Maturity:** 5 meters in situ.

The LULUCF inventory builds upon the 2020 National Greenhouse Gas Inventory (GHGI) classification of forest land, which had only two broad categories—plantation and indigenous forests. In addition, the LULUCF inventory is in line with the country's FRL which divides forest land into seven distinct classes, providing a more granular view of Eswatini's diverse forest ecosystems.

6.2.2 Forest Subcategories

The inventory categorizes forest land into seven specific classes to account for ecological and management differences. These subcategories are as follows:

1. **Montane and Highland Forest:**
   - Found at elevations above 800 meters.
   - Comprises Afromontane and mixed woodlands classified as indigenous forests.
   - Predominantly located in the Highveld and Upper Middleveld regions.
2. **Dryer Acacia Savannah Forest:**
   - Found at elevations between 200–400 meters.
   - Dominated by Acacia species, this forest type occurs in areas with annual precipitation below 600mm.
   - Concentrated in the Lowveld, especially in the eastern parts of the country.
3. **Moister Savannah Forest:**
   - Found at elevations between 400–800 meters.
   - Characterized by broad-leaved, mixed woodland classified as indigenous forests.
   - Commonly located in the Middleveld and along the Lubombo Range.
4. **Riparian Forest:**
   - Occurs along rivers and streams across all physiographic zones.
   - Composed of mixed woodland classified as indigenous forests.
5. **Plantations:**
   - Man-made forests dominated by pine and eucalyptus species.
   - Managed for timber and pulp production.
   - Primarily found in the Highveld.
6. **Wattle Forest:**
   - Forests dominated by *Acacia mearnsii* (black wattle).
   - Classified as man-made forests, often used for planned logging and charcoal production.
   - Found predominantly in the Highveld.
7. **Woodlots:**
   - Small forest patches managed for domestic use, including fuelwood.
   - Typically located near urban and rural settlements, primarily in the Middleveld and Highveld regions.

Comparison Between GHGI and FRL Forest Classes

To ensure consistency with the 2020 GHGI, the seven forest classes in the FRL are grouped into plantation and indigenous forests as follows:

GHGI Forest Class	FRL Forest Class
Plantation Forests	Plantations, Wattle Forest, Woodlots
Indigenous Forests	Montane and Highland Forest, Moister Savannah Forest, Dryer Acacia Savannah Forest, Riparian Forest

6.2.3 Land-Use Representation Across Categories

The inventory assessed all six IPCC land-use categories, providing detailed classifications for each:

1. **Cropland:**
   - **Annual Crops:** Includes maize (harvested March–May), cotton, and sugarcane (harvested April–November).
   - **Perennial Crops:** Includes citrus, bananas, macadamia nuts, and pineapples. Agroforestry systems, with fruit trees intercropped with legumes or annual crops, are also classified under cropland.
2. **Grassland:**
   - **Bushveld:** Found at elevations of 200–800 meters, dominated by thicket communities and bushland.
   - **High Mountain Grasslands:** Found at elevations above 800 meters, characterized by open grasslands used for grazing.
3. **Wetlands:**
   - Includes natural water bodies like rivers and lakes, as well as artificial reservoirs such as irrigation dams and animal watering holes.
4. **Settlements:**
   - Includes both urban and rural settlements. Some settlements are classified as woody settlements when tree cover is present, such as in homestead forestry areas.
5. **Other Land:**
   - Barren lands, including bare rock and mining areas. Coal mining activities are included under this category.

6.2.4 Land Representation Methodology

1. **Sampling and Data Collection:**
   - A grid-based sampling system with a resolution of 2.5 x 2.5 kilometers was used to collect data across all land-use categories.

- The sampling included 7,702 plots, ensuring national coverage and spatial representation.

2. **Land-Use Matrices:**
   - **Matrix Type I:** Tracks annual transitions between land-use categories, providing a detailed temporal dataset.
   - **Matrix Type II:** Tracks cumulative land-use changes over the 2000–2020 reference period, enabling long-term analysis of trends in deforestation, forest degradation, and land-use recovery.
3. **Remote Sensing and GIS Tools:**
   - High-resolution satellite imagery (Landsat and MODIS) was used for land-use classification and transition analysis.
   - Data were processed and validated using GIS software, including QGIS.

6.2.5 Definitions of Land-Use Categories

The following table summarizes the definitions and characteristics of land-use classes in Eswatini's FRL:

Land-Use Category	Subcategory	Elevation	Description	Location
Forest Land	Montane and Highland Forest	>800m	Afromontane and mixed woodland, Indigenous forest	Highveld, Upper Middleveld
	Dryer Acacia Savannah Forest	200–400m	Acacia-dominated woodland, Indigenous forest, precipitation <600mm	Lowveld
	Moister Savannah Forest	400–800m	Broad-leaved mixed woodland, Indigenous forest	Middleveld, Lubombo Range
	Riparian Forest	All zones	Mixed woodland, Indigenous forest along rivers	Across all physiographic zones
	Plantations	N/A	Man-made forests of pine and eucalyptus for timber and pulp	Highveld
	Wattle Forest	>800m	*Acacia mearnsii* dominated, man-made, used for planned logging	Highveld
	Woodlots	>600m	Forest patches for domestic use like fuelwood	Middleveld, Highveld

Land-Use Category	Subcategory	Elevation	Description	Location
Cropland	Annual and Perennial Crops	N/A	Includes maize, sugarcane, citrus, bananas, macadamia nuts, pineapples	Throughout the country
Grassland	Bushveld	200–800m	Thicket communities, natural grasslands	Lowveld, Middleveld
	High Mountain Grasslands	>800m	Open grasslands, mainly used for grazing	Highveld
Wetlands	Natural and Artificial Wetlands	N/A	Rivers, lakes, marshes, dams for irrigation and livestock	Various regions
Settlements	Urban and Rural Settlements	N/A	Includes housing, industry, roads, and woody settlements	Throughout the country
Other Land	Barren Land	N/A	Includes rocky outcrops, coal mining sites	Various regions

This detailed classification and representation approach ensures that Eswatini's FRL is scientifically robust and fully aligned with international best practices, providing a reliable framework for tracking and reporting land-use dynamics and associated GHG emissions and removals.

Chapter 7. WASTE (CRT 5)

7.1. Overview of the sector

7.1.1. Description of the sector

Greenhouse gas (GHGs) emissions from the waste sector result from the disposal and treatment of waste and wastewater. The categories under this sector include:

- 4A – Solid Waste Disposal – CH_4
- 4B – Biological Treatment of Solid Waste – CH_4 and N_2O
- 4C – Incineration and Open Burning of Waste – CH_4, CO_2 and N_2O
- 4D – Wastewater Treatment and discharge – CH_4

In the country, all categories within the waste sector are present, although to varying degrees. For instance, waste composting is performed on a small percentage of the solid waste generated. The Tier 1 method was employed to estimate emissions from this sector, with primary data sources including population statistics from the Eswatini Central Statistics Office (CSO), the Eswatini Environment Authority (EEA), municipalities, the Eswatini Ministry of Health and Social Services, company towns, and the Eswatini Water Services Corporation (EWSC).

7.1.2. Trend in the sector's GHG

The total emissions for the waste sector are summarised in Table 7-1. The highest amount of emissions were from open burning which accounted for 6.1 kt CO_2, 2.58 kt CH_4 and 0.003 kt from N_2O. Composting contributed the least amount of 0.002 kt in 2022 as shown in Table 7-1. The emissions shows an increasing trend as the activity data is based on population. Precursor gases could not be estimated.

Table 7-1.
Waste sector: emissions by GHG, category and subcategory (kt) for 2022

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_X	Total GHG emissions (1)
	(kt)							CO_2 equivalents (kt) (2)
5. Total waste	6.23	2.53	0.00	NO	NO	NO	NO	78.20
5.A. Solid waste disposal		0.88		NO	NO	NO		24.72
5.A.1. Managed waste disposal sites		0.88		NE	NE	NE		24.72
5.A.2. Unmanaged waste disposal sites		NO		NO	NO	NO		NO
5.A.3. Uncategorized waste disposal sites		NO		NO	NO	NO		NO
5.B. Biological treatment of solid waste		0.002	0.00	NO	NO	NO		0.11
5.B.1. Composting		0.002	0.00	NE	NE	NE		0.11
5.B.2. Anaerobic digestion at biogas facilities		NO	NO	NO	NO	NO		NO
5.C. Incineration and open burning of waste	6.23	0.22	0.00	NE	NE	NE	NE	13.09
5.C.1. Waste incineration	0.12	0.00	0.00	NE	NE	NE	NE	0.13
5.C.2. Open burning of waste	6.10	0.22	0.00	NE	NE	NE	NE	12.96
5.D. Wastewater treatment and discharge		1.43	0.00	NO	NO	NO		40.30
5.D.1. Domestic wastewater		1.43	0.00	NE	NE	NE		40.30
5.D.2. Industrial wastewater		IE	IE	NE	NE	NE		IE
5.D.3. Other		NO		NO	NO	NO		NO
5.E. Other *(please specify)*	NO	NO	NO	NO	NO	NO	NO	NO
Other waste emissions [IPCC Software 4.E, SO_2 from 4.A-4.D]	NO	NO	NO	NO	NO	NO	NO	NO
Other waste emissions [IPCC Software 4.E, SO_2 from 4.A-4.D]	NO	NO	NO	NO	NO	NO	NO	NO

Memo item: [3]								
5.F.1. Long-term storage of C in waste disposal sites	157.28							157.28
5.F.2. Annual change in total long-term C storage	3.29							3.29
5.F.3. Annual change in total long-term C storage in HWP waste [4]	1.75							1.75

Note: Use the following notation keys where numerical data are not available: NA = not applicable; NE = not estimated; NO = n ot occurring; IE = included elsewhere; C = confidential.
Source: [], based on the **Table5** spreadsheet of the CRT.

In waste management, certain subcategories were not estimated due to insufficient segregation data, leading to their consolidation into a single category. For instance, all wastewater was categorized as domestic wastewater, as it is typically combined with industrial wastewater.

The waste sector contributed 78.17 kt CO_2 equivalent, representing 3.43% of the total emissions for 2022. Emissions from this sector have gradually increased from 1990 to 2022. This rise can be attributed to the fact that emissions were estimated based on population data across all subcategories, resulting in a 43% increase from 1990 to 2022.

Table 7-2 shows the emissions from the subcategories from 1990 – 2022. All the emissions show a gradual increase across the time-series. The major contributor in this sector is wastewater treatment which accounts for about 52% of the total emissions in 2022 followed by waste SWDS at 32% and open burning which contributes 17% of the total sector emissions for 2022. Contribution from biological treatment as well as healthcare waste incineration have negligible emissions. This trend cuts across all the inventory years.

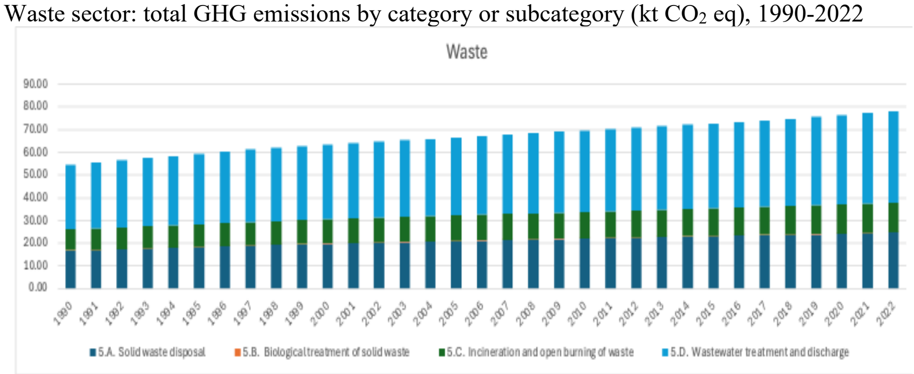
Table 7-2.
Waste sector: total GHG emissions by category (kt CO_2 eq)

Category	1990	1995	2000	2005	2010	2015	2020	2021	2022
Managed waste disposal sites	16.74	18.30	19.79	20.99	22.08	23.12	24.20	24.45	24.72
Incineration	0.06	0.06	0.06	0.06	0.09	0.12	0.12	0.13	0.13
Open burning of waste (CO2)	9.19	9.96	10.56	11.05	11.54	12.03	12.66	12.81	12.96
Composting	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
Wastewater treatment & disposal	28.60	30.98	32.85	34.37	35.89	37.40	39.37	39.83	40.30
Total	**54.64**	**59.35**	**63.32**	**66.53**	**69.66**	**72.73**	**76.42**	**77.29**	**78.17**

Note:
Source: [], based on the **Table10s1** spreadsheet of the CRT.

Figure 7-1 shows an illustration of the sector emissions in CO_2 equivalence across the time series.

Figure 7-1.
Waste sector: total GHG emissions by category or subcategory (kt CO_2 eq), 1990-2022



Methane contributes about 91% (Table 7-3 and Figure7-2) of the total GHG emissions for this sector and this comes from all most of the waste disposal practices where most of it is generated in wastewater treatment. This also consistent across the time series.

Table 7-3.

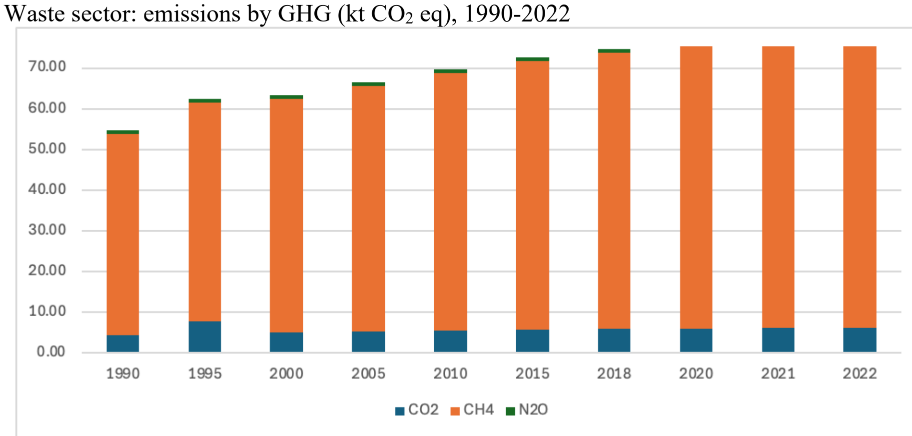
Waste sector: emissions by GHG (kt CO_2 eq)

GHG	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
CO_2	4.39	7.75	5.04	5.27	5.53	5.78	5.94	6.08	6.16	6.23
CH_4	49.49	53.78	57.41	60.36	63.18	65.96	67.79	69.29	70.07	70.87
N_2O	0.78	0.85	0.90	0.94	0.99	1.03	1.06	1.08	1.09	1.11
Total	**54.67**	**62.38**	**63.35**	**66.56**	**69.69**	**72.77**	**74.78**	**76.46**	**77.33**	**78.20**

Figure 7-2 shows the GHG waste sector emissions in CO2 equivalence.

Figure 7-2.

Waste sector: emissions by GHG (kt CO_2 eq), 1990-2022



7.1.3. General methodological issues of the sector

Tier 1 estimation methodologies were maintained across the categories due to activity data limitations. The data was based on population data. A waste characterisation study was done for the country in 2021 and the results from this survey were used to assign the percentage of waste in the different groups such as food waste, plastics etc. this survey provided the basis for using country data even though it still needs to be improved as this was done for a short time.

7.2. Solid waste disposal (CRT 5.A)

7.2.1. Description and trend of GHGs in the category

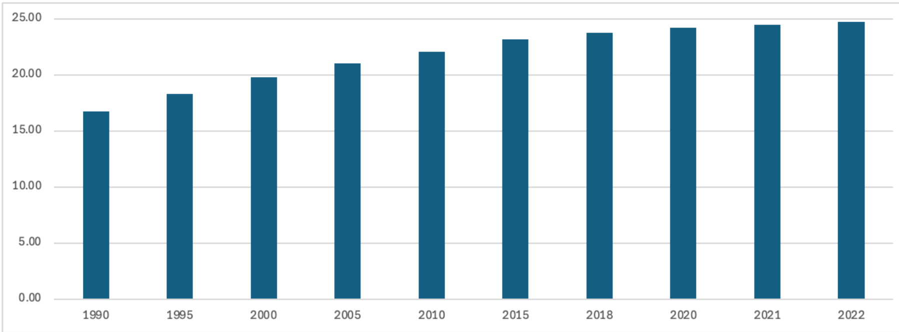
Solid waste disposal sites (SWDS) generate significant amounts of greenhouse gases, primarily methane, as organic waste decomposes in the anaerobic layers of the disposal area. In Eswatini, there are five managed landfill sites located in Matsapha, Mbabane, Simunye, Piggs Peak and Bhunya. These facilities are equipped with weighbridges and systems for collecting and disposing of leachate. Other disposal sites, including both formal and informal dumps managed by local authorities, were classified as poorly managed solid waste disposal sites. Currently, no methane recovery factor applies to any of the landfills in Eswatini.

The emissions from this subcategory are mainly CH_4 accounting for 32% of the sector emissions. Since these are also based on population, they also show a steady increase over time as shown in Table 7-6 and Figure 7-5.

Table 7-64.
Solid waste disposal: total GHG emissions by subcategory (kt CO_2eq)

Subcategory	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
Managed waste disposal sites	16.74	18.30	19.79	20.99	22.08	23.12	23.73	24.20	24.45	24.72
Total	**16.74**	**18.30**	**19.79**	**20.99**	**22.08**	**23.12**	**23.73**	**24.20**	**24.45**	**24.72**

Figure 7-53.
Solid waste disposal: total GHG emissions by source (kt CO_2eq), 1990-2022



Note:
Source:

7.2.2. Methodological issues of the category

A Tier 1 approach was employed for all categories within the Waste sector due to the lack of country-specific activity data. The total solid waste generated was estimated from a national waste generation rate (51 kg/cap/year) obtained from a recent country survey on waste characterisation. The same study gave rise to percentage fractions of the different components of MSW hence these values were used.

7.2.2.1. Activity data of the category

Activity data was based on population (Table 7-7), and it was multiplied by the national waste generation factor to get waste generated. The percentage of waste sent to SWDS was assumed to be 30% based on the percentage of the population that stays in urban areas, where there are waste management sites. The rest of the population resides in rural areas and practice mainly open burning of waste.

Table 7-75.
Solid waste disposal: activity data by GHG source (activity data unit)

Year	Population data
1990	832525
1991	846410
1992	860295
1993	874179
1994	888064
1995	901949
1996	915834
1997	929718
1998	938592
1999	947465
2000	956338
2001	965211
2002	974084
2003	982957
2004	991830
2005	1000703
2006	1009576
2007	1018449
2008	1027250
2009	1036050
2010	1044850
2011	1053650
2012	1062450
2013	1071251
2014	1080051
2015	1088851
2016	1097651
2017	1106451
2018	1119728
2019	1132941
2020	1146197
2021	1159607
2022	1173175

7.2.2.2. Emission factors applied in the category

Emission factors used for this category were all the default values specified in the *2006 IPCC Guidelines.*

7.2.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

7.2.4. Uncertainty assessment and time-series consistency of the category

The waste generation rate study was done for a short time and hence may need improvement to cover a year to be representative.

7.2.5. Category-specific QA/QC and verification

Double checking was done as well as confirming data with EEA who are custodians of waste management in the country.

7.2.6. Category-specific recalculations

There were no recalculations for the subcategory.

7.2.7. Category-specific planned improvements

There is need to improve the waste characterisation study to get a more representative waste generation rate.

7.3. Biological treatment of solid waste (CRT 5.B)

7.3.1. Description and trend of GHGs in the category

In Eswatini, the biological treatment of waste is primarily carried out through composting. When managed effectively, composting is an aerobic process that converts a significant portion of the degradable organic carbon in the composted material into CO_2. However, because these CO_2 emissions are of biogenic origin, they are not included in emission estimates. As a result, composting generates minimal greenhouse gas emissions. Conversely, poorly managed composting can lead to higher emissions of CH_4 and N_2O.

In terms of domestic and commercial composting activities, we estimate that 1% of the Municipal Solid Waste (MSW) generated is composted. Given the low volume of waste being composted and the minimal GHG emissions associated with this process, the greenhouse gas emissions from composting in Eswatini are considered negligible.

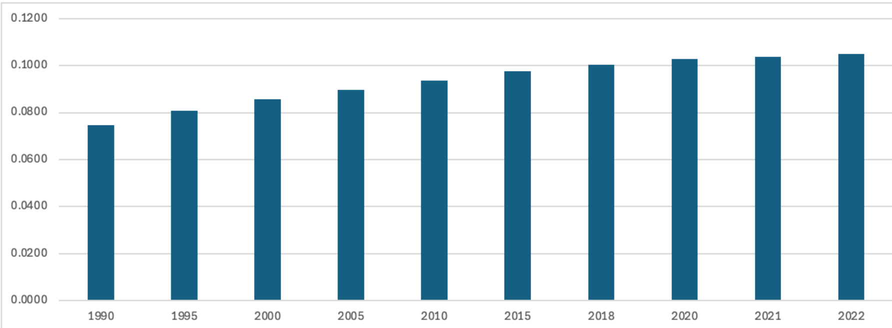
Table 7-11 shows the emissions from this subcategory where the emissions were 0.105 kt CO_2eq in 2022.

Table 7-116.
Biological treatment of waste: total GHG emissions by subcategory (kt CO_2eq)

Subcategory	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
Composting	0.0746	0.0808	0.0856	0.0897	0.0936	0.0975	0.1003	0.1027	0.1038	0.1050
Total	**0.0746**	**0.0808**	**0.0856**	**0.0897**	**0.0936**	**0.0975**	**0.1003**	**0.1027**	**0.1038**	**0.1050**

Figure 7-6 shows a graphic representation of these emissions which show an increasing trend.

Figure 7-4.6
Biological treatment of waste: total GHG emissions by source (kt CO_2eq), 1990-2022



7.3.2. Methodological issues of the category

Tier 1 approach was employed because of the limitations in country-specific activity data. The total amount of waste composted was estimated as the portion of waste not sent to solid waste disposal sites (SWDS) or openly burned, accounting for 1% of the total solid waste generated in the country.

It was assumed that only 1% of waste generated in the country is composted. This amount was calculated from the population and waste generation rate to get the amount of waste. The equation below was then used to estimate the CH_4 emissions from composting.

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

Where:

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

7.3.2.1. Activity data of the category

The total Municipal Solid Waste generated was calculated using population data from the Central Statistical Office (CSO) alongside the IPCC default MSW generation rate (Table 7-7).

7.3.2.2. Emission factors applied in the category

Emissions of Methane (CH_4) and Nitrous Oxide (N_2O) from composting were estimated using the default emission factors provided in the 2006 IPCC Guidelines as shown in Table 7-13.

Table 7-7.13

Biological treatment of waste: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Composting	CH_4	4	g CH_4/kg waste treated
Composting	N_2O	0.24	g N_2O/kg waste treated

7.3.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

7.3.4. Uncertainty assessment and time-series consistency of the category

The amount of waste composted and the methods of composting are unknown and poorly documented.

7.3.5. Category-specific QA/QC and verification

Double checking was done as well as confirming data with EEA who are custodians of waste management in the country.

7.3.6. Category-specific recalculations

There were no recalculations.

7.3.7. Category-specific planned improvements

Gather data on the real estimates of amount waste composted

7.4. Incineration and open burning of waste (CRT 5.C)

7.4.1. Description and trend of GHGs in the category

In Eswatini, incineration is primarily utilized for the management of healthcare risk waste. Emissions generated from waste incineration consist of CH_4, CO_2, and N_2O. The incinerators used are batch semi-continuous systems, and the clinical waste being incinerated includes items such as plastics, syringes, animal tissues, bandages, and cloth. However, these incinerators lack provisions for managing combustion air (including waste agitation and aeration) and residence time, which leads to the assumption that they are not capable of achieving complete combustion. This information was provided to support some of the parameters in the chosen estimation method.

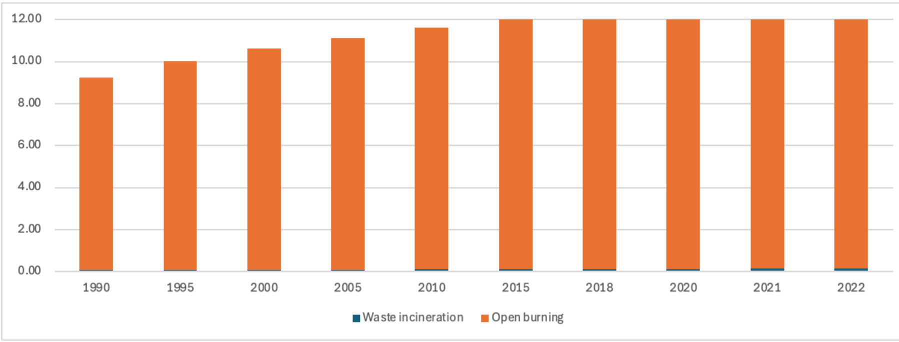
The open burning of waste accounts for over 99% of the emissions in this subcategory as shown in Table 7-16.

Table 7-8.
Incineration and open burning: total GHG emissions by subcategory (kt CO_2eq)

Subcategory	1990	1995	2000	2005	2010	2015	2018	2020	2021	2022
Waste incineration	0.0626	0.0626	0.0626	0.0626	0.0936	0.1197	0.1197	0.1197	0.1285	0.1285
Open burning	9.1944	9.9612	10.5619	11.0518	11.5394	12.0253	12.1581	12.6586	12.8068	12.9565
Total	**9.2570**	**10.0238**	**10.6245**	**11.1144**	**11.6330**	**12.1450**	**12.2778**	**12.7783**	**12.9353**	**13.0850**

Figure 7-7 shows the same data graphically.

Figure 7-5.
Incineration and open burning: total GHG emissions by source (kt CO_2 eq), 1990-2022



7.4.2. Methodological issues of the category

Tier 1 approach was used to estimate the waste incinerated. The amount of clinical waste generated was calculated using the national number of beds in health facilities multiplied the rate of clinical waste generation per bed per day in 365 days. Default emission factors provided in the 2006 IPCC Guidelines were used. The equation below was used to calculate the emissions.

$$CO_2\ Emissions = \sum_i \left(SW_i \bullet dm_i \bullet CF_i \bullet FCF_i \bullet OF_i \right) \bullet 44/12$$

Where:

CO_2 Emissions = CO_2 emissions in inventory year, Gg/yr

SW_i = total amount of solid waste of type *i* (wet weight) incinerated or open-burned, Gg/yr

dm_i = dry matter content in the waste (wet weight) incinerated or open-burned, (fraction)

CF_i = fraction of carbon in the dry matter (total carbon content), (fraction)

FCF_i = fraction of fossil carbon in the total carbon, (fraction)

OF_i = oxidation factor, (fraction)

44/12 = conversion factor from C to CO_2

i = type of waste incinerated/open-burned

7.4.2.1. Activity data of the category

The amount of clinical waste generated was calculated using the national number of beds in health facilities multiplied the rate of clinical waste generation per bed per day in 365 days.

Table 7-9.17

Incineration and open burning: activity data by GHG source (activity data unit)

Year	Number of beds
1990	1455
1991	1455
1992	1455
1993	1455
1994	1455
1995	1455
1996	1455
1997	1455
1998	1455
1999	1455
2000	1455
2001	1455
2002	1455
2003	1455
2004	1455
2005	1455
2006	2176
2007	2176
2008	2176
2009	2176
2010	2176
2011	2176
2012	2784
2013	2784
2014	2784
2015	2784
2016	2784
2017	2784
2018	2784
2019	2784
2020	2784
2021	2984
2022	2984

7.4.2.2. Emission factors applied in the category

Emission factors used were from the IPCC guidelines. The data used to estimate incineration emissions was based on the number of beds as shown in Table 7-18.

Table 7-10.18

Incineration and open burning: emission factors applied by GHG source

GHG source	GHG	Value	Unit
Waste incineration – dry matter content	CO_2	0.65	
Waste incineration – Fraction of carbon in dry matter	CO_2	0.6	
Waste incineration – Fraction of fossil carbon in total carbon	CO_2	0.4	
Waste incineration – Oxidation factor	CO_2	1	
Open burning – Dry matter content – Food waste Disposable nappies Garden and wood waste Paper and cardboard Plastic	 CO_2 CH_4 N_2O	0.4 0.4 0.4 0.9 1	
Open burning – methane emission factor	CH_4	6500	Kg CH_4/Gg Wet Waste
Open burning – N2O emission factor	N_2O	150	Kg N_2O/Gg Wet Waste

7.4.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

7.4.4. Uncertainty assessment and time-series consistency of the category

Uncertainties stem from the activity data where the amounts are estimated based on the number of beds, hence the actual amount of waste incinerated in unknown.

7.4.5. Category-specific QA/QC and verification

The data was obtained from the last inventory, and it was also confirmed with key stakeholders from EEA and MOH.

7.4.6. Category-specific recalculations

There are no recalculations for this subcategory.

7.4.7. Category-specific planned improvements

There is need to improve activity data which can give the actual amounts of clinical waste incinerated. The country is in the process of establishing a centralised waste incinerator to cover healthcare waste from all healthcare facilities. This may help improve the quality of the data in the future.

7.5. Wastewater treatment and discharge (CRT 5.D)

7.5.1. Description and trend of GHGs in the category

In Eswatini, wastewater originates from domestic, commercial, and industrial activities. Domestic wastewater may be collected and treated on-site, channelled to centralized wastewater treatment plants, or disposed of untreated. Industrial wastewater is typically integrated with domestic sources within the sewer system, which is a closed underground network. The handling of wastewater results in emissions of CH_4 and N_2O.

In urban areas, wastewater is treated at centralized wastewater treatment plants, shallow lagoons, septic tanks, and latrines. The effectiveness of these treatment systems varies depending on the population's income level. Fraction estimates were sourced from the Eswatini Water Services Corporation (EWSC). In rural and peri-urban areas, the most common practices include the use of latrines, no treatment, or discharge pathways, where wastewater may be untreated in pit latrines or result in open defecation. Alternatively, it may be treated on-site in underground tanks/compartments under anaerobic conditions, with the treated effluent then released into the ground through 'French' drains.

For the purposes of the inventory, all wastewater was treated under domestic wastewater treatment and discharge. This is because it was not possible to segregate the data.

Table 7-11.21

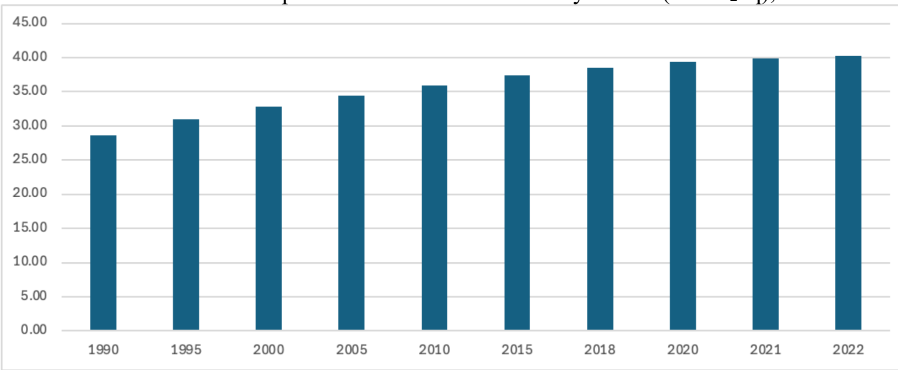
Wastewater treatment and disposal: total GHG emissions by subcategory (kt CO_2eq)

Subcategory	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2018*	*2020*	*2021*	*2022*
Domestic wastewater treatment	28.5977	30.9825	32.8507	34.3747	35.8913	37.4027	38.4633	39.3726	39.8332	40.2991
Total	**28.5977**	**30.9825**	**32.8507**	**34.3747**	**35.8913**	**37.4027**	**38.4633**	**39.3726**	**39.8332**	**40.2991**

Figure 7-8 shows a graphic representation of the emissions from this subcategory.

Figure 7-6.8

Wastewater treatment and disposal: total GHG emissions by source (kt CO_2eq), 1990-2022



7.5.2. Methodological issues of the category

Tier 1 approach was used for the estimation of emissions from the wastewater category due to limitations in country specific activity data. Emissions of methane were calculated using population data gathered from the Central Statistics Office. Equation 6.1 from the IPCC guidelines was used.

7.5.2.1. Activity data of the category

Population data was used and this data is similar to the population data in Table 7-12.

7.5.2.2. Emission factors applied in the category

Default emission factors were used for the calculations of the emissions from this subcategory. The BOD value used was 37 g/cap/day and a correction factor of 0.3 was used for industrial BOD discharge in sewers.

7.5.3. Description of any flexibility applied to the category

No flexibility was applied in lieu of required emissions in this category.

7.5.4. Uncertainty assessment and time-series consistency of the category

The wastewater treatment methods, including formal treatment plants, lagoons, and septic tanks, were introduced relatively recently, around 2010. The process of sludge removal remains uncertain, as it's unclear what occurs to the sludge afterward; service providers do not specify whether it is applied to soils or disposed of as solid waste. Consequently, it has been assumed that there is no sludge removal.

7.5.5. Category-specific QA/QC and verification

After entering the data, double-checking of calculations and trends was done to ensure consistency.

7.5.6. Category-specific recalculations

The are no recalculations for this subcategory.

7.5.7. Category-specific planned improvements

To generate country specific BOD values that can be used in the calculations.

7.6. Other (specify) (CRT 5.E)

Not Applicable

Chapter 8. OTHER (CRT 6)

Not Applicable

Chapter 9. INDIRECT CO_2 AND N_2O EMISSIONS

Indirect emissions not consistently estimated across the inventory, with partial estimations (reporting year only) covered under the LULUCF sector.

Chapter 10. RECALCULATIONS AND IMPROVEMENTS

10.1. Explanations and justification for recalculations

Following the adoption of the use of 100-year time-horizon global warming potential (GWP) values from the IPCC Fifth Assessment Report, the whole time series changed, and Eswatini then did not undertake an assessment of recalculations, also noting that this is the first submission of a National Inventory Document/Report. Previously, the country emissions were only reported as part of National Communications and the Biennial Update Report.

In addition to changes owing to the change in GWPs, the following changes were effected in the NGI:

1. A country specific waste generation rate was applied for the waste sector based on a local study.
2. For HFCs, recent data was obtained from a receive HFC inventory which was done under the Kigali Amendment.
3. Improvements were made to the land classification utilising the CfRN Land Use Assessment Application

10.2. Implications for emission and removal levels

The implication for emissions and removals were not assessed.

10.3. Implications for emissions and removal trends

Implications on tends not assessed.

10.4. Areas of improvement and capacity-building in response to the review process

Eswatini has not had a preceding review and associated recommendations for improvements. However, the following recommendations for improvements have been identified by the relevant technical teams:

Table 10-112.
Summary of areas of improvement identified and how the country addresses them

Sector	*Category*	*Description of area of improvement*	*Time frame for application*

10.5. Areas of improvement and capacity-building related to flexibility provisions

MPG: provision 7c and 7d.

Flexibility provisions were ustilised regarding paragraphs 29, 34 and 35 of the MPGs as outlined in Table 10-2 below.

Table 10-13.
Summary of the flexibility provisions applied

Sector	*Category*	*Description of area of improvement*	*MPG flexibility provision*	*Capacity-building support needs*	*Progress made*
All	All	Uncertainty Assessment	Para 29	Need to build capacity in undertaking qualitative uncertainty assessment	
All	All	QA/QC Plan	Para 34	Development of a QA/QC Plan that aligns to the ETF	
All	All	QC Procedure	Para 35	Development and implementation of a procedure that will allow for timely conclusion of NGI	

Note:
Source:

ANNEXES TO THE NATIONAL INVENTORY DOCUMENT

Annex I: Key categories

MPG: provision 25. Provision 25 offers flexibility to countries that may need it.

[Include the following detailed information: (1) description of methodologies used for identifying key categories (if different from the IPCC Guidelines tier 1 approach); (2) information on the level of disaggregation; and (3) Table 4.2 and 4.3 of volume 1 of the *2006 IPCC Guidelines*, including and excluding LULUCF]

Annex II: Uncertainty assessment

Flexibility (MPG provision 29) used, with uncertainty reported qualitatively.

Annex III: Detailed description of the reference approach

MPG: provision 36.

[Include detailed information on inputs to the reference approach (such as the national energy balance and its tables) and the results of the comparison of national estimates of emissions with those obtained using the sectoral approach]

Annex IV: Quality assurance and quality control plan

MPG: provisions 34 and 35. Provisions 34 and 35 offer flexibility to countries that may need it.

Eswatini is utilising as there was no

Annex VI: Common reporting tables (CRT)

Common Reporting Tables are being submitted separately, including through the Reporter Tool.

REFERENCES

i http://www.erc.uct.ac.za/sites/default/files/image_tool/images/119/Papers-pre2004/01Stone-Bennett_Diesel_emissions.PDF. (Accessed November 13, 2020).

ii http://www.erc.uct.ac.za/sites/default/files/image_tool/images/119/Papers-2012/12-Merven-etal_Quantifying_energy_needs_transport%20sector.pdf. (Accessed February 4, 2020).

CBIT
GSP