SOUTH AFRICA'S FIRST
BIENNIAL TRANSPARENCY REPORT

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE UNDER THE PARIS AGREEMENT

forestry, fisheries & the environment
Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

30 YEARS OF FREEDOM
South Africa 1994 - 2024

2030 NDP

forestry, fisheries
& the environment

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DEPARTMENT OF FORESTRY, FISHERIES AND THE ENVIRONMENT

DECEMBER 2024

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The DFFE further wishes to thank all the data providers as referenced in South Africa's first Biennial Transparency Report (BTR1) including the Project Steering Committee for the compilation of the international climate change reports under the United Nations Framework Convention on Climate Change.

Dr. Dion George
Minister: Forestry, Fisheries and the Environment (South Africa)

Ministerial Foreword

It is my honour, as the Minister of Forestry, Fisheries and the Environment, to submit South Africa's First Biennial Transparency Report (BTR1) under Article 13 of the Paris Agreement. This report provides a reflection of South Africa's ongoing efforts to implement our mitigation and adaptation contributions as outlined in the update of South Africa's first Nationally Determined Contribution (NDC) (2021). Furthermore, it demonstrates South Africa's dedication in doing our fair share towards achieving the collective goal of limiting the global average temperature rise to well below 2°C, while striving to limit the rise to 1.5°C, as well as fostering resilience, and increasing the ability to adapt to the adverse effects of climate change.

In this BTR, South Africa tracks the first two years of implementing our NDC; that is from the 1st of January 2021 to the 31st of December 2022. South Africa has made all effort to report in line with the modalities, procedures and guidelines of the Enhanced Transparency Framework, whilst making use of the flexibility provisions that we require in light of our capacities. South Africa's updated first NDC has two single-year targets, for the years 2025 and 2030. In 2025, the annual greenhouse gas (GHG) emissions will be in a range of 398-510 Mt CO2-eq whilst in in 2030, they will be in the range of 350-420 Mt CO2-eq. The NDC represents a significant progression, based on science and equity, in light of South Africa's national circumstances. South Africa's indicator for tracking progress in implementation of our NDC consists of our net annual GHG emissions, excluding GHG emissions from natural disturbances. All sectors are covered - Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry, and Other Land Use (AFOLU), as well as Waste.

It is worth noting that South Africa, is implementing this NDC under significant developmental complexities. As outlined in the National Development Plan, it is of the highest priority for South Africa to address our high levels of unemployment as well as persistent poverty and inequality. In curbing GHG emissions, South Africa is implementing key policies and measures, including but not limited to our framework National Climate Change Response Policy, Sectoral Emission Targets to provide strategic direction for sectoral decarbonization policy, Carbon Budgets for large emitters, national GHG reporting regulations, the Just Transition Framework, the Carbon Tax, the Integrated Resources Plan for electricity, the Integrated Energy Plan for the whole energy sector, 12L Tax Incentive Programmes for renewables and energy efficiency, the Renewable Energy Independent Power Producer Procurement (REIPPP) Programme, the Green Transport Strategy, the Waste Management Strategy and the Green Hydrogen Commercialization Strategy. Our President has recently signed into law our Climate Change Act. The act will now be the key legislative instrument to coordinate and enhance climate change action in South Africa.

The BTR also details progress in the implementation of South Africa's National Climate Change Adaptation Strategy, as well as supporting provincial and sectoral strategies, demonstrating the key vulnerable sectors as highlighted in the NDC, including water, agriculture, health, biodiversity, infrastructure as well as human settlements. The BTR further demonstrates what is needed to foster resilience and adaptive capacity in those sectors. Moreover, it demonstrates some of the economic losses and damages suffered in South Africa that are attributed to climate change, as well as what South Africa is doing to avert and minimize losses and damages from climate change.

I would like to take this opportunity to express our sincere gratitude for the financial, technology transfer and development as well as capacity building support that has been channelled to South Africa for climate action. South Africa has received significant financial support for climate change action, including over USD $816.9 million in bilateral assistance and USD $10.7 million from multilateral sources aimed at supporting and/or benefiting efforts to address climate change in the country. South Africa still remains concerned that a significant portion of climate finance support still comes mostly in the form of loans rather than grants as analyzed in this BTR. The support received through the Just Energy Transition Investment Plan (JET IP) will be critical in assisting South Africa to transit to a lower-carbon and climate resilient economy. Additionally, our Capacity Building Initiative for Transparency (CBIT) project has been instrumental in enhancing South Africa's ability to report transparently and in accordance with the MPGs. South Africa is equally grateful for the funding it has receiving for the preparation of this BTR through the Global Environment Facility (GEF), as well as United Nations Environment Programme (UNEP) as the implementing agency.

In conclusion, I sincerely thank all stakeholders, government departments, municipalities, state-owned entities, academia and NGOs for their invaluable collaboration in developing and finalising this report, ensuring that South Africa's climate action is demonstrated to the international community. I also salute the committed efforts of the Climate Change and Air Quality branch, that coordinates the reporting process for South Africa, as well as the CSIR and UCT in ensuring that we develop a BTR that represents our best first attempt.

13/12/24

Dr. Dion George
Minister: Forestry, Fisheries and the Environment (South Africa)

Overview Chapter: Executive Summary of the First BTR of South Africa

The Republic of South Africa submits its first Biennial Transparency Report (BTR1) which complies with the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement reporting requirements, while responding to its national development goals. The BTR1 was developed in accordance with the Modalities, Procedures, and Guidelines (MPGs) for the Enhanced Transparency Framework (ETF) for action and support as outlined in Article 13 of the Paris Agreement (FCCC/PA/CMA/2018/3/Add.2), with specific attention to the perspectives and priorities of South Africa.

All the supporting Common Reporting Tables (CRTs) and Common Tabular Formats (CTFs) as per Decision 5/CMA.3 including its Annex I, Annex II *, Appendix as well Annex III (Annex III will focus only on financial, technology development and transfer and capacity building support needed and received) will be completed through the final UNFCCC ETF Reporting Tools application. Electronic reporting of information on NIRs used common reporting tables (CRTs) and will be submitted as annexes to this BTR. Information necessary to track progress made in implementing and achieving NDCs will be provided as annexes in common tabular formats (CTFs). This information includes detail on financial, technology development and transfer, and capacity-building support needed, and received.

Chapters in South Africa's BTR1 are presented as follows:

1. National inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases
2. Information necessary to track progress made in implementing and achieving NDCs under Article 4 of the Paris Agreement
3. Information related to climate change impacts and adaptation under Article 7 of the Paris Agreement
4. Information on financial, technology development and transfer and capacity-building support needed and received under Articles 9–11 of the Paris Agreement
5. Information on flexibility
6. Improvements in reporting over time

The Executive Summaries (ES) for each of the four main chapters are provided below:

ES.1 NATIONAL INVENTORY REPORT OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES

ES1.1: Introduction

A summary of the National Greenhouse Gas (GHG) Inventory for South Africa is presented in this chapter. The Inventory covers the period of 2000 to 2022 and the GHG emissions are reported under five sectors: Energy; Industrial Process and Product Use (IPPU), Agriculture, Land Use, Land Use Change and Forestry (LULUCF) and Waste. In South Africa's previous inventory, Agriculture and LULUCF were grouped together under the Agriculture, Forestry and Other Land Use (AFOLU). As the country is transitioning to the Enhanced Transparency Framework (ETF) Common Reporting Tables (CRT) reporting format, Agriculture and LULUCF are treated as separate sectors with the categories and sub-categories following those outlined in the CRT formats.

ES.1.2 Institutional arrangements

The Department of Forestry, Fisheries and the Environment (DFFE) is responsible for the co-ordination and management of all climate change-related information, including mitigation, adaption, monitoring and evaluation, and GHG inventories. The DFFE therefore played a lead role in the compilation, implementation and reporting of the national GHG inventory, with other relevant agencies and ministries providing support through the provision of data used in the inventory. The compilation of the inventory is further supported by the National Greenhouse Gas Emission Reporting Regulations, 2016 under Notice No. 275 in the Gazette No. 40762 of 03 April 2017 (DEA, 2017a) and the South African Greenhouse Gas Emissions Reporting System (SAGERS).

ES1.3 Summary of national emission and removal trends

GWP

In this inventory the emissions for each of the major GHGs are presented as carbon dioxide equivalents (CO_2e) using the 100- year global warming potentials (GWPs) from the 2014 IPCC Fifth Assessment Report (AR5) (IPCC, 2014b).

Gas trends

Carbon dioxide (CO_2) is the largest contributor to South Africa's emissions (Figure ES1.1). CO_2 emissions contributed 81.9 % (excl. LULUCF) to South Africa's emissions in 2022. The contribution from methane (CH_4) have increased from 12.9% to 13.2% (excl. LULUCF) between 2000 and 2022. Nitrous oxide (N_2O) emissions increased from 3.4% to 3.5% (excl. LULUCF) between 2000 and 2022. Fluorinated gases (F-gases) emissions have increased from 0.2% to 1.3% (excl. LULUCF) between 2000 and 2022. CO emissions varied between 1 693 Gg CO to 2 941 Gg CO between 2000 and 2022. The NO_x emissions were between 41 Gg NO_x and 114 Gg NO_x, while NMVOCs were between 83 Gg NMVOCs and 244 Gg NMVOCs over the period 2000 to 2022.

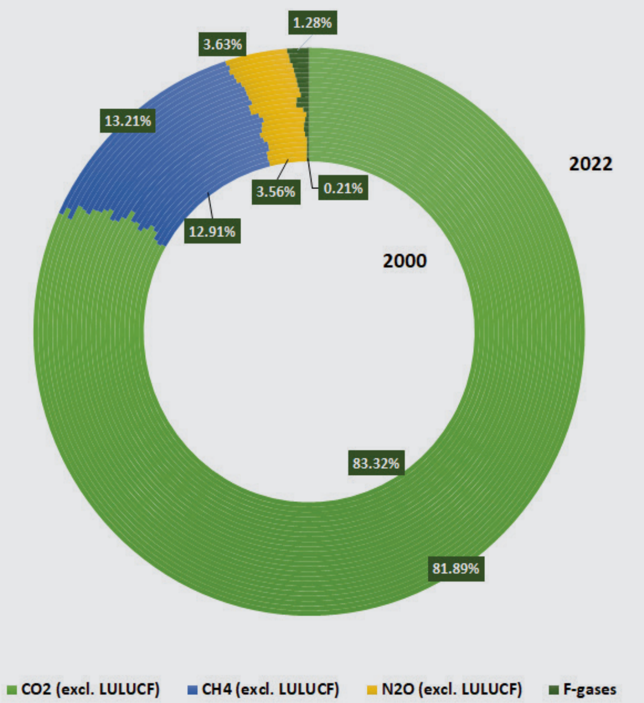


Figure ES 1.1: Gas contribution to South Africa's emissions (excl. LULUCF) between 2000 and 2022

Sectoral trends

Energy emissions in 2022 accounted for 78 % (excl. LULUCF) (Figure ES1.2) and 86 % (incl. LULUCF) of total emissions for South Africa. Energy emissions declined by 0.2% since 2020. In 2021 emissions increased by 3.5 % but then dropped again in 2022 to pandemic levels. This decrease is due to a 6.5% decrease in emissions from the *Energy Industries* sub-sector, which on average accounts for 67 % of the Energy sector's emissions.

Since 2000, IPPU emissions have decreased by 6.7%. The decline can be attributed to the decline in metals production (-39.0%), specifically Iron and Steel, and Aluminum. This can be ascribed to the deteriorating economy. The chemicals industry also declined (-31.4%). IPPU emissions for 2022, accounted 6.4% of South Africa's emissions (excl. LULUCF). The IPPU sector emissions increased by 23.1% since 2020. This was mainly due to restoration of production materials post covid.

Agriculture emissions in 2022 accounted for 11% (excl. LULUCF) and 12% (incl. LULUCF) of total emissions for South Africa. Since 2020 the Agriculture sector emissions have declined by 9.1% and this is due mainly to declining livestock population. LULUCF sector was a sink of 43 181 Gg CO_2e in 2022. The LULUCF sink grew by a further 55% between 2020 and 2022. *Forest lands remaining forest lands* showed a general increase from 2009. Between 2014 and 2022 the was an increase in the conversion of grasslands to woodlands which contributed to the increasing sink during this time. *Grasslands* led to increased emissions between 2000 and 2022 due to land conversions between low shrublands and grasslands.

Waste sector emissions for 2022 accounted 4% (excl. LULUCF) and 4.8% (incl. LULUCF) of the total emissions, with waste sector emissions have increased by 44.1% since 2000.

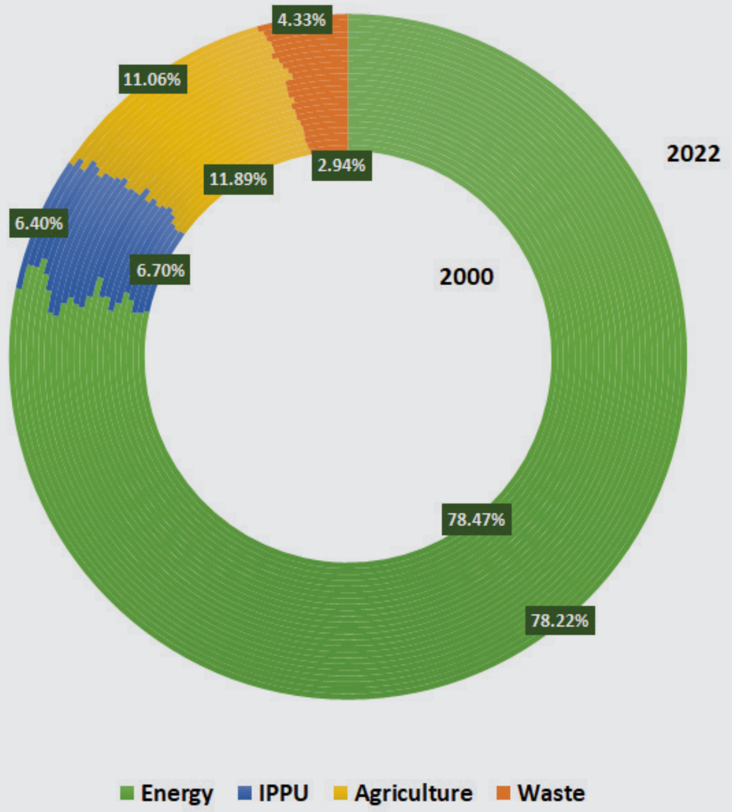


Figure ES 1.2 1: Sector contribution to total emissions (excluding LULUCF) in South Africa between 2000 and 2022.

ES1.4 Improvements and recalculations

Improvements were made to emission estimates from each sector and therefore recalculations were completed for the full time-series. The data shows that the current inventory estimates (excl. LULUCF) are between 0.4% and 5.3% lower than the 2020 inventory estimates, while the estimates (incl. LULUCF) are between 0.2% and 4.9%. The Energy sector improvements contribute the most to the reduction in the estimates in this inventory, with an average reduction of 14 294 Gg CO_2e since 2007 compared to the previous inventory.

ES1.5 Key category analysis

A Tier 1 level and trend assessment were conducted, following Approach 1 (IPCC, 2006), on both the emissions including and excluding LULUCF to determine the key categories for South Africa. For the 2000-2022 inventory the level of disaggregation for each sector was updated.

Forest land converted to grassland, *Direct N_2O emissions from managed soils* and *Ferroalloy production* are new to the top 10 key categories. In the previous inventory these categories were in 26th (as *Land converted to grassland*), 16th and 15th place, respectively.

ES1.6 General uncertainty evaluation

Uncertainty analysis is regarded by the IPPC Guidelines as an essential element of a complete and transparent inventory. A trend uncertainty between the base year and 2022, as well as a combined uncertainty of activity data and emission factor uncertainty was determined using an Approach 1. The total uncertainty for the inventory was determined to be between 12.1% and 12.5% including LULUCF, with an uncertainty of 8.9% introduced into the trends. Excluding LULUCF reduced the overall uncertainty to 5.7%-6.4% with the trend uncertainty dropping to 4.4%.

ES1.7 Quality control and quality assurance

In accordance with IPCC requirements, the national GHG inventory preparation process must include quality control and quality assurance (QC/QA) procedures. For the 2000-2022 National Inventory, quality checks were completed at four different levels, namely (a) inventory data (activity data, EF data, uncertainty, and recalculations), (b) database (data transcriptions and aggregations), (c) metadata (documentation of data, experts and supporting data), and (d) inventory report.

ES1.8 Completeness of the national inventory

The South African GHG emission inventory for the period 2000 – 2022 is not complete, mainly due to the lack of sufficient data. This chapter provides information on the completeness of the inventory in terms activities that are not estimated (NE), included elsewhere (IE) or that is not occurring (NO) within the South African jurisdiction.

ES1.9 Uncertainty analysis

South Africa has conducted uncertainty analysis for the inventory. A trend uncertainty between the base year and 2022, as well as a combined uncertainty of activity data and emission factor uncertainty was determined using an Approach 1. The total uncertainty for the inventory was determined to be between 11.9.% and 12.3%, including LULUCF, with a trend uncertainty of 8.8%. Excluding LULUCF reduced the overall uncertainty to between 5.7% and 6.4%, with the trend uncertainty reduced to 4.5%.

ES1.10 Improvement plan

The main challenge in the compilation of South Africa's GHG inventory remains the availability of specific-activity and emission factor data. The DFFE is in the process of implementing the National Greenhouse Gas Improvement Programme (GHGIP). The programme consists of a series of sector-specific projects that will result in improvements in activity data, country-specific methodologies and emission factors used in the most significant sectors.

ES1.11 Supplementary information to facilitate tracking progress on implementation and achievement of South Africa's NDC

South Africa's updated NDC outlines a framework for tracking progress on emission reductions in accordance with information for Clarity, Transparency and Understanding. Progress will be assessed by comparing emissions in 2025 and 2030 with annual data from South Africa's Greenhouse Gas (GHG) inventory, excluding emissions from natural disturbances in the land sector. Emissions from natural disturbances will be reported separately in the NIR by sector (Forest lands, Grasslands, Wetlands, Settlements) and disaggregated by relevant IPCC categories. The methodology for estimating these emissions is described in detail in the NIR. The uncertainty around separating wildfires from controlled fires due to data limitations is noted.

ES.2 INFORMATION NECESSARY TO TRACK PROGRESS MADE IN IMPLEMENTING AND ACHIEVING NATIONALLY DETERMINED CONTRIBUTIONS UNDER ARTICLE 4 OF THE PARIS AGREEMENT

This chapter provides information to report on South Africa's progress in implementing and achieving the country's NDC under Article 4 of the Paris Agreement. This includes providing information on national circumstances, institutional arrangements, and the metrics and methodologies used for tracking progress. Furthermore, information about mitigation policies and measures (PAMs), along with the resulting greenhouse gas (GHG) emission reductions or removals, is reported on.

This reporting explains how South Africa's efforts contribute to the global goal of limiting temperature increases under the Paris Agreement, while also enhancing transparency by facilitating consistent reporting that allows stakeholders to understand the effectiveness of the country's actions to reduce GHG emissions. It promotes accountability by holding the country responsible for her climate commitments through reporting on efforts and outcomes, and contributes to the Global Stocktake process, which assesses collective progress toward the long-term goals of the Paris Agreement.

ES2.1 National circumstances and institutional arrangements

Since 2013, the nation has endured extended and severe droughts, as well as destructive flash floods in multiple areas. The interplay between South Africa's challenging climatic conditions and its socio-economic struggles highlights the intricate relationship between environmental changes and the nation's development trajectory. South Africa faces persistent challenges of high unemployment, poverty, and inequality, which are deeply entrenched in its socio-economic fabric. Between 2017 and 2022, the population grew from 56.52 million to 62.02 million, with Gauteng accounting for the largest share and the Free State the smallest. An unemployment rate exceeding 30%, especially among the youth, coupled with a substantial portion of the population living in poverty, underscores the country's struggle with low economic mobility and widening income disparities. These socio-economic issues are further aggravated by slow economic growth, which deepens the divide and limits opportunities for development.

This economic vulnerability is mirrored in South Africa's environmental challenges, where the country's reliance on high-emission exports, such as vehicles, Platinum Group Metals, coal, and petroleum products, positions it as a major net exporter of GHG emissions, despite relatively low domestic GHG emissions from goods and services. The energy sector, critical to the economy for job creation and value addition, remains heavily dependent on fossil fuel-based systems, notably coal and diesel thermal power generation. As a result, South Africa records the highest per capita carbon dioxide (C02) emissions in Africa, with its energy consumption per unit of GDP approximately 50% higher than the global average. Recognizing the dual challenges of socio-economic inequality and climate vulnerability, the South African government remains committed to stabilizing GHG concentrations and limiting global average warming to below 2°C above pre-industrial levels. However, the country's reliance on fossil fuels, sprawling cities, and limited public transport infrastructure complicates its transition to a low-carbon economy, threatening future economic growth and job creation. To address worsening climate impacts while alleviating poverty and improving well-being, South Africa is encouraged to invest in green technologies, paving the way for sustainable economic transformation.

ES2.2 Legal arrangements for mitigation

South Africa has established robust legal and institutional arrangements for the Measurement, Reporting, and Verification (MRV) of GHG emissions to track its NDC implementation, supported by the Presidential Climate Commission (PCC). The PCC oversees a just transition to a low-emissions, climate-resilient economy, engaging various stakeholders to ensure the NDC implementation aligns with just transition principles. The DFFE is mandated by the National Environmental Management: Air Quality Act to coordinate and manage national environmental policies, including climate change-related information and National GHG Inventories through the NGHGIS. The Climate Change Mitigation and Specialist Monitoring Services Chief Directorate oversees these inventories, while the International Climate Change Relations and Reporting Chief Directorate handles UNFCCC submissions. Mitigation efforts involve Sectoral Emissions Targets (SETs) for public sectors and Carbon Budgets for industry, with a framework for coordination across government levels, making these measures legally enforceable under the Climate Change Act 22 of 2004. The verification process for the Carbon Tax regime is also supported by the DFFE.

The DFFE has historically collected data for GHG emission inventories from various sectors, supported by the National Greenhouse Gas Emission Reporting Regulations (NGERs) to ensure accurate and consistent national GHG inventories. To facilitate industry compliance with GHG reporting, the DFFE developed the South African Greenhouse Gas Emissions Reporting System (SAGERS), managed by the Climate Change Mitigation and Specialist Monitoring Services Unit.

ES2.3 Cross-cutting institutional arrangements for climate response

The South African Climate Change Information System (NCCIS) is a web-based platform that tracks and enhances the country's progress towards climate resilience and a low carbon economy, offering decision support tools and a database of adaptation and mitigation actions. Managed by DFFE Climate Change Mitigation and Specialist Monitoring Services, it relies on national, provincial, and local data-collection systems to provide accurate and up-to-date information across themes like Climate Information, Climate Services, Tracking and Evaluation, and the Carbon Sinks Atlas.

The South African Weather Service updates climate data on the Climate Information Portal (CIP) and National Hazardous Events Database (NHED), while the DFFE Climate Change Mitigation and Specialist Monitoring Services Unit updates the National Climate Change Response Database. Future plans include integrating data from Provincial Climate Change Response Databases (PCCRD) to the national system, with potential for local municipality data to filter through to the PCCRD and then to the national system.

The T&E Portal, a sub-module of the NCCIS, tracks South Africa's progress towards NDC goals and commitments, and financial data is managed by the DFFE in collaboration with National Treasury and other stakeholders. The Climate Change

Monitoring and Evaluations System produces communication materials on South Africa's climate actions, which are shared with the Climate Change Development and International Mechanisms Directorate for the Biennial Transparency Report.

ES2.4 Description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates

South Africa has set economy-wide goals to reduce GHG emissions, targeting 398-510 million tonnes of CO_2-eq by 2025 and 350-420 million tonnes by 2030, without using reference points or baselines. The NDC is structured into two five-year periods (2021-2025 and 2026-2030) and covers sectors like Energy, IPPU, AFOLU, and Waste, excluding emissions from natural disturbances. The NDC aligns with the 2017 National Inventory Report. While South Africa hosts Clean Development Mechanism projects, the country presently does not engage in cooperative approaches under Article 6 of the Paris Agreement.

ES2.5 Information necessary to track progress made in implementing and achieving South Africa's nationally determined contribution under Article 4 of the Paris Agreement

The indicator selected to track progress of the NDC under Article 4 is South Africa's total GHG emissions and removals, including those from LULUCF. This total excludes emissions due to natural disturbances from wildfires and deadwood in the land sector. The NDC target and indicator are expressed in absolute terms. The 2022 NIR provides the basis for the accounting methodology. Coverage is economy-wide, including the land sector, and encompasses the gases CO_2, CH_4, N_2O, HFCs, and PFCs. The GWP metrics from the IPCC's 5th Assessment Report have been used. The Energy, IPPU, AFOLU, and waste sectors are covered. The methodologies, as per the 2022 NIR, align with UNFCCC guidelines and follow the 2006 IPCC Guidelines for National GHG Inventories, IPCC Good Practice Guidance, and the 2019 Refinement to the 2006 IPCC Guidelines. The indicator values for 2021 and 2022 have been reported. These values exceed the lower bound but remain below the upper bound of the 2025 target, indicating progress towards achieving the 2025 target. However, the values also surpass both the lower and upper bounds of the 2030 target, highlighting the need for significantly increased mitigation efforts to meet the 2030 target. Meeting the 2025 and 2030 targets is based on the assumption that the Paris Agreement will be fully implemented, and that support will be provided for the implementation of the specified targets and goals for mitigation, adaptation, and loss and damage.

ES2.6 Mitigation policies and measures, actions and plans, related to implementing and achieving a nationally determined contribution under Article 4 of the Paris Agreement

South Africa adhered to the guidance provided in the Climate and Development Knowledge Network Planning for NDC Implementation Guide to compile a short-list of existing PAMs that support the implementation and achievement of the NDC under Article 4. A total of 28 prioritized PAMs have been identified, including seven that are cross-cutting, nine focused on the energy sector, three targeting the transport sector, one addressing the IPPU sector, six related to the AFOLU sector, and two pertaining to the waste sector. (see figure below). Developing the short-list of PAMs involved two main steps: first, identifying PAMs, and second, prioritizing these PAMs. The PAMs was informed by several factors. Firstly, PAMs that cover the IPCC categories of emissions sources and sinks were considered. Secondly, national and sub-national PAMs that are most likely to have a significant impact on South Africa's current and expected GHG emissions were taken into account. Lastly, PAMs for which mitigation techniques and technologies have been prioritized, piloted, or implemented were included, with information provided by mitigation potential analysis studies. The prioritization of PAMs to a shortlist was informed by consideration of the resources, time and practical constraints that do not allow for the monitoring of all identified PAMs. The Multi-Criteria Decision Analysis (MCDA) approach was used to further refine the list of PAMs.

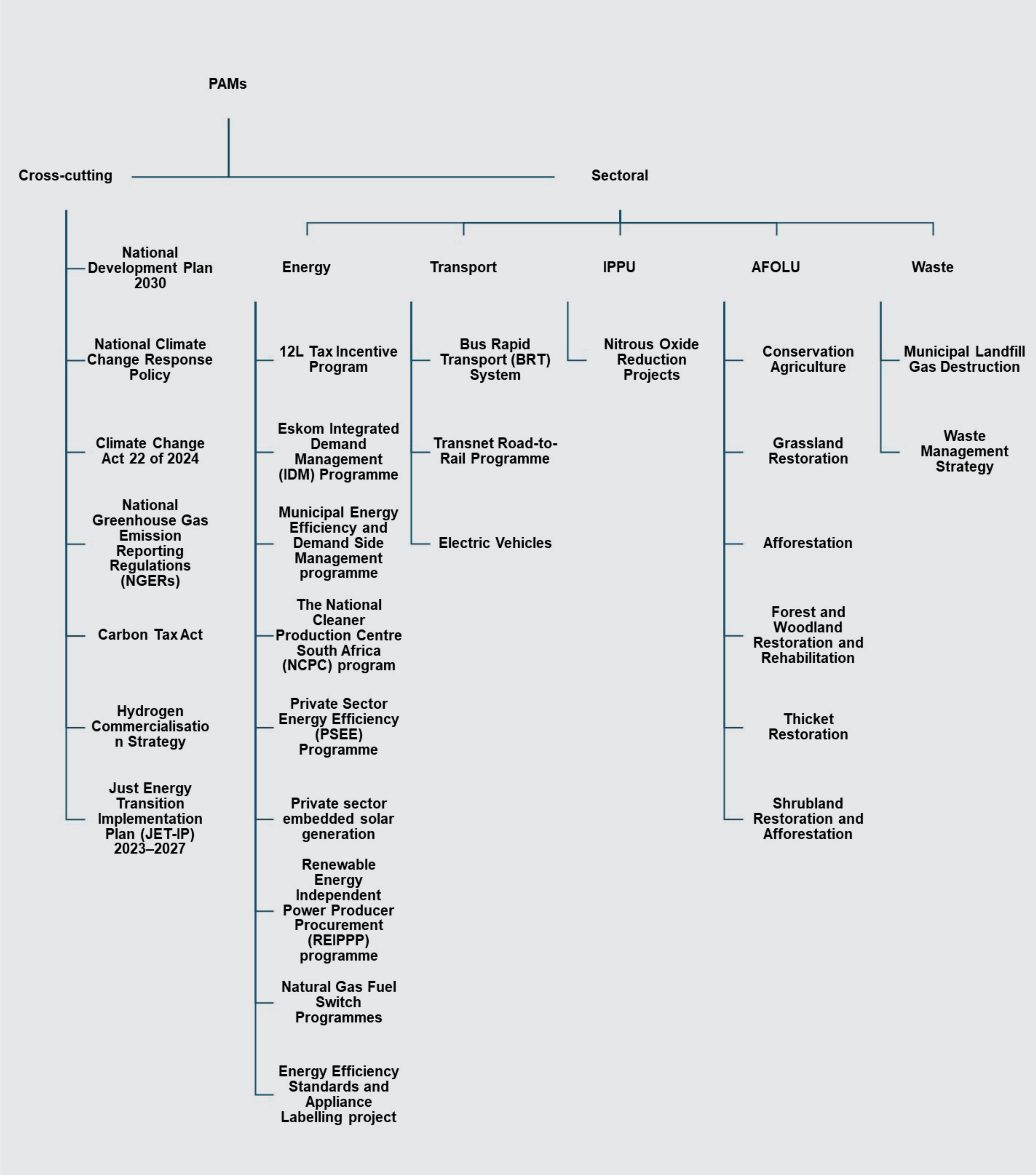


Figure ES 2.6.1 PAMs that support the implementation and achievement of South Africa's NDC under Article 4

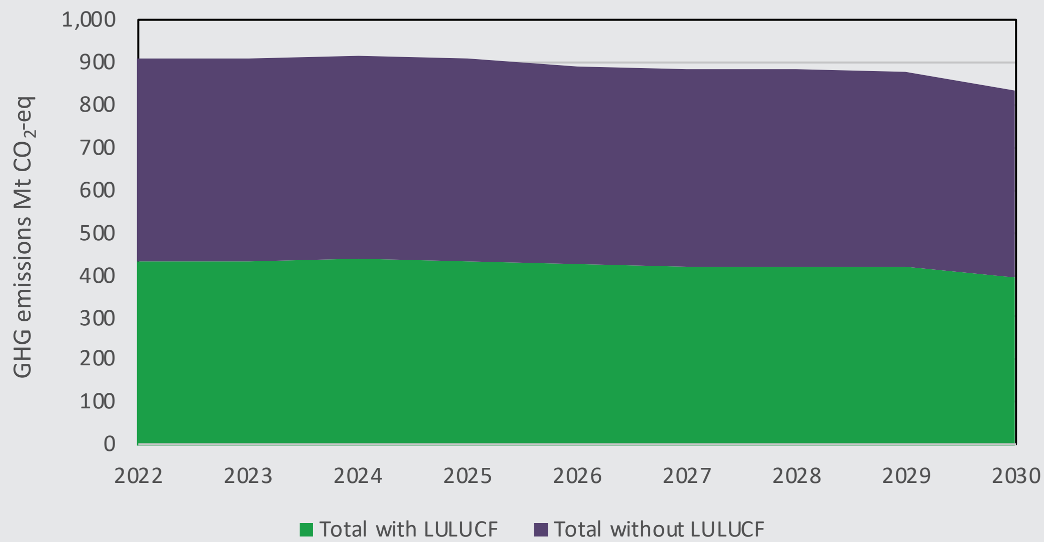
Four main drivers have influenced the long-term trends in GHG emissions. Firstly, the lower costs of renewable energy technology have boosted mitigation efforts in the electricity sector. Secondly, there is a decreased demand for liquid fuels due to improved efficiency, changes in transportation methods, and the rise of fuel cell and electric vehicles. Thirdly, slower economic growth has led to reduced industrial activity and energy consumption. Lastly, an improved understanding of South Africa's land-based sequestration capabilities has revealed that past estimations of removals in the land sector were underestimated. Most of the short-listed PAMs impact GHG emissions and removals in the short-term. The instruments provisioned in the Climate Change Act 22 of 2024 including sectoral emission targets and carbon budgets are orientated to steer sectors to make transformative changes for achieving long-term reductions of GHG emissions.

No aggregated analysis of the GHG emission reductions due to each PAM is reported in this BTR. Emission reduction information is gathered from secondary data sources that either report on emission savings directly or provide activity data used to calculate the reductions. These data sources lack sufficient information regarding the methods used to calculate either the emission savings or the activity data. Furthermore, there are different calculation methodologies applied in the case of different PAMs. For these reasons, the verification and standardisation of the quantified emission reductions could not be carried out which can help with aggregation analysis.

Data collection and reporting of activity data and emission savings is hindered by a number of factors, including no formal arrangement existing between DFFE and data providers, the high cost of membership fees required for DFFE to access data, the frequent turnover of professional staff leading to personnel shortages, delays in report approvals affecting the timing and availability of data for certain PAMs, and the need for additional capacity-building support to prepare data for reporting under the ETF.

ES2.7 Summary of greenhouse gas emissions and removals

South Africa has projected GHG emissions for the 2023–2030 period under a 'with measures' scenario but has not identified this as its baseline. Reporting on the 'with additional measures' and 'without measures' scenarios is not mandatory and is therefore excluded from this BTR. Projections, including LULUCF, are shown in the figure below. Using flexibility provisions under paragraph 95 of the MPGs, South Africa reports projections up to the NDC endpoint of 2030. While GHG emission modelling was completed in February 2024, the analysis is ongoing as part of developing sectoral mitigation plans, which involve consultations with ministerial heads and stakeholders. Due to the later timeline for these plans, detailed modelling outputs and sectoral findings will be included in BTR3, scheduled for submission in 2028.



ES 2.7.1: A 'with measures' Projection of Greenhouse Gas Emissions and Removals 2023- 2030 and including inventory values for preceding years 2014 -2022

The GHG emission projections are an output of the DFFE Integrated Climate Change Mitigation Model. The model uses historical data and assumptions to project South Africa's GHG emissions up to 2050. It incorporates various studies and models, including the Mitigation Potential Analysis and the Policies and Measures model, to update historical data and assumptions. The model employs a bottom-up approach, using two linked economic models to estimate emissions and assess socio-economic impacts of mitigation strategies. Additionally, it integrates population projections aligned with the United Nations' data to provide comprehensive insights for policymakers on the economic and environmental implications of different energy pathways.

ES.3 INFORMATION RELATED TO CLIMATE CHANGE IMPACTS AND ADAPTATION UNDER ARTICLE 7 OF THE PARIS AGREEMENT

This chapter on Climate Change Impacts and Adaptation offers a comprehensive overview of South Africa's efforts to respond to the escalating challenges posed by climate change. Although this chapter is not mandatory for reporting in the first Biennial Transparency Report (BTR), South Africa has chosen to include this aspect as adaptation presents a key priority for the country to effectively address the challenges posed by climate change and build resilience in vulnerable communities. The primary objective of the adaptation chapter in the BTR1 is to report on South Africa's climate change impacts, vulnerabilities, adaptation; progress and efforts to address these, including domestic and international support received and mobilisation of resources; and the international support required for South Africa's climate change adaptation response to effectively reduce impacts, vulnerabilities and strengthen resilience. This chapter therefore provides a comprehensive picture of the country's efforts towards climate change response and the progress towards expected outcomes. As a developing country with significant reliance on climate-sensitive sectors, particularly agriculture, water resources, and biodiversity, South Africa has recognized the urgency of adaptation as integral to its development goals.
The Climate Change Adaptation Chief Directorate within the Department of Forestry, Fisheries, and the Environment (DFFE) plays a pivotal role in leading South Africa's climate change adaptation efforts. It is responsible for developing, coordinating, and implementing national climate adaptation policies, strategies, and plans, ensuring alignment with both national development goals and international climate agreements such as the Paris Agreement. The Chief Directorate facilitates cross-sectoral collaboration among various government departments, research institutions, civil society, and the private sector to promote adaptive capacity and resilience across all levels of government. It also oversees the monitoring and evaluation of adaptation initiatives, ensuring that progress is tracked and reported in accordance with the National Climate Change Adaptation Strategy (NCCAS) and other regulatory frameworks, thereby fostering a coordinated and effective national response to climate change impacts. South Africa's recently enacted Climate Change Act (2024) is a significant legal framework guiding South Africa's transition to a low-carbon, climate-resilient economy. The Act provides mechanisms for both mitigation and adaptation, defining roles for government departments to coordinate climate actions.

South Africa is experiencing significant climate shifts, with temperatures rising at 1.5 times the global average, leading to more frequent and severe extreme weather events, including droughts, floods, and heatwaves. The country is highly vulnerable to these changes, which have profound effects on critical sectors such as agriculture, water resources, health, biodiversity, and infrastructure. The agricultural sector is highly vulnerable to changes in temperature and precipitation patterns, resulting in reduced crop yields, increased pest outbreaks, and livestock productivity losses. Water resources are at risk due to heightened variability in rainfall, more frequent droughts, and declining water quality, threatening supply for human consumption, agriculture, and industry. The health sector faces heightened risks from climate-induced diseases, heat stress, and food and water insecurity, which disproportionately affect vulnerable communities. Biodiversity is threatened by habitat loss, shifting species distributions, and increased frequency of extreme weather events, which disrupt ecosystems and reduce resilience. Infrastructure, including transport, energy, and coastal developments, is increasingly exposed to damage from flooding, storm surges, and sea-level rise, necessitating significant adaptation efforts to safeguard socio-economic stability and development.

South Africa's adaptation response to sectoral risks and vulnerabilities is anchored in a comprehensive and integrated approach that aligns with the National Climate Change Adaptation Strategy (NCCAS). The country emphasizes cross-sectoral coordination, stakeholder engagement, and community participation to ensure that adaptation actions are inclusive, locally relevant, and effectively implemented across all levels of governance. Acknowledging the crucial role of gender and indigenous knowledge, South Africa's adaptation framework actively promotes the inclusion of women in decision-making processes and leverages indigenous knowledge systems (IKS) to enhance community-based adaptation. Integrating traditional practices and local knowledge, particularly from marginalized communities, remains an important yet pending step for the country. By incorporating these insights, adaptation strategies can become more culturally relevant, effective, and sustainable, ensuring inclusivity and equitable benefits in climate resilience efforts.

South Africa has made significant strides in climate adaptation through a combination of mechanisms, strategies, and policies with clear objectives on adaptation aimed at enhancing resilience across various sectors. However, key barriers to effective adaptation still remain, and include financial constraints and a shortage of skilled personnel, particularly in local governments. Overcoming these barriers is essential for fully realizing South Africa's adaptation goals.

The establishment of the National Climate Change Information System (NCCIS) marks a critical step in tracking progress on adaptation actions. The system is intended to support monitoring, evaluation, and reporting on adaptation strategies, contributing to greater transparency and accountability in South Africa's climate change response.

South Africa is facing considerable loss and damage from climate change, particularly through extreme events such as floods, droughts, and heatwaves. These impacts have resulted in damage to infrastructure, decreased agricultural productivity, water shortages, and heightened health risks. In response, South Africa has made progress in developing a framework to assess and manage loss and damage through various research initiatives and collaborations. Funding has been allocated to enhance reporting on climate disaster impacts and to address existing data gaps. Additionally, a National Dialogue is underway to enhance knowledge on addressing loss and damage, improve access to support mechanisms such as finance, technology, and capacity-building, and strengthen dialogue and coordination among stakeholders for a more integrated response.

This chapter underscores the urgency of advancing South Africa's adaptation efforts to safeguard its people, ecosystems, and economy. By focusing on sectoral vulnerabilities, strengthening legal frameworks, and enhancing institutional collaboration, the country is working towards building a climate-resilient society. However, sustained financial investment and capacity-building are crucial for the long-term success of these initiatives.

ES.4 INFORMATION ON FINANCIAL, TECHNOLOGY DEVELOPMENT AND TRANSFER AND CAPACITY-BUILDING SUPPORT NEEDED AND RECEIVED UNDER ARTICLES 9–11 OF THE PARIS AGREEMENT

The chapter provides an update from the previous Biennial Update Reports (BURs) on financial, capacity and technical support received and needed by South Africa between 1 Jan 2021 and 31 Dec 2022. The chapter presents an overview of international climate-related finance received and needed, and capacity building and technology development and transfer support received and needed within the reporting period.

South Africa's national circumstances are described in the context of the climate finance landscape and institutional arrangements relevant to reporting on financial, technology and capacity building support needed and received. Tools and/or assessments to track and report support needed and received include the Climate Finance Landscape Analysis, the Climate Budget Tagging (CBT) system, the Green Finance Taxonomy, and the JET Projects' Register.

The institutional arrangements relevant to reporting on financial, technology and capacity support needed and received are described in terms of data providers and the flow of information from various directorates within the DFFE who are responsible for outputs to the United Nations Framework Convention on Climate Change (UNFCCC), viz. National Communications, Biennial Transparency Reports and Nationally Determined Contributions.

South Africa's climate finance needs are informed by the revised targets proposed in South Africa's revised NDC lodged with the UNFCCC in 2021, as well as on the Just Transition Investment Plan (JET IP) (2023-2027). Investments are needed in three priority sectors: electricity, New Energy Vehicles (NEVs), and Green Hydrogen (GH_2). More specifically, investment is needed in our electricity transmission and distribution networks and dramatically expanding renewable energy generation, as well as investment in local production of green hydrogen and electric vehicles and investing in local economies to develop skills and enable economic diversification. Further investments are needed in two cross-cutting areas: skills development and municipalities.
The international financial support received and committed (grants, loans, and equity) were provided in Section 4.4. Over the reporting period for 2021 and 2022, South Africa has received significant financial support for climate change action, including over USD $816.9 million in bilateral assistance and USD $10.7 million from multilateral sources aimed at supporting and/or benefiting efforts to address climate change in the country.

Technology support needed and received from international donor funding sources are described in terms of the Just Energy Transition (JET). Capacity-building support needed is outlined in terms of capacity needs for Climate Budget Tagging; for the JET Skills Implementation Plan, and for gender-climate mainstreaming. Capacity building support received from the developed countries is also provided. South Africa received multilateral financial support from the Global Environment Facility (GEF) as part of the Capacity Building Initiative for Transparency (CBIT) Project for South Africa, and this included support for the compilation of the BTR1. South Africa also received multilateral financial support from the GEF as part of GEF Expedited Enabling Activity (EEA) for South Africa for the preparation of its initial Biennial Transparency Report to the UNFCCC (current report).

TABLE OF CONTENTS

01 NATIONAL INVENTORY REPORT OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES

02 INFORMATION NECESSARY TO TRACK PROGRESS MADE IN IMPLEMENTING AND ACHIEVING NDCS UNDER ARTICLE 4 OF THE PARIS AGREEMENT

03 INFORMATION RELATED TO CLIMATE CHANGE IMPACTS AND ADAPTATION UNDER ARTICLE 7 OF THE PARIS AGREEMENT

List of Figures

List of Tables

List of Abbreviations

ABBREVIATION	NAME
ADZs	Aquaculture Development Zones
AFOLU	Agriculture, Forestry and Other Land Use
BMA	Biodiversity Management Agreements
BMP	Biodiversity Management Plan
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CBIT	Capacity Building Initiative for Transparency
CBT	Climate Budget Tagging
CCAMP	Climate Change Adaptation and Mitigation Plan
CCAQM	Climate Change Air Quality Management
CCD&IM	Climate Change Development and International Mechanisms
CCRS	Climate Change Response (Adaptation and Mitigation) Strategy
CDD	Consecutive dry days
CGE	Consultative Group of Experts
CH_4	Methane
CHASA	Climate and Health Alliance of South Africa
CHBS	Climate-Based Health Services Project
CHP	Combined Heat and Power
CMIP6	Coupled Model Intercomparison Project Phase 6
CO	Carbon monoxide
CO_2	Carbon dioxide

ABBREVIATION	NAME
CO_2e	Carbon dioxide equivalent
COL	Cut-off-low
COP	Conference of the Parties
CRT	Common Reporting Table
CRF	Concentration Response Function
CRU	Climatic Research Unit
CRV	Climate Risk and Vulnerability
CSA	Climate Smart Agriculture
CSIR	Council for Scientific and Industrial Research
CSP	Country Strategy Paper
CTF	Common Tabular Formats
CWD	Consecutive wet days
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
DARDLEA	Department of Agriculture, Rural Development, Land and Environmental Affairs
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
DFFE	The Department of Department of Forestry, Fisheries and the Environment
DFFE-ACF	DFFE Adaptive Capacity Facility
DMRE	Department of Mineral Resources and Energy
DoE	Department of Energy

ABBREVIATION	NAME
DOH	Department of Health
DPME	Department of Planning, Monitoring and Evaluation in the Presidency
DSI	Department of Science and Innovation
DTI	Department of Trade and Industry
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EbA	Ecosystem-Based Adaptation
EEP	Energy Environment Partnership
EF	Emission factor
ENSO	El Niño–Southern Oscillation
FAW	Fall armyworm
F-gases	Fluorinated gases: e.g., HFC, PFC, SF_6 and NF_3
FOLU	Forestry and Other Land Use
FSA	Forestry South Africa
GAP	Gender Action Plan
GBF	Global Biodiversity Framework
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GFT	Green Finance Taxonomy
Gg	Gigagram
GHG	Greenhouse gas
GHS	General Household Survey
GIS	Geographic Information Systems

ABBREVIATION	NAME
GPG	Good Practice Guidance
GWLs	global warming levels
GWP	Global warming potential
IPG	International Partner Group
HFC	Hydrofluorocarbons
HWP	Harvested wood products
HySA	Hydrogen South Africa
ICAT	Initiative for Climate Action Transparency
IDP	Integrated Development Plans
IKS	Indigenous Knowledge Systems
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IRP	Integrated Resource Management Plan
ISIMIP	Inter-Sectoral Impact Model Intercomparison Project
ISO	International Organization for Standardization
IWRM	Integrated Water Resource Management
JET IP	Just Energy Transition Implementation Plan
KCA	Key category analysis
L&D	Loss and Damage
LC	Land cover
LEDS	Low Emissions Development Strategy
LPG	Liquefied petroleum gas
LULUCF	Land Use, Land Use Change and Forestry

ABBREVIATION	NAME
M&E	Monitoring and Evaluation
MH-EWS	Multi-hazard Early Warning System
MSPF	Marine Spatial Planning Framework
MTSF	Medium-Term Strategic Framework
MURP	Municipal Risk Pooling
MWH	Megawatt hours
MWTP	Municipal wastewater treatment plant
N_2O	Nitrous oxide
NAEIS	National Atmospheric Emissions Inventory System
NAP	National Adaptation Plan
NBSAP	National Biodiversity Strategy and Action Plan
NCCARA	National Climate Change Adaptation Research Agenda
NCCAS	National Climate Change Adaptation Strategy
NCCHAP	National Climate Change and Health Adaptation Plan
NCCIS	National Climate Change Information System
NCCMR&E Framework	National Climate Change Monitoring and Evaluation System Framework
NCCRD	National Climate Change Response Database
NCCRP	National Climate Change Response Policy
NCCRS	National Climate Change Response Strategy
NCV	Net calorific value
NDC	Nationally Determined Contribution
NDMC	National Disaster Management Centre

ABBREVIATION	NAME
NDMF	National Disaster Management Framework
NDP	National Development Plan
NE	Not estimated
NEMBA	National Environmental Management: Biodiversity Act
NEV	New Energy Vehicles
NFCS	National Framework for Climate Services
NGHGIS	National Greenhouse Gas Inventory System
NICD	National Institute for Communicable Diseases
NMVOC	Non-methane volatile organic compound
NO	Not occurring
NOx	Oxides of nitrogen
NQF	National Qualifications Framework
NT	National Treasury
NTCSA	National Terrestrial Carbon Sinks Assessment
NTCSP	National Treasury Cities Support Programme
OECM	Other Effective Area-Based Conservation Measures
PCC	Presidential climate commission
PFC	Perfluorocarbons
PGM	Platinum group metals
QA/QC	Quality assurance/quality control
r20mm	count of extreme rainfall days which is used for events that potentially lead to floods

ABBREVIATION	NAME
REIPPPP	Renewable Energy Independent Power Producer Procurement Program
RSA	Republic of South Africa
SAAQIS	South African Air Quality Information System
BTR1	South Africa's First Biennial Transparency Report
SADC	Southern African Development Community
SAGERS	South African GHG Emissions Reporting System
SAMA	South African Medical Association
SAMRC	South African Medical Research Council
SANBI	South African National Biodiversity Institute
SAPIA	South African Petroleum Industry Association
SAR	Second Assessment Report
SAREM	South African Renewable Energy Master Plan
SARVA	South African Risk and Vulnerability Atlas
SAWS	South African Weather Service
SDG	Sustainable Development Goals
SF_6	Sulphur hexafluoride
SOC	Soil organic carbon
SPEI	Standardized precipitation index
SPLUMA	Spatial Land Use Management Act
SSPs	Shared Socioeconomic Pathways
Stats SA	Statistics South Africa
SUDS	Sustainable Urban Drainage Systems

ABBREVIATION	NAME
SWID	Severe Weather Impact Database
TAR	Third Assessment Report (IPCC)
TNA	Technology Needs Assessment
TM	Tier method
Txx	Maximum daytime temperature
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UBPL	Upper-bound poverty line
WCWDM	Water Conservation and Water Demand Management
WCWDMS	Water Conservation and Water Demand Management Strategy
WfW	Working for Water
WMO	World Meteorological Organisation

01

NATIONAL INVENTORY REPORT OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES

1. National inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases

1.1 INTRODUCTION

This chapter presents a summary of the National Greenhouse Gas (GHG) Inventory for South Africa prepared for the year 2022. It also reports on the GHG trends for the period 2000 to 2022. The inventory was compiled in accordance with the Intergovernmental Panel on Climate Change (IPCC) 2006 guidelines for Inventories, IPCC Good Practice Guidance (GPG) (IPCC, 2000; IPCC, 2003; IPCC, 2014) and the 2019 Refinement to the 2006 IPCC Guidelines (IPCC, 2019).

The 2000-2022 National GHG Inventory for South Africa covers sources of GHG emissions and removals by sinks, resulting from human (anthropogenic) activities for the major GHGs: carbon dioxide (CO_2), methane (CH_4), nitrogen dioxide (N_2O), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs). The indirect GHGs: carbon monoxide (CO), nitrous oxides (NO_X) and non-methane volatile organic compounds (NMVOCs) are also included for biomass burning, with some information on sulphur hexafluoride (SF6) also included. The gases are reported under five sectors: *Energy*; *Industrial Processes and Product Use* (*IPPU*); *Agriculture, Land Use, Land Use Change and Forestry (LULUCF)* and *Waste*, and a summary is contained in Table 1.6.

1.2 NATIONAL CIRCUMSTANCES

1.2.1 Background information on GHG inventories

The Republic of South Africa ratified the UNFCCC in August 1997. South Africa submitted its first national GHG inventory in 1998 (Van der Merwe & Scholes, 1998) using 1990 data, and was subsequently published the 2004 national GHG inventory using data for 1994. These inventories were developed using the 1996 IPCC Guidelines for National Greenhouse Gas Inventories. The national GHG inventory that followed for 2000 (DEAT, 2009) used the 2006 IPCC Guidelines (IPCC, 2006). Subsequently, the 2014 the GHG inventory for the years 2000 to 2010 (DEA, 2014), an update for 2011 and 2012 in 2017 (DEA, 2017), 2013 to 2015 in 2019 (DEA, 2019), 2017 in 2021 (DFFE, 2021), and for 2018, 2019 and 2020 in 2023 (DFFE, 2023) were compiled using the 2006 IPCC guidelines.

1.2.2 Global warming potentials

To allow for the integrated effect of emissions of the various gases to be compared, GHGs are converted to carbon dioxide equivalents (CO_2e). CO_2e using the 100-year global warming potentials (GWPs) from the 2014 IPCC Fifth Assessment Report (AR5). These GWPs Table 1.1 are following the Modalities, Procedures, and Guidelines (MPGs) for transparency framework for action and support, referred to in Article 13 of the Paris Agreement, used to comply with international reporting obligations under the UNFCCC.

Table 1.1. Global warming potential (GWP) of greenhouse gases used in 2000-2022 National GHG inventory and taken from AR5 (IPCC, 2014b).

Greenhouse gas	Chemical formula	AR5 GWP
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous oxide	N_2O	265
Hydrofluorocarbons (HFCs)		
HFC-23	CHF_3	12 400
HFC-32	CH_2F_2	677
HFC-125	CHF_2CF_3	3170
HFC-134a	CH_2FCF_3	1300
HFC-143a	CF_3CH_3	4 800
HFC-227ea	C_3HF_7	3350
HFC-365mfc	$C_4H_5F_5$	804
HFC-152a	CH_3CHF_2	138
Perfluorocarbons (PFCs)		
PFC-14	CF_4	6 630
PF-116	C_2F_6	11 100

In South Africa's National GHG Inventories prior to the 2000 – 2020 inventory were prepared using the IPCC Second Assessment Report (AR2) (IPCC, 1996) GWPs, whereas for the 2000-2022 National inventory the AR5 values as shown in Table 1.1 were used.

1.3 INSTITUTIONAL ARRANGEMENTS

1.3.1 National Entity

In South Africa, the Department of Forestry, Fisheries and the Environment (DFFE) is the central coordinating and policy-making authority with respect to environmental conservation. The work of the DFFE is underpinned by the Constitution of the Republic of South Africa (RSA) and all other relevant legislation and policies applicable to government to address environmental management, including climate change. The DFFE is mandated by the Air Quality Act (Act 39 of 2004) (RSA, 2004) to formulate, co-ordinate and monitor national environmental information, policies, programmes and legislation.

The DFFE as the lead climate institution is responsible for co-ordination and management of all climate change-related information, such as mitigation, adaptation, monitoring and evaluation programmes, including the compilation and update of National GHG Inventories. The Climate Change and Air Quality Chief Directorate is responsible for the management and co-ordination of GHG inventories at the DFFE (Figure 1.1).

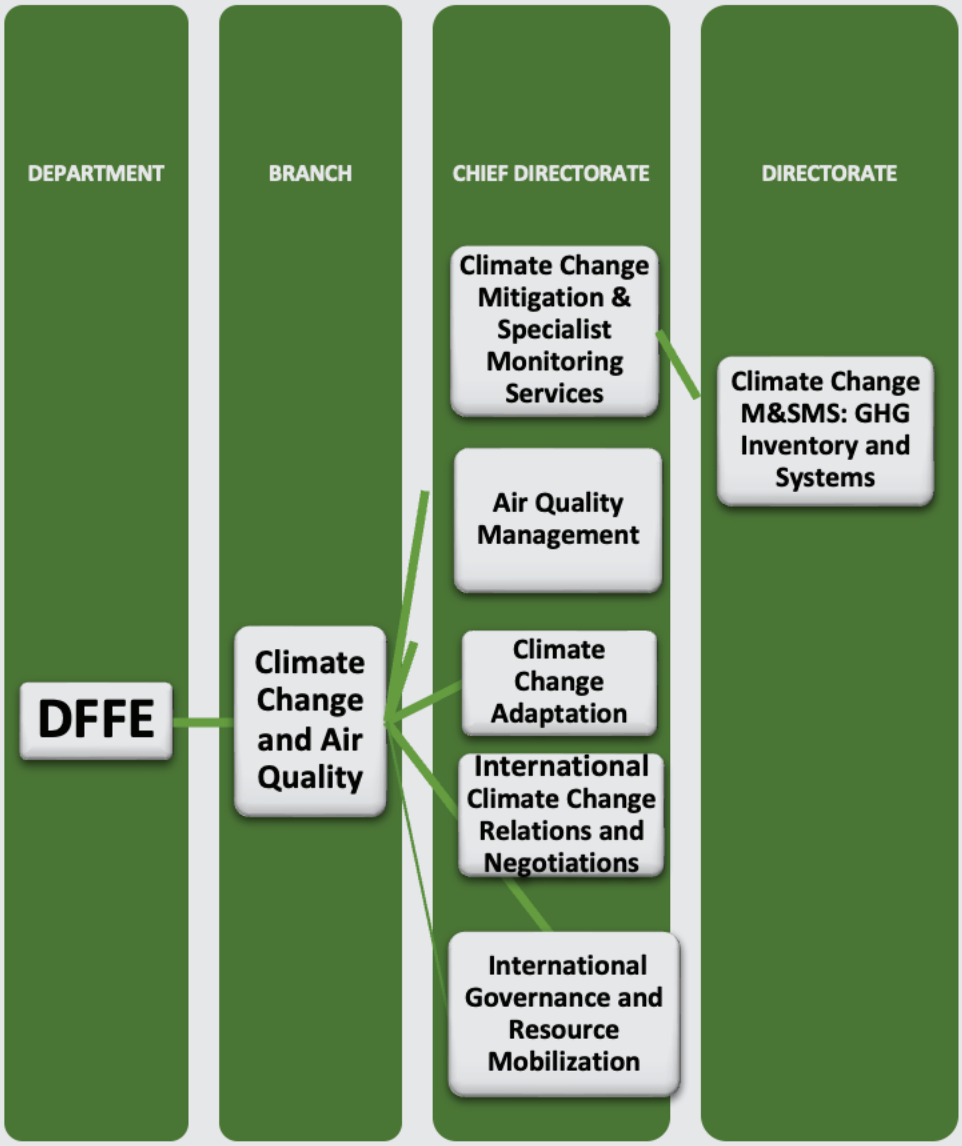


Figure 1.1: Organogram showing where the GHG Inventory compilation occurs within DFFE.

1.3.2 Legal Arrangements

The DFFE takes a lead role in the compilation, implementation and reporting of the national GHG inventories, whilst other relevant agencies and ministries play supportive roles in terms of data provision across relevant sectors. There are no formal agreements between the government departments for the provision of this data.

The National Greenhouse Gas Emission Reporting Regulations (NGERs) (DEA, 2017a), under Section 53(a), (o) and (p) read with section 12 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), in the Government Gazette of the 3rd April 2017, supports the collection of data for the energy and industrial sectors on a continuous basis in support of the maintaining the National GHG inventory, meeting UNFCCC reporting obligations and informing the formulation and implementation of legislation and policy.

The South African Greenhouse Gas Emissions Reporting System (SAGERS) which is the GHG module of the National Atmospheric Emissions Inventory System (NAEIS) further helps to facilitate the process of enabling Industry to meet its

GHG reporting requirements in a web-based secure environment and facilitates the data collection process for energy related activities and IPPU.

The inventory compilation process (Figure 1.2) is coordinated through a central web-based inventory management system (National GHG Information Management System (NGHGIS)).

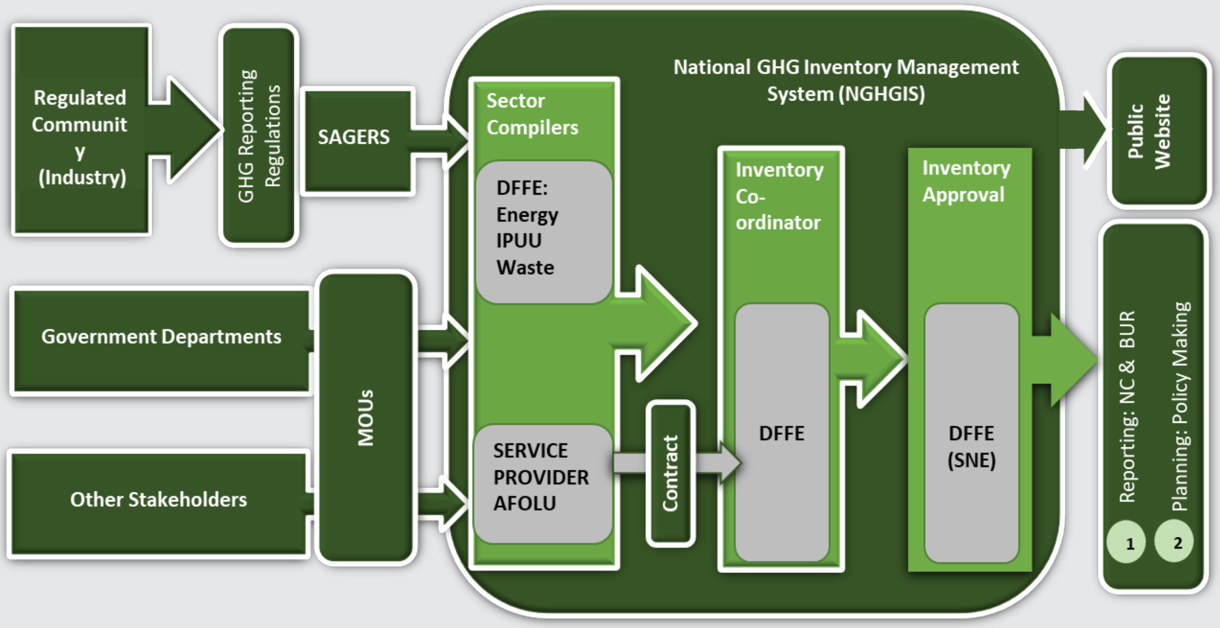


Figure 1.2: The inventory compilation process in South Africa.

1.4 INVENTORY MANAGEMENT AND INVENTORY PREPARATIONS

1.4.1 Inventory management

The management and coordination of the inventory programme, as well as compilation, publication and submission of the inventory are carried out by the Single National Entity (being the DFFE) in a centralised manner. The DFFE is currently responsible for collecting data, compiling and Quality Control (QC) of the Energy, IPPU, Agriculture and Waste sector inventories, while the LULUCF sector is compiled (in collaboration with DFFE) by external consultants (Gondwana Environmental Solutions (GES)) who are appointed via a formal project-based contract with the UNDP as part of the Capacity Building Initiative for Transparency (CBIT) project of South Africa. DFFE assists with the QC of the LULUCF sector. DFFE is also responsible for combining and compiling the overall inventory and compiling the draft National Inventory Report.

1.4.2 Inventory preparation

The stages and activities undertaken in the inventory update and improvement process are shown in Figure 1.3. The process for the 2000-2022 National Inventory Report began with a planning phase that included the setting of timelines and the preparation of templates for the inventory compilation. This was followed by the preparation phase. The collection phase was dedicated to data collection and preliminary processing, such as data cleansing, data checks and preliminary formatting for further use. The writing phase focused on the drafting of the inventory report and QC of the draft was completed. The draft document was then subjected to the public commenting process. During the finalization phase the archives were prepared and final Report approvals were obtained before being submitted to UNFCCC.

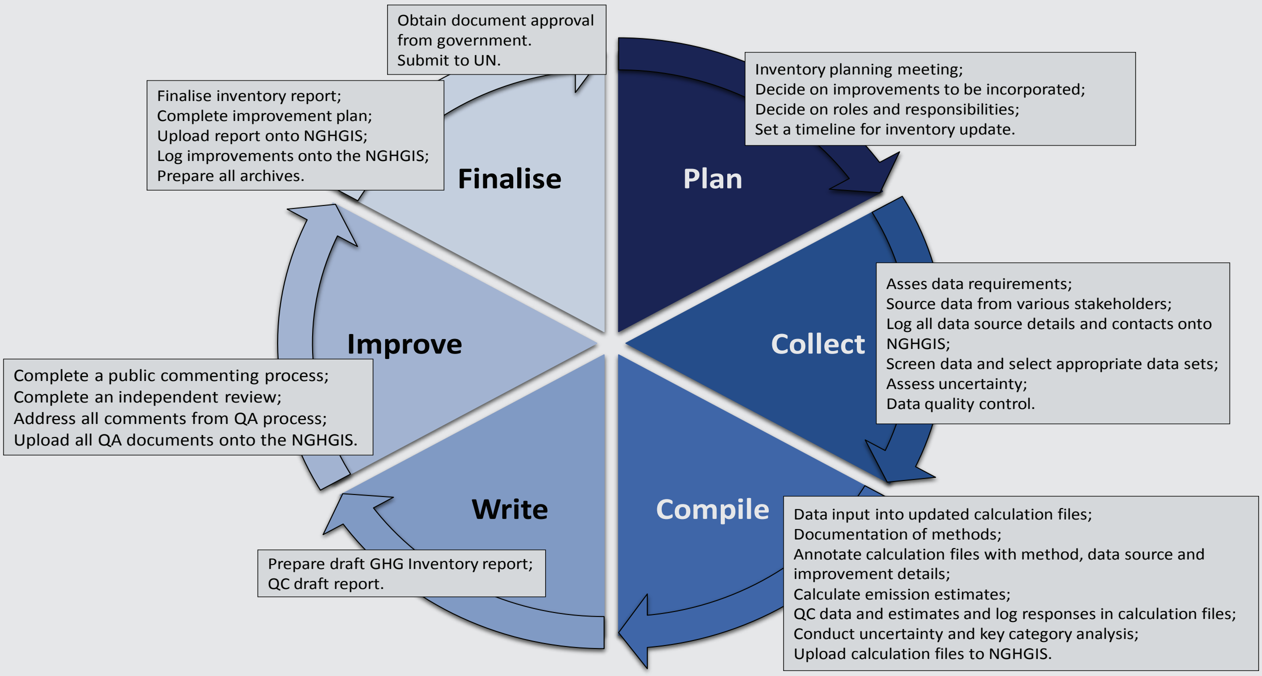


Figure 1.3: Overview of the phases of the GHG inventory compilation and improvement process undertaken for South Africa's 2020 GHG inventory.

1.4.3 Data collection, storage and archiving

1.4.3.1 Data collection

Data collection and documentation for the compilation of the GHG inventory takes place under the responsibility of the relevant experts. Three different processes are used to collect data for South Africa's inventory. The first is by obtaining data from government departments, institutes, companies, and organisations through an informal process, i.e. where data is obtained without any formal data collection agreements. The second is through the evaluation of publicly available data, official statistics, association statistics, studies, periodicals and third-party research projects. Most of the inventory data is collected using these two approaches, but for industry, South Africa has started to move towards a more formalised data collection system.

The NAEIS is an online reporting platform for air quality and GHG emissions from companies to manage the mandatory reporting of GHG emissions. Emissions information including activity data from the NAEIS serves as input data during the national inventory compilation process. DFFE has modified the NAEIS to meet the requirements of the NGERs (DEA, 2017a). This component of the portal, the SAGERS, serves as a tool for the implementation of the online registration and reporting by industry in fulfilment of mandatory NGERs. The key benefit of the portal is that it will enhance the data collection process for the inventory, therefore improving the quality of the national GHG inventories consistent with the requisite principles of completeness, consistency, accuracy, comparability, and transparency.

1.4.3.2 Data preparation and emission calculations

The process of data preparation and emissions calculation comprises the following steps:

a. Data entry
    - Data preparation (model formation, disaggregation, aggregation)
    - Calculation of emissions
    - Preparation of report sections (texts) and
    - Approval by the relevant experts.

Report texts are prepared along with the time series for activity data, emission factors, uncertainties, and emissions. As a result, the term "data" is understood in a broad sense. In addition to number data, time series, etc., it also includes contextual information such as the sources for time series, and descriptions of calculation methods, and it also refers to preparation of report sections for the NIR and documentation of recalculations.

After all checks have been carried out, and the relevant parties have been consulted where necessary, the emissions are calculated in excel by each sector lead based on the following principle:

$$\textit{activity data} * \textit{emission factor} = \textit{emission}$$

As much of the data as possible is included in the calculation files, but where larger data sets are referred to these are stored in the NGHGIS.

1.4.3.3 Data storage and archiving

The NGHGIS for South Africa assists in managing and storing the inventory related documents and processes through keeping records of the following:

- Stakeholder list with full contact details and responsibilities
- List of input datasets which are linked to the stakeholder list
- QA/QC plan
- QA/QC checks
- QA/QC logs which will provide details of all QA/QC activities
- All method statements
- IPCC categories and their links to the relevant method statements together with details of the type of method (Tier 1, 2 or 3) and emission factors (default or country-specific) applied
- Calculation and supporting files
- Key references
- Key categories; and
- All inventory reports.

1.5 BRIEF DESCRIPTION OF METHODS AND DATA

The methods used for the individual categories are outlined in the sector overview sections in each of the sector chapters of the National Inventory Report (DFFE, 2024). In addition, detailed descriptions are provided in the relevant category chapters. A distinction is made between calculations made with country-specific ("CS") methods and calculations made, in the various categories, with IPCC calculation methods of varying degrees of detail ("Tiers"). Similarly for the emission factors. The way a calculation is assigned to the various IPCC methods depends on the pertinent category's share (expressed as equivalent emissions) of total emissions and this is determined via the key category analysis.

In terms of data, for the Energy Sector, Energy balance data is obtained from the Department of Mineral Resources and Energy (DMRE), while petroleum data is collected from Petroleum companies (e.g. Petro SA and Sasol) Annual reports of SAPIA and Transnet. Electricity data is obtained from the grid supplier, Eskom. There are currently no formal processes in place for requesting or obtaining data from DMRE. SAGERS, through the GHG Reporting Programme, is used for data from major companies.

For the IPPU sector the SAGERs system is used to obtain the data required. The DFFE waste branch supplied the data for HFC and PFC, though no formal data collection process is in place for this.

Agricultural data is primarily obtained from the Department of Agriculture, Land Reform and Rural development (DALRRD). Fertiliser and liming data are sourced from South African Revenue Service (SARS), DMRE and Fertilizer Association of South Africa (FertASA). Small amounts of crop statistics data are obtained from Statistics SA. There are no formal data collection processes in place for all the agriculture data.

Data for the LULUCF sector sub-categories is obtained from various with the DFFE employing consultants on, a project-by-project basis, to process the satellite imagery to generate land cover datasets that are used to determine land cover change for the LULUCF sector.

For all the other land, such as carbon stock data and fuel wood removals data there are no formal data collection processes in place. Data is obtained from available government reports, agricultural association reports, statistical databases and scientific literature. Forestry SA supplies Plantation data and DALRRD supplies cropland data. The MODIS burnt area product which is processed by Gondwana Environmental Solutions is used for the burnt area data. The SAGERS system uses plantation data.

Waste data is collected from various data reports, statistics and global data sets. The main data providers for the Waste sector are Statistics SA, DFFE, Department of Water and Sanitation (DWS) and UN. Currently no formal data collection processes are place, though it is expected that it may be possible, for future inventories, to collect some of the Waste data through the SAGERS system.

1.6 QUALITY ASSURANCE, QUALITY CONTROL AND VERIFICATION PLANS AND PROCEDURES

Following the preparation of data, report sections and QC/QA checklists by the responsible experts, these materials are transmitted to the Single National Entity where it is reviewed by category-specific specialists at the Single National Entity. The results of this review are then provided to the sector lead experts to revise and finalise.

The compilation of the GHG inventory was guided by the inventory quality principles as defined in 2006 IPCC Guidelines (IPCC, 2006). As part of the NGHGIS, South Africa developed a formal quality assurance/quality control plan (see Appendix

1.A of 2015 NIR (DEA, 2019)) which provides a list of QC procedures that are to be undertaken during the preparation of the inventory.

The QC procedures (Figure 1.4) are performed by the experts during inventory calculation and compilation. QC measures are aimed at the attainment of the quality objectives. The QC procedures comply with the IPCC Good Practice Guidance and the 2006 IPCC Guidelines. General inventory QC checks include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions.

In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

The general quality checks were used routinely throughout the inventory compilation process. Although general QC procedures are designed to be implemented for all categories and on a routine basis, it is not always necessary or possible to check all aspects of inventory input data, parameters, and calculations every year. Checks are then performed on selected sets of data and processes. A representative sample of data and calculations from every category may be subjected to general QC procedures each year.

Several workshops and training sessions are also held during the preparation of the inventory. A process of public review is also undertaken. The expert and public reviews each present opportunity to uncover technical issues related to the application of methodologies, selection of activity data, or the development and choice of emission factors. Emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system where available.

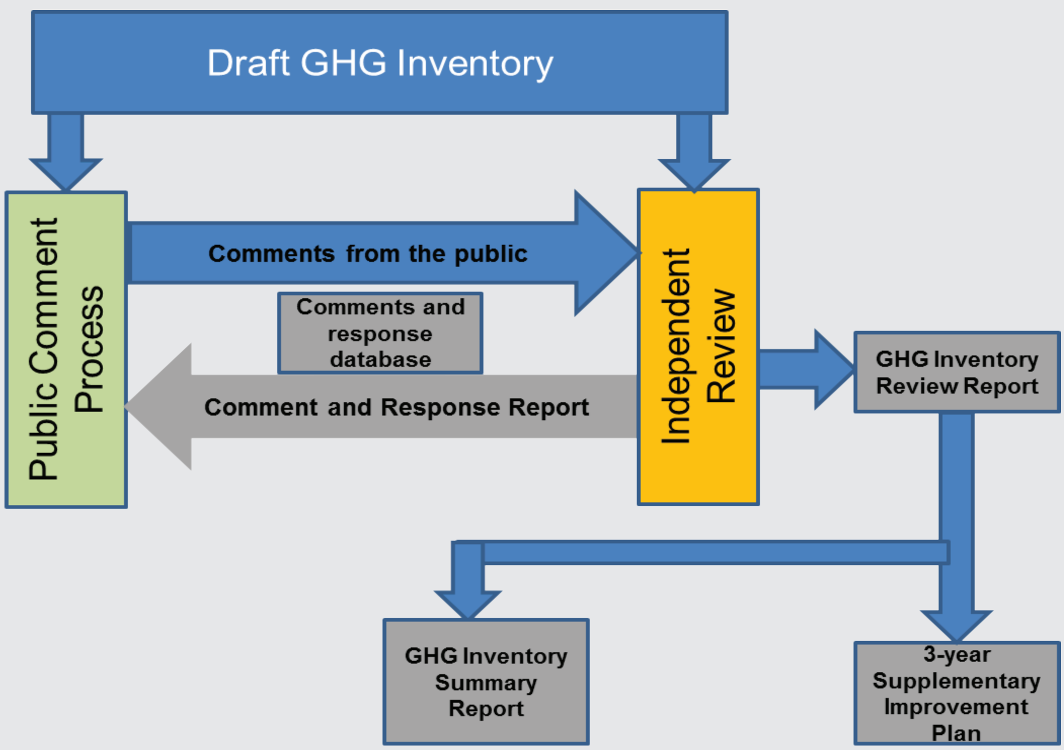


Figure 1.4: The quality assurance review process for the 2000 – 2022 inventory.

In terms of verification, emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system where available. These include national and international statistics, measurement and research projects and programmes started to support the inventory system, or for other purposes, but producing information relevant to the inventory preparation.

1.7 KEY CATEGORY ANALYSIS

A key category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of GHG's in terms of the absolute level of emissions and removals, the trend in emissions and removals, or uncertainty in emissions or removals. This includes both source and sink categories.

The key categories have been assessed using the Approach 1 level (L1) and Approach 1 trend (T1) methodologies from the 2006 IPCC Guidelines (IPCC, 2006). Key categories based on uncertainty have not yet been included due to a lack of country specific data on uncertainties. The level and trend key category analysis identify key categories of emissions and removals as those that sum to 95 % of the gross (excluding LULUCF) or net (including LULUCF) emissions and those that are within the top 95 % of the categories that contribute to the change between 2000 and 2022, or the trend of emissions. This includes both source and sink categories. In the previous inventory there were 58 key categories, while in this inventory there are 54 with the top 30 shown in *Forest land converted to grassland*, *Direct N_2O emissions from managed soils* and *Ferroalloy production* are new to the top 10 key categories. In the previous inventory these categories were in 26th (as *Land converted to grassland*), 16th and 15th place, respectively.

Table 1.2: Key categories for South Africa for 2022 (including LULUCF) and their ranking

Rank	IPCC code	IPCC Category	GHG#	Criteria
1	4.A.2.b	Grassland converted to forest land – all pools	CO_2	L,T
2	1.A.3.b	Road Transportation – Liquid Fuels	CO_2	L,T
3	4.A.1.a	Forest land remaining forest land – biomass	CO_2	L,T
4	1.A.1	Energy Industries – Solid Fuels	CO_2	L,T
5	3.D.1	Direct N_2O Emissions from Managed Soils	N_2O	L
6	4.C.1.a	Grassland remaining Grassland – biomass	CO_2	L,T
7	4.F.2.c	Grassland converted to other land – all pools	CO_2	L,T
8	1.A.5	Other – Solid Fuels	CO_2	L,T
9	2.C.2	Ferroalloys Production	C	L
10	1.B.3	Other emissions from energy production	CO_2	L,T
11	1.A.4	Other Sectors – Liquid Fuels	CO_2	L,T
12	3.A.1.a.ii	Non-dairy Cattle	CH_4	L,T
13	1.A.3.a	Domestic Aviation	CO_2	T
14	1.A.1	Energy Industries – Gaseous Fuels	CO_2	T
15	1.A.5	Other – Liquid Fuels	CO_2	T
16	1.A.4	Other Sectors – Solid Fuels	CO_2	L,T
17	2.C.1	Iron and Steel Production	CO_2	L,T
18	3.A.1.a.i	Dairy Cattle	CH_4	L
19	4.A.1.b	Forest land remaining forest land – dead organic matter	CO_2	T
20	5.A	Solid Waste Disposal	CH_4	L,T
21	1.B.3	Other emissions from energy production	CH_4	L
22	2.B.2	Nitric Acid Production	N_2O	T
23	4(V)	Biomass Burning	CH_4	L
24	2.C.3	Aluminium Production	F-gases	T

Rank	IPCC code	IPCC Category	GHG[#]	Criteria
25	1.A.2	Manufacturing Industries and Construction – Gaseous Fuels	CH_4	L,T
26	4.C.2.a	Forest land converted to Grassland – all pools	CO_2	L,T
27	1.B.2	Oil and Natural Gas	CO_2	T
28	4.B.2.b	Grassland converted to Cropland – all pools	CO_2	L
29	4.C.2.c	Wetland converted to Grassland – all pools	CO_2	T
30	2.D.2	Paraffin wax use	CO_2	T

[#]C=Confidential Uncertainty assessment

1.7.1 Procedures for determination of uncertainty

Uncertainty is inherent within any kind of estimation and arises from the limitations of the measuring instruments, sampling processes and model complexities and assumptions. The IPCC (2006) recognises that managing these uncertainties, and reducing them over time, is an important element of inventory preparation and development. Chapter 3 of the 2006 IPCC Guidelines (IPCC, 2006) describes the methodology for estimating and reporting uncertainties associated with annual estimates of emissions and removals. There are two methods for determining uncertainty:

- Tier 1 methodology which combines the uncertainties in activity rates and emission factors for each source category and GHG in a simple way; and
- Tier 2 methodology which is generally the same as Tier 1; however, it is taken a step further by considering the distribution function for each uncertainty, and then carries out an aggregation using the Monte Carlo simulation.

As South Africa still lacks data in terms of country specific uncertainty for all sectors, the simple propagation of error (Approach 1) method was used to determine the uncertainty in this inventory. A trend uncertainty between the base year (2000) and 2022 was determined, as well as a combined uncertainty of activity data and emission factor uncertainty. As more uncertainty data becomes available it will be incorporated into the uncertainty assessment. It is recognised that there is a general need to build capacity and develop projects to assess the uncertainty in each sector.

1.7.2 Uncertainty assessment results

Emission estimate uncertainties typically are low for CO_2 from energy consumption as well as from some industrial process emissions. Uncertainty surrounding estimates of emissions are higher for LULUCF and synthetic gases.

The total uncertainty for the inventory, including LULUCF was determined to be between 11.9% and 12.3%, with a trend uncertainty of 8.8%. This is an increase in the uncertainty in the last inventory (8.7%), however there were a few new categories in this inventory and a more detailed uncertainty assessment for Forest lands have been included. This led to an increase in uncertainty about the activity data (mostly due to the increased variability in the land change maps), but a reduction in the emission factor uncertainty. Excluding LULUCF reduces the overall uncertainty to 5.7%-6.4%, which is a reduction of the uncertainty from the last inventory.

The Energy sector's uncertainty was reduced slightly (by 5% on the upper limit) compared to the previous inventory. The IPPU trend uncertainty increased by 32% compared to the last inventory. The IPPU sector did introduce some new categories in 2021 and 2022 and update some of the uncertainty estimates to be based on country specific data rather than defaults so these changes could contribute to the uncertainty change. The agriculture sector's uncertainty reduced for both the overall uncertainty and trend uncertainty. The uncertainty data did not really change but the emission estimates did, and there was also reallocation of some categories between Agriculture and LULUCF to align with the ETF CRT reporting.

LULUCF uncertainty increased by about 30% compared to the previous inventory uncertainty analysis. Part of this change was due to the introduction of new land change maps; however additional changes were made due to a more in-depth analysis of the uncertainty data rather than it being an actual change in uncertainty. The uncertainty data is one aspect of the inventory, which is being improved, so it is likely there will be further changes in the next inventory. Waste sector uncertainty was reduced, but this is likely due to the reduction in the emissions in this sector due to improvements.

1.8 ASSESSMENT OF COMPLETENESS

The South African GHG emission inventory for the period 2000 – 2022 is not complete, mainly due to the lack of sufficient data. Table 1.3 provides information on the completeness of the inventory. It shows which activities are not estimated (NE), included elsewhere (IE) or that is not occurring (NO) within the South African jurisdiction.

Table 1.3: Activities in the 2022 inventory which are not estimated (NE), included elsewhere (IE) or Not Occurring **(NO)**

NE, IE or NO	IPCC Category	Activity	Comments
NE	1B1b	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams	Research to be initiated in future, depended on availability of funding to initiate a study.
	1B1ai2	CH_4 emissions from abandoned mines	Research to be initiated in future, depended on availability of funding to initiate a study.
	1C1	CO_2 transport	Insufficient data to include
	1C2	Injection and storage	Insufficient data to include
	2D2	CH_4 and N_2O emissions from paraffin wax use	Insufficient data to include
	2E	Electronics industry	Insufficient data to include, an assessment to assess the significance of this source in South Africa.
	2F5	PFCs and HFCs from solvents	Insufficient data to include
	2G1	PFCs from electrical equipment	Insufficient data to include
	2G2	PFCs from other product uses	Insufficient data to include
	2G3	N_2O from product uses	Insufficient data to include
	3D1f	Cultivation of organic soils	Organic soils are not included due to insufficient data, incorporating detail on organic soils is included in the improvement plan
	3C7	CH_4 emissions from Rice cultivation	CH_4 emissions from Rice cultivation is assessed to be Insignificant.
	3I	Other carbon containing fertilisers	Research needs to be done to investigate the availability of this category in South Africa.
	4(I)	Direct and indirect N_2O emissions from N inputs to managed soils other than cropland and grassland	Nitrogen application to forest plantations has not been included due to a lack of data. Data will be available for inclusion in the next inventory.
	4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	Not included due to insufficient data.
	4	Land use change emissions from overseas territories	These are considered insignificant and a basic assessment based on area was completed to show insignificance, but a further assessment of this insignificance is included in the improvement plan for the next inventory.
	4D1a, 4D2a	Emissions from peat extraction	Insufficient data to include.
	All sectors	NOx, CO, NMVOC emissions	These have only been included for biomass burning due to a lack of data in other sectors
	All sectors	SO_2 emissions	Insufficient data.

NE, IE or NO	IPCC Category	Activity	Comments
IE	1A1aii	CO_2, CH_4 and N_2O emissions from Combined Heat and Power (CHP) combustion systems	Not separated out but is included within 1A1ai
	1A3eii	CO_2, CH_4 and N_2O emissions from off-road vehicles and other machinery	Included under Road transportation.
	1A5b	Non-specified mobile	Included under Non-specified Mobile (1A3b)
	3E	Prescribed burning of savannas	Emissions are included under LULUCF Forest land (4A) as prescribed burning could not be separated from wildfires.
	4A-4F	Organic soils	Included under mineral soils as insufficient data to separate.
	4B	Non-CO_2 emissions from cropland burning	These are included under Field burning of agricultural residues (3F).
NO	2B3	CO_2, CH_4 and N_2O emissions from Adipic acid production	
	2B4	CO_2, CH_4 and N_2O Caprolactam, Glyoxal and Glyoxylic acid production	
	3J	Other	

1.9 IMPROVEMENTS AND RECALCULATIONS

Improvements were made to emission estimates from each sector and therefore recalculations were completed for the full time series. As the current inventory applied the AR5 GWPs, the previous inventory data was converted to CO_2 equivalents by using the AR5 GWP to gauge the actual impacts of the improvements made. The data shows that the current inventory estimates (excl. LULUCF) are between 0.4% and 5.3% lower than the 2020 inventory estimates, while the estimates including LULUCF are between 0.2% and 4.9% lower than the 2020.

The Energy sector improvements contribute the most to the reduction in the estimates in this inventory, with an average reduction of 14 294 Gg CO_2e since 2007 compared to the previous inventory. The LULUCF sector showed an average reduction of 16 929 Gg CO_2e between 2003 and 2014, after which it increases emissions by an average of 14 899 Gg CO_2e until 2018. This then changes to a reduction of 9 832 Gg CO_2e in 2020. The agriculture sector shows an increase in emissions by an average of 5 234 Gg CO_2e across the time-series, while waste emissions are reduced by an average of 7 082 Gg CO_2e over the same period.

1.10 IMPROVEMENT PLAN

A National Greenhouse Gas Improvement Programme (GHGIP) is being implemented to improve activity data, country-specific methodologies and emission factors used in the most significant sectors. It is through the GHGIP that the country is working to resolve the main challenge to the GHG inventory on available data. Table 1.4 presents a summary of projects under implementation and the status of tasks.

Table 1.4: List of planned improvements for South Africa's GHG inventory

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Completed Tasks						
Energy	CO_2 and CH_4 fugitive emissions from oil and natural gas operations	Medium	Completeness	Completed	2022 inventory	Included in this inventory (2000-2022).
	Fugitive emissions from coke production to be reported separately from 2C process emissions	Low	Transparency	Completed	2022 inventory	Included in this inventory (2000-2022).
	Develop EFs, carbon content of fuels and NCVs of liquid fuels	High	Key category; Accuracy	Completed	2022 inventory	Included in this inventory (2000-2022).
Agriculture	Incorporate all background equations for the Tier 2 calculations of enteric fermentation	High	Key category; Accuracy; Transparency	Completed	2022 inventory	Included in this inventory (2000-2022).
LULUCF	Estimate the HWP contribution based on other approaches.	Medium	Key Category; Accuracy	Completed	2022 inventory	Included in this inventory (2000-2022).
	Incorporate updated National Terrestrial Carbon Sinks Assessment (NTCSA) data to improve estimates, particularly for soils	High	Key category; Accuracy	Resolved	2022 inventory	The NTCSA data is not being updated regularly and does not incorporate the latest land cover maps. This data is therefore not being incorporated into the inventory due to issues of sustainability. The general carbon stock data per land type is being used for verification purposes.
	Include CO_2 estimates for wetlands	Low	Accuracy; Completeness	Completed	2022 inventory	Included in this inventory (2000-2022).
	Included 2018 and 2020 SANLC maps	High	Key category; Accuracy; Completeness	Completed	2022 inventory	Included in this inventory (2000-2022); there are numerous improvements that need to be made to the LULUCF data, so a detailed LULUCF improvement plan has been developed and these ongoing improvements are listed below.
	Justify reason for use of Tier 1 methods for key categories and pools and include moving to higher tiers in the improvement plan.	Medium	Transparency	Completed	2022 inventory	Included in this inventory (2000-2022).

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
LULUCF	Highlight the need for a National Forest Inventory	High	Key category; Accuracy	Completed	2022 inventory	Included in this inventory (2000-2022). The need for a national forest inventory was highlighted in the report and is listed in the improvement plan below as an outstanding task.
	Include growth of biomass in the last 5 years in the maturity cycle in the cropland remaining cropland	Low	Accuracy	Completed	2022 inventory	Included in this inventory (2000-2022).
	Identify significant sub-categories and carbon pools	Medium	Key category; Accuracy	Completed	2022 inventory	Included the pools for each of the land classes and also included these in the KCA.
	Further explain the appropriateness of the country specific EF for CH_4 for wetlands	Medium	Accuracy	Completed	2022 inventory	Included in this inventory (2000-2022). The country specific emission factor was assessed, and it was found that it was a very site and condition specific factors, therefore the value was reverted to the default emissions factor. Another country-specific factor was found to be similar to the default factor in support of this change.
Tasks in progress						
Cross-cutting	Improve uncertainty data for all sectors by incorporating more country specific uncertainty values	Medium	Accuracy	In progress	Incorporated as data becomes available	Lack of uncertainty data constrains this activity. As data becomes available it will be incorporated. In this inventory a more detailed analysis of uncertainty for LULUCF sector was completed.
	Improve QA/QC process by addressing all issues in external review	High	Transparency	In progress	Future inventories	Challenges in addressing external review comments have been limited by resources and process management. The DFFE inventory team has increased in size, which should assist in addressing this issue. There are still many issues not resolved but the inventory team is working through them. It is an ongoing process.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Energy	Improve the improvement plan by incorporating all review activities not addressed in current inventory	High	Transparency	In progress	Ongoing	Partly resolved. Challenges around inclusion of further improvements into the improvement plan are limited resources and process management. The DFFE inventory team has increased in size, but it is still taking time to completely address all the issues. The review outputs are included in this report as a reminder of what still needs to be completed.
	Improve explanation of large changes in trends	High	Transparency	In progress	Ongoing	Partly resolved. Additional explanations have been provided, but there are still areas where this can be improved further. Ongoing process.
Agriculture	Incorporate all background data for the Tier 2 calculations of enteric fermentation	High	Key category; Accuracy; Transparency	In progress	2024 inventory	All the background equations have been included, but average data is still being used for most of the factors (instead of annual data) due to a lack of a sustainable data source. Data sources are being investigated and data will be included once it becomes available.
	There is a need for an alternate data source for Lime data	Medium	Key category; Accuracy	In progress	2024 inventory	Past inventory reviews have mentioned upgrading this information and investigating the alternate method of calculating potential lime use.
LULUCF	Complete a full uncertainty analysis for the Land sector, including area bias corrections	High	Key category; Accuracy	In progress	2024 inventory	A more detailed uncertainty analysis was included for biomass, DOM and SOC data in the LULUCF sector. Mapping uncertainties were improved; however, these will be improved further during the land change improvement plan.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
LULUCF	Improvement of land change data through detailed assessment of maps and tracking of land parcels	High	Key category; Accuracy; Consistency	In progress	The land use improvement plan will be completed over the next 3 years so data will be incorporated as it becomes available (2024 and 2026 inventory).	This 2022 inventory incorporated a more detailed assessment of the land change data and identified the most important land change categories that need attention. The assessment also identified improvements that need to be done moving forward and the priority of these improvements. Removing changes due to seasonality is the top priority and this will be improved as more land change maps are obtained. The 2022 SANLC map will already assist with making improvements. Tracking land parcels over time is the second most important issue and training on Collect Earth to assist in this process is underway.
	Include deadwood in the DOM pool for all land categories	Low	Completeness	In progress	2024	Deadwood has been included for the forest land category. The other land categories with woody components are settlements and perennial crops, but data is very limited for these land categories. Deadwood in these categories is assumed to be very small, but an explanation of this will be included in the next inventory.
LULUCF	Move to a higher tier level for DOM in forest lands	Medium	Key category; Accuracy	In progress	2024	This was considered in the 2022 inventory and more detailed disturbance matrix data was included to determine the amount of biomass entering the DOM pool, however there were still one or two pieces of data missing which requires further investigation. This will be completed and included in the next inventory.
Waste	Data collection on quantities of waste disposed of into managed and unmanaged landfills		Key category; Accuracy	In progress	2024	Project is underway so data will be included in 2024 inventory.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Tasks outstanding						
Cross cutting	Investigate inconsistencies in lime activity data (for lime production in IPPU and lime application emission in Agriculture), explore alternative data sources or improve consistency.	Low	Consistency	Planned	BTR 3	Not resolved. Various methods were compared but gave varying results. Alternative data sources have not yet been found, but it may be possible to collect further data through the SAGERS system in future.
	Incorporate NOx, CO, NMVOC, and SOx emissions	Medium	Completeness	Proposed	BTR 3	Not resolved.
Energy	Further disaggregation of 1A2	Medium	Accuracy	Planned	Future inventories	Current inventory breaks down 1A2 into 1A2a, 1A2b and 1A2-ab. Further work is required to further disaggregate this sector and have emissions calculated per sub-sector.
	More activity data for estimating emissions associated with non-energy fuel use	Low	Accuracy	Planned	Future inventories	Research to be initiated in future.
	Inclusion of methodology documentation/summary/ approval process for tier 3 methods	Low	Transparency	Planned	Future inventories	To be collated and included in future.
	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams	Low	Completeness	Planned	Future inventories	Research to be initiated in future.
	CH_4 emissions from abandoned mines	Low	Completeness	Planned	Future inventories	Research to be initiated in future.
	Investigate pipeline transport	Low	Completeness	Proposed	Future inventories	Proposed but nothing planned.
	Investigate ground activities at airports and harbours	Low	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Update of the VKT study, including segregation of on-road/off-road	Medium	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Comparison of the next VKT approach with fuel statistics	Low	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Segregation of military energy use.	Low	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Incorporate emissions from biogas	Low	Completeness	Proposed	Future inventories	This would require a study and so should be recommended as a project under the GHGIP.
	CO_2 transport and storage	Low	Completeness	Proposed	Future inventories	Proposed but nothing planned.
	CO_2, CH_4 and N_2O emissions from combined heat and power (CHP) combustion systems	Medium	Completeness	Proposed	Future inventories	Proposed but nothing planned.
	Development of T3 methods for CTL-GTC and GTL	Low	Accuracy	Proposed	Future inventories	Resources and funding are required to complete this study so it will be incorporated into the GHGIP.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
IPPU	Include emissions from electronics industry	Medium	Completeness	Planned		A study needs to be undertaken to understand emissions from this source so it should be highlighted as a project for the GHGIP.
	Incorporate emissions SF_6 emissions	Medium	Completeness	In progress		Lack of data is still a challenge.
Agriculture	Improve manure management data, including biogas digesters as a management system	Medium	Accuracy	Proposed	2024	Proposed project as there is a high variability in this dataset.
LULUCF	Incorporate organic soils study to include emissions from organic soils	Low	Completeness	Planned	Future inventories	Not resolved. Due to the other more pressing issues relating to land this was not a priority and will be incorporated once the land mapping system is running.
	Undertake a National Forest Inventory and include SOC in the inventory	High	Key category; Accuracy	Proposed	Future inventories	This is an activity which would need to be completed by the Department of Forestry, therefore the date for completion is not known.
	Complete an assessment of crop types and areas and investigate discrepancies between crop statistics and NLC data	Medium	Consistency; Comparability	Planned	2024 inventory	This was partially investigated in this inventory; however, a proper assessment will be included in the land use change improvement plan that will run over the next few years.
	Perform a more detailed assessment of HWP to include a wider range of products	Medium	Key category; Accuracy	Proposed		Proposed project that could be considered under the GHGIP. For future evaluation.
	Report activity data and parameters (e.g. half-life) used for HWP emission estimation for the whole time-series	Medium	Transparency	Planned	2024 inventory	This will be included in the 2024 inventory.
	Report on the frequency of the HWP activity data collection	Low	Transparency	Planned	2024 inventory	This will be included in the 2024 inventory.
	Collect data on other disturbances besides fire in forest lands	Low	Key category; Accuracy	Proposed	Future inventory	This would require a study so it will be recommended as a project under the GHGIP.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
LULUCF	Assess the significance of peatlands	Low	Completeness	Proposed	2026 inventory	Assessing the areas of peatlands would be the first step and this part could be done as part of the land use improvement plan.
	Improve the transparency and accuracy of the LULUCF estimation file and report	High	Key category; transparency	Planned	2026 inventory	This will start next year but will continue through to the following year.
	Address the LULUCF section corrections	High	Accuracy	In progress	Next inventory	The LULUCF sector estimates will be assessed and corrections made to address the issues. This has already started.
	Further assessment of impacts of fires	Medium	Accuracy	Planned	Next inventory	This will involve the provision of a more detailed assessment and methodology for determining impacts of fire, particularly natural disturbance.
Waste	Improve MCF and rate constants	Medium	Key category; Accuracy	Proposed	BTR 3	This would require a study so will be recommended as a project under the GHGIP.
	Include economic data for different population groups	Medium	Key category; Accuracy	In progress	BTR 3	Will be included in the 2024 inventory
	Include information on population distribution in rural and urban areas as a function of income	Medium	Key category; Accuracy	In progress	BTR 3	Insufficient data.
	Include HWP in solid waste	Medium	Key category; Completeness	Proposed	BTR 4	Once HWP data is improved (see above) it will be incorporated into solid waste.
	Obtain data on waste streams and the bucket system	Medium	Accuracy	Planned	BTR 3	Insufficient data.
	CH_4, N_2O emissions from biological treatment of waste	Medium	Completeness	Planned	BTR 3	Insufficient data.
	CO_2, CH_4 and N_2O from waste incineration	High	Completeness	Planned	BTR 3	Insufficient data.

1.11 APPROVAL AND PUBLISHING PROCESS

The Biennial Transparency Report (BTR) and National Inventory Reports (NIRs) are endorsed by the Project Steering Committee (PSC) before being submitted to the Minister of the DFFE for approval. The PSC is chaired by the DFFE and comprises of various state departments. Once the reports are approved by Minister, they are submitted to the UNFCCC by the Chief Directorate for Climate Change International Relations and Reporting and undergo an international review process.

1.12 APPLICATION OF FLEXIBILITY PROVISIONS

The application of flexibility provisions is contained in Chapter 5 of this report.

1.13 TRENDS IN GHG EMISSIONS

1.13.1 National GHG inventory Emissions for 2022

The 2022 National Inventory Document for South Africa is the country's ninth inventory report and provides estimates of South Africa's net GHG emissions for the period 2000 to 2022 and will be submitted to United Framework Convention on Climate Change (UNFCCC) to fulfil South Africa's reporting obligations under the UNFCCC.

National emissions of CO_2, CH_4 and N_2O and GHG precursors for 2022 are shown in Table 1.6.

Emissions of GHG precursor gases (NO_x, CO and NMVOCs) are only estimated from biomass burning. Global Warming Potentials (GWPs)) from the 2014 IPCC Fifth Assessment Report (AR5) were used.

Table 1.5: Summary emission table for South Africa for 2022

IPCC 2006 category	Emissions and removals									
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF6	NOx	CO	NMVOC	Total GHGs
	(Gg)			(Gg CO_2e)		(Gg)				(Gg CO_2e)
Emissions (incl. LULUCF)	335 766.9	2 669.1	69.4	5 944.8	125.9	65.7	106.6	2 241.9	211.3	435 037.1
Emissions (excl. LULUCF)	392 180.1	2 258.6	63.2	5 944.8	125.9	65.7	1.6	57.2	0.0	478 300.9
1 - Energy	365 729.7	210.0	9.4	0.0	0.0	0.0	0.0	0.0	0.0	374 114.1
1.A - Fuel Combustion Activities	341 817.6	36.1	9.4				NE	NE	NE	345 316.3
1.B - Fugitive emissions from fuels	23 912.1	173.9	0.1				NE	NE	NE	28 797.9
1.C - Carbon dioxide Transport and Storage	NE									NE
2 - Industrial Processes and Product Use	23 976.1	4.3	1.4	5 944.8	125.9	65.7	0.0	0.0	0.0	30 598.0
2.A - Mineral Industry	6 055.1	NE								6 055.1
2.B - Chemical Industry	1 267.7	4.3	1.4							1 753.1
2.C - Metal Industry	15 528.5	0.0	0.0	NE	125.9					15 654.6
2.D - Non-Energy Products from Fuels and Solvent Use	1 124.8	NE	NE							1 124.8
2.E - Electronics Industry	NE		NE	NE	NE					NE
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE			5 944.8	NE					5 944.8
2.G - Other Product Manufacture and Use			NE	NE	NE	65.7				65.7
2.H - Other	NA	NA	NA							NA
3 - Agriculture	2 445.4	1 362.2	46.4	0.0	0.0	0.0	1.6	57.2	0.0	52 890.3
3.A – Enteric fermentation		1 298.3								36 351.4
3.B – Manure management		62.2	9.6							4 284.5
3.C – Rice cultivation		NO								NO
3.D – Agricultural soils		NA	36.8				NE	NE	NE	9 750.5
3.E – Prescribed burning of savannas		IE	IE				IE	IE	IE	IE
3.F – Field burning of agricultural residues		1.7	0.0				1.6	57.2	NE	58.5
3.G – Liming	1 860.7									1 860.7
3.H – Urea application	584.7									584.7
3.I – Other carbon-containing fertilisers	NE									NE
4 - LULUCF	-56 413.2	410.6	6.2	0.0	0.0	0.0	105.1	2 184.7	211.3	-43 263.7
4.A – Forest land	-85 684.3	76.4	4.5				57.7	1 421.2	150.1	-82 341.1
4.B - Cropland	3 790.9	IE	IE				IE	IE	IE	3 790.9
4.C - Grassland	10 427.5	16.7	1.5				42.8	713.2	55.3	11 300.8
4.D - Wetland	746.9	317.5	0.2				4.4	47.6	5.7	9 678.4
4.E - Settlements	-2 369.8	0.0	0.0				0.2	2.7	0.2	-2 368.3
4.F – Other land	19 022.0	NO	IE				NO	NO	NO	19 022.0
4.G – Harvested wood products	-2 346.5									-2 346.5
5 - Waste	28.9	682.1	5.9							20 698.4
5.A - Solid Waste Disposal		307.0	NE							8 596.0
5.B - Biological Treatment of Solid Waste		62.0	3.0							2 530.4
5.C - Incineration and Open Burning of Waste	28.9	8.7	0.2							325.4
5.D - Wastewater Treatment and Discharge		304.4	2.7							9 246.7
5.E – Other	NO	NO	NO							NO
Memo items										
International bunkers	3 673.2	0.1	0.1							3 703.8
International aviation	2 311.0	0.0	0.1							2 328.2
International water-borne transport	1 362.1	0.1	0.0							1 375.7
Multilateral operations	NA	NA	NA							NA

1.13.2 Trends in GHG emissions and removals since 2000

1.13.2.1 Overall emissions (excluding LULUCF)

Overall emissions (excl. LULUCF) include those from Energy, IPPU, Agriculture and Waste. It does not include the sources and removals from land use change and *harvested wood products*, which together form the LULUCF sector.

1.13.2.2 2000 - 2022

South Africa's GHG emissions excl. LULUCF were 489 188 Gg CO_2e in 2000 and these decreased by 2.2% by 2022. Emissions (excl. LULUCF) in 2022 were estimated at 478 300 Gg CO_2e. The decrease in emissions compared to 2020 is attributed to the marginal decrease in emissions across all the sectors (Energy, IPPU, Agriculture and Waste).

Emissions (excl. LULUCF) in 2022 were estimated at 478 300 Gg CO_2e, this represents an increase of 1,4% compared to 2020 and was influenced by increased activities post the COVID-19 pandemic in the manufacturing sector.

Annual emissions data for South Africa from 2000 to 2022, both excluding and including LULUCF, measured in gigagrams of carbon dioxide equivalent (Gg CO_2e) is shown in Figure 1.5.

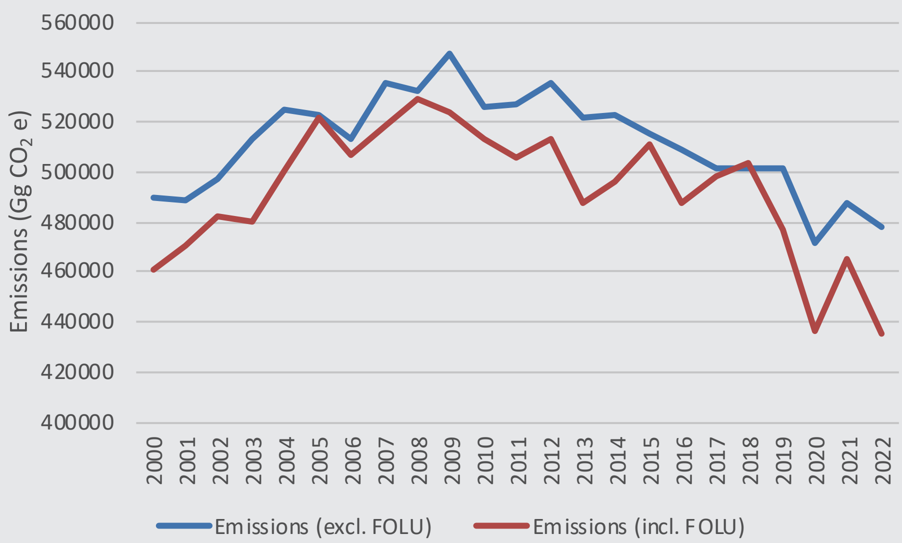


Figure 1.5: National GHG emissions (excluding and including FOLU) for South Africa, 2000 – 2022.

Notable points include a peak in emissions in 2004 at 524 341Gg CO_2e, a dip in 2010 with a 3.71% decrease, and a significant decline in 2020 by -5.79%. The emissions increased in 2021 by 3.36% due to post COVID-19 economic recovery. The data reflects South Africa's ongoing journey to balance economic development with environmental sustainability.

1.13.2.3 Emission Trends by Sector

a. Energy

The Energy sector is the largest contributor to South Africa' emissions (excl. LULUCF), contributing 78% in 2022 and on average since 2000. Since 2000, the Energy sector emissions have decreased by 2.5% with the biggest decrease (6.4%) being in 2020 due to COVID-19 lockdown restrictions. In 2021 emissions increased by 3.5% and then dropped by 3.4% in 2022 to pandemic levels (2020). This decrease is due to a 6.5% decrease in emissions from the *Energy Industries* sub-sector, which on average accounts for 67% of the Energy sector emissions (Figure 1.6).

b. IPPU

In 2022 the IPPU sector produced 30 598 Gg CO_2e which is 6.4% of South Africa's emission (excl. LULUCF). The IPPU sector produces CO_2 emissions (78.4%), fluorinated gases (20.0%) and smaller amounts of CH_4 (0.4%) and N_2O (1.2%). CO_2 and any other emissions from combustion of fuels in these industries are reported under the energy sector. The largest source category is the *Metal industry* category. which contributes 51.2% to the total IPPU sector emissions. The *Mineral industry* and the *Product used as substitutes for ozone depleting substances* subsectors contribute 19.8% and 19.4%, respectively, to the IPPU sector emissions.

IPPU sector emissions are estimated to 2 183 Gg CO_2e (-6.7%) lower than the emissions in 2000 and is attributed to the decline in global demand for iron and steel, and aluminium, resulting metals production to decline by 39.0%. The chemicals industry also declined (31.4%) whereas the local demand for cement increased dramatically from 2000 resulting in increased emissions from 2000 by 2 081 Gg CO_2e in *Cement Production* and *Non-Energy Product Use from Fuels and Solvents*.

c. Agriculture

The agriculture sector contributed between 10% and 12% to total emissions (excluding LULUCF) between 2000 and 2022. Overall emissions have declined by 9.1% since 2000. The main driver of change in the Agriculture sector is the livestock population. Livestock has input into the *Enteric fermentation*, *Manure management,* as well as *Direct* and *Indirect N_2O emissions from managed soils*. *Enteric fermentation* emissions show a declining trend due to a decline in livestock population. Dairy cattle, pigs and poultry are the largest contributors to *Manure management* emissions, and with increasing poultry numbers these emissions increase over the 22- year period.

The agriculture sector produced 52 890.3 Gg CO_2e (excl. LULUCF) in 2022. Livestock contributed 77% to the agriculture emissions in 2022, and the largest contributor to this category is CH_4 from *Enteric fermentation* (68.7%), while *Manure management* contributed (8.1%) to the total livestock emissions. Agricultural soil contributed 19 % to total Agriculture emissions, while the least emissions were from *Liming* (3%), *Urea application* (1.1%) and *Field burning of agricultural residues* (0.1%).

d. LULUCF

The LULUCF sink was estimated at 43 181 Gg CO_2e in 2022. Forest lands were estimated to have a sink of 82 341 Gg CO_2e, with 62% of this being due to land being converted to *Forest lands*. The conversion of *Grasslands* to *Forest land* (mainly woodlands) accounted for 86.3% of the total land conversion sink. All other land categories were sources of emissions with *Other lands* contributing the most (44.1%) to this source, followed by *Grasslands* (26.1%). All the emissions for *Other lands* were from land being converted to bare ground and the largest conversion was low shrublands to bare ground.

The LULUCF sector showed an increase of 55.1% in its sink since 2000. The sink increased by 17.9% since 2020. The sink was reduced between 2015 and 2018, and these changes were brought about by the change in land conversions introduced by the 2014-2018 change maps. During this period there was an increase in the emissions from *Grasslands* (due mainly to conversion between low shrubland and grasslands) and *Croplands*. The increased *Cropland* emissions were attributed to an increase in conversion of *Forest land* to *Cropland* and conversions between perennial and annual crops. These increased emissions led to a reduction in the sink during this period.

Grasslands were estimated to be a small sink between 2000 and 2014, but the trends show that from 2015 onwards they become a source of emissions. This is due to the conversions between low shrublands and grasslands, however this is one of the categories that can be impacted by seasonal variation. The land change improvement plan will investigate these changes further over the next few years in the aim of better understanding the changes and reducing the uncertainty.

The trends also show an increase in the *Forest land* sink. There is an increase in conversion of *Grassland* to *Forest land*, mainly grasslands to woodlands, which also supports the findings of a reduced *Grassland* sink. Thickets are an important sink in the *Forest land* category and the sink is seen to be stable; however thickets are the land category that showed the most change in the land change maps due to reclassification, so the improvement plan will interrogate this further.

e. Waste

In South Africa, the total Waste sector emissions for 2022 were 20 698 Gg CO_2e. Most of these emissions are from *Wastewater treatment and discharge* contributing 9247 Gg CO_2e (44.1%) of the total Waste sector emissions. *Solid waste disposal* contributed a further 8 596 Gg CO_2e (41.5%) of waste emissions while *biological treatment of solid waste* contributed 2 530 Gg CO_2e (12.2%). Emissions from *Incineration and Open Burning of Waste* were estimated to be 325 Gg CO_2e (1.57%).

Solid waste disposal emissions have increased 47.6% since 2000. *Incineration and open burning of waste* emissions increased by 53.1% since 2000, while emissions from *Wastewater treatment and discharge* increased slightly across the time series. This overall increase in emissions is largely driven by increases of 35.6% in *Domestic wastewater treatment and discharge* emissions, whilst there was a 9.4% decline in *Industrial wastewater treatment and discharge* emissions.

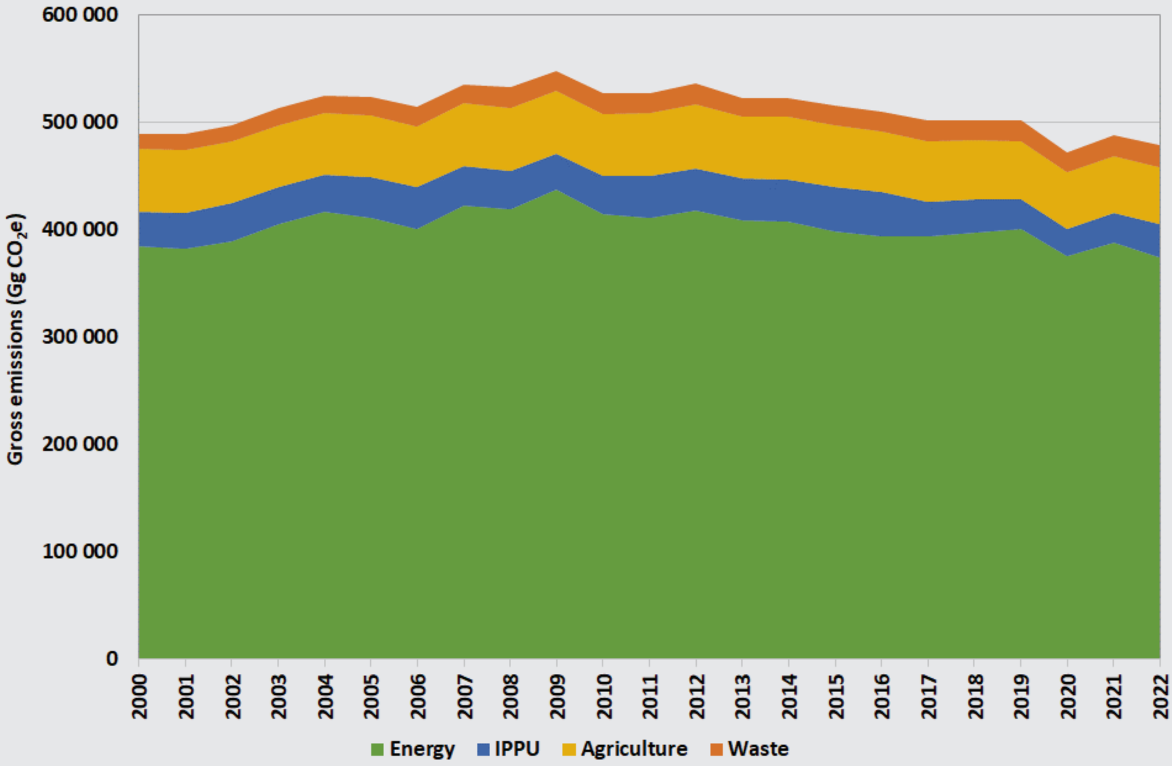


Figure 1.6: Trend in emissions by sector for 2000 to 2022.

1.13.3 Emission Trends by Gas

1.13.3.1 Carbon Dioxide (CO_2)

CO_2 is the largest contributor to South Africa's emissions; followed by CH_4 and then N_2O. CO_2-emissions contributed 81.9% (excl. LULUCF) to South Africa's emissions in 2022. Most CO_2 emissions are from the Energy sector, contributing an average of 92.3% (excl. LULUCF) to the total CO_2 emissions between 2000 and 2022. The IPPU sector's contribution (excluding LULUCF) is an average of 7.1% of the total CO_2 emissions between 2000 and 2020, while the agriculture sector contributed an average of 0.5%. The trend and contribution of each sector to CO_2 emissions can be seen in Figure 1.7.

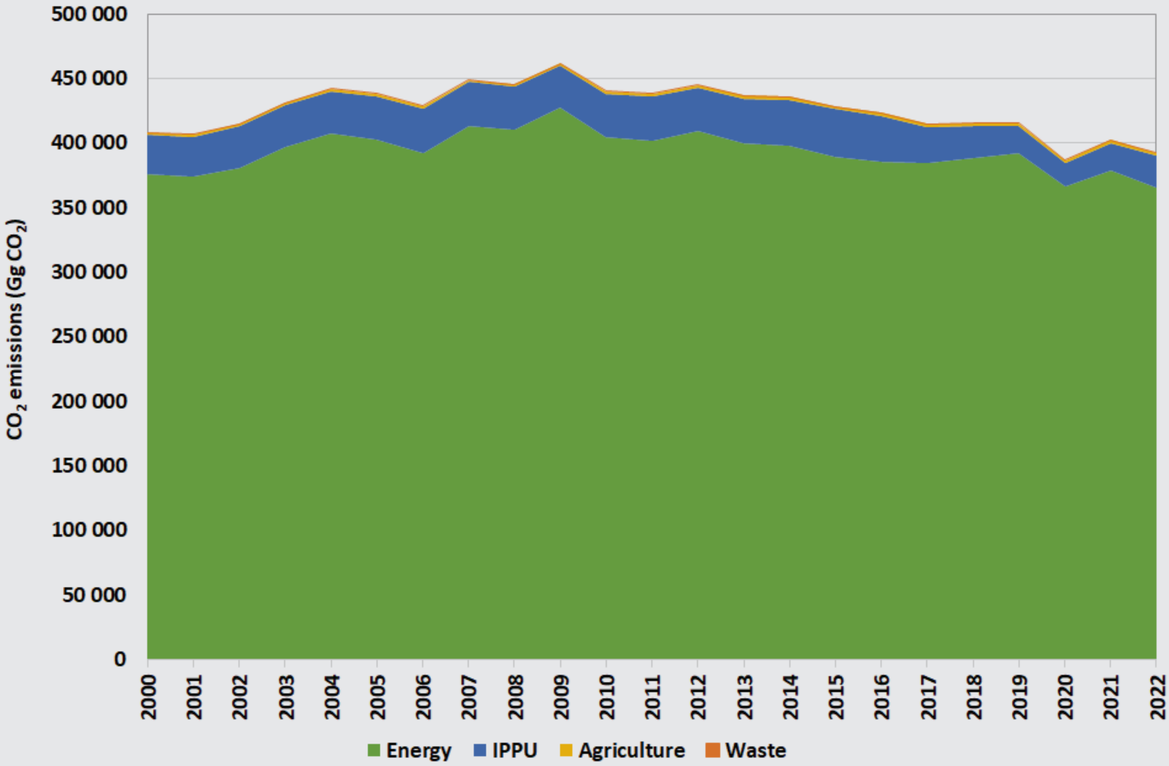


Figure 1.7: Trend and sectoral contribution to CO_2 emissions (excl. LULUCF), 2000 – 2022.

1.13.3.2 Methane (CH_4)

The trend and contribution of all the sectors to the total CH_4 emissions in South Africa are shown in Figure 1.8. CH_4 emissions (excl. LULUCF) only increased by 0.02% between 2000 and 2022. The *Enteric Fermentation* from Agriculture and *Solid Waste Disposal* from Waste were the major contributors to the total CH_4 emissions in 2022.

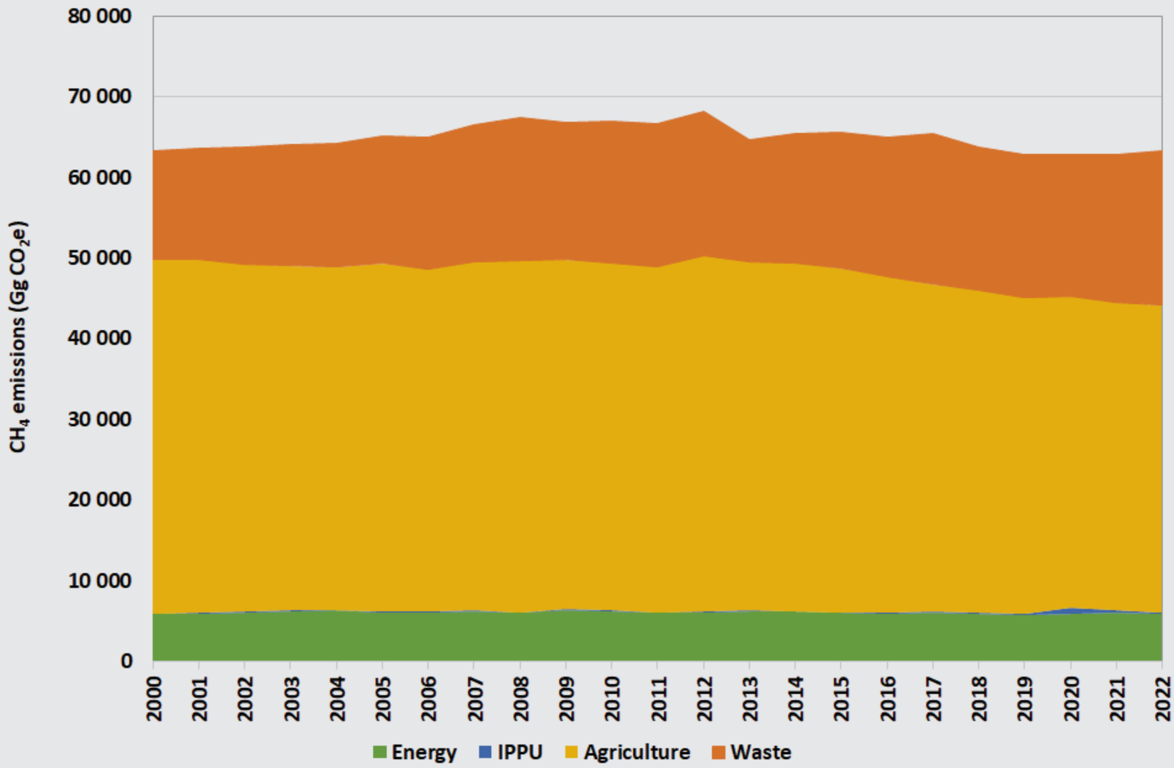


Figure 1.8: Trend and sectoral contribution to CH_4 emissions, 2000 – 2022.

1.13.3.3 Nitrous oxide (N_2O)

The contribution of all the sectors to the N_2O emissions is shown in Figure 1.9. The main contributor to N_2O emissions is the agriculture sector followed by Energy sector, contributing 73.5% and 15.0% (excl. LULUCF) respectively. N_2O emissions for 2022 from IPPU sector have decreased by 74.0% since 2000.

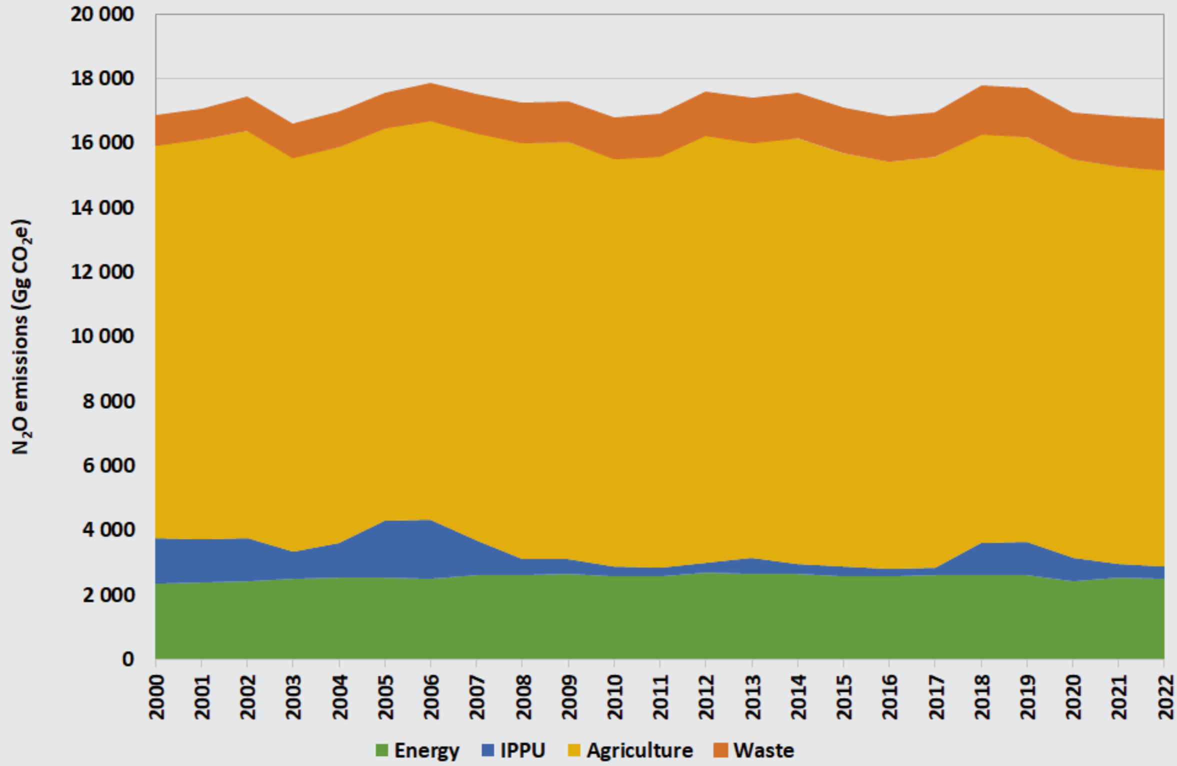


Figure 1.9: Trend and sectoral contribution to N_2O emissions in South Africa, 2000 – 2022.

1.13.3.4 F gases

Estimates of HFC and PFC emissions were only estimated for the IPPU sector in South Africa (Figure 1.10). F-gases contributed 1.3% to overall emissions (excluding LULUCF) in 2022 and emission estimates vary annually. This time-series is not consistent as there is no data prior to 2005. The emissions increase from 2011 is due to the addition of data on HFC emissions from air conditioning, foam blowing agents, fire protection and aerosols. The elevated F-gas emissions are therefore not necessarily due to an increase in emissions but rather due to the incorporation of new categories.

PFCs are produced during the production of aluminium. The *Aluminium production* data were updated for the years 2014 onwards and the updated data were an order of magnitude lower than the previous years, resulting in the decline in the PFC emissions. There was a sharp decline in emissions from the *Metal industry* between 2007 and 2009 and this is attributed to reduced production caused by electricity supply challenges and decreased demand following the economic crisis that occurred during 2008/2009. Increases in 2011 and 2012 were due to increased emissions from aluminium plants due to inefficient operations, due to switching on and off at short notice due to rotational electricity load shedding.

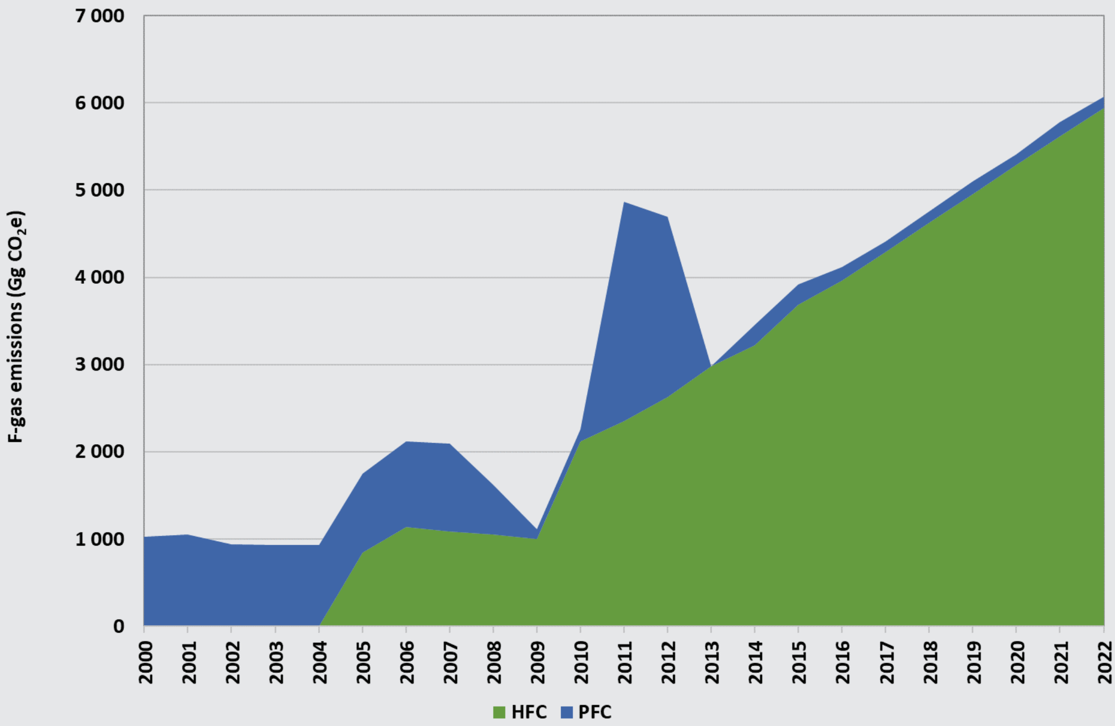


Figure 1.10: Trend in F-gas emissions in South Africa, 2000 – 2022.

1.13.4 Trends in Indirect GHG Emissions

The trend in emissions of CO, NO_x and NMVOCs is shown in Table 17. These emissions were estimated for biomass burning only, and as the emissions include wildfires as well as controlled fires, there is annual variability.

Table 1.6: Trends in indirect GHG emissions between 2000 and 2022.

Greenhouse gas source and sink categories	CO_2	CH_4		N^2O		Total
	Gg CO_2e	Gg	Gg CO_2e	Gg	Gg CO_2e	Gg CO_2e
1. ENERGY	365 730	210	5 882	9	2 498	**374 114**
1A Fuel combustion activities	349 971	36	1 012	9	2 493	**345 316**
1B Fugitive emissions from fuels	33 889	174	4 870	0	5	**28 798**
1C CO_2 transport and storage	NO	NO	NO	NO	NO	**NO**

1.13.5 Time-Series Consistency

Time-series inconsistencies were noted in the Energy and IPPU sectors.

1.13.5.1 1A1a Electricity and heat production

The time-series for 1A1a *Electricity and heat production* is incomplete with regards to fuel consumption data for diesel from other electricity producers prior to 2019. In the last two years diesel has not contributed more than 0.6% to the total fuel consumption for other electricity producers.

Additionally, the time-series is not consistent because from 2019 onwards data from the SAGERS is used as it is regarded to be more accurate.

1.13.5.2 1A1b Petroleum refining

The time-series for 1A1b *Petroleum refining* is incomplete with regards to fuel consumption data for diesel, natural gas, MRG and LPG prior to 2019. In the last two years these fuels have not contributed more than 8% to the total fuel consumption for the sub-category. Additionally, the time-series is not consistent because from 2019 onwards data from the SAGERS is used as it is regarded to be more accurate.

1.13.6 For IPPU

From 2020 industry reported via the SAGERS through the GHG Reporting Programme brought better consistency. Other improvements are noted below.

- **The *Other Process Uses of Carbonates*** is a new category introduced to the inventory in 2018. This has resulted in an inconsistent time series as historical data is unavailable currently. The time series consistency will be updated as industry continues to report in future via the SAGERS Portal.
- **Aluminium production (CRT 2.C.3):** Emissions were estimated using a Tier 1 approach for Prebake and Soderberg processes from 2000 to 2013 and 2000 to 2008, respectively. A Tier 3 approach was used to estimate emissions from Centre-Worked Prebake (CWPB), Side Worked Prebake (SWPB), Vertical Stud Søderberg (VSS) and Horizontal Stud Søderberg (HSS) processes from 2000 to 2008.
- The Soderberg, SWPB, VSS and HSS processes were stopped in 2008. A Tier 3 approach was used to estimate emissions for CWPB from 2012 onwards.
- **Ferroalloys production (CRT 2.C.2):** The time series is not consistent due to a change in data sources in 2018 and 2019. From 2020 industry reported via the SAGERS through the GHG Reporting Programme brought better consistency
- **Hydrogen Production (2.B.8.g):** The time series is not consistent as hydrogen production is a new category added in 2018. Historical data is not available. The time series will be built on in future as more data becomes available.
- **Aerosols (2.F.4).** Time series is not consistent over the full 20-year period as emission data for this sub-category is only available from 2011. Due to a lack of consistency in data availability, activity data was assumed to be the same from 2016.

1.14 SECTORAL ANALYSIS

1.14.1 Energy

The primary energy supply for South Africa is dominated by coal and crude oil. South Africa's energy intensity is high mainly due to the economy being dominated by large-scale, energy-intensive primary minerals beneficiation industries and mining industries. Furthermore, there is a heavy reliance on fossil fuels for the generation of electricity and to produce a significant proportion of the liquid fuels consumed in the country.

South Africa's Energy sector inventory includes:

- Exploration and exploitation of primary energy sources;
- Conversion of primary energy source into more useable energy forms in refineries and power plants;
- Transmission and distribution of fuels; and
- Final use of fuels in stationary and mobile applications.

The Energy sector is South Africa's largest emitting sector. This sector is the largest source of CO_2 emissions and the second largest source of N_2O emissions mainly because of *Fuel Combustion* activities.

1.14.1.1 Trends

Total emissions from the Energy sector for 2022 are shown in Table 1.8. Emissions from *Fuel Combustion* activities accounted for 92% of the Energy sector emissions, with *Energy Industries* accounting for 65 % of emissions from *Fuel Combustion* activities.

Table 1.7: Summary of methods and emission factors for the energy sector and an assessment of the completeness of the energy sector emissions.

GHG Source and sink category		CO_2		CH_4		N_2O		NOx	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
1A	**Fuel combustion activitie**										
1A1	***Energy industries***										
	a. Main activity electricity and heat production	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Petroleum refining	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Manufacture of solid fuels and other energy industries	T3	CS	T3	CS	T3	CS	NE	NE	NE	NE
1A2	***Manufacturing industries and construction***	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
1A3	***Transport***										
	a. Civil aviation	T1	CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Road transportation	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Railways	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	d. Water-borne navigation	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	e. Other transportation	NO		NO		NO		NO	NO	NO	NO
1A4	***Other sectors***										
	a. Commercial/ Institutional	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Residential	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Agriculture/ Forestry/ Fishing/ Fish farms	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
1A5	***Non-specified***										
	a. Stationary	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Mobile	IE		IE		IE		IE	IE	IE	IE
1B	**Fugitive emissions from fuels**										
1B1	***Solid fuels***										
	a. Coal mining and handling	T2	CS	T2	CS						
	b. Uncontrolled combustion and burning coal dumps	NE		NE		NE		NE	NE	NE	NE
	c. Solid fuel transformation	T1	DF	T1	DF	T1	DF	NE	T1	NE	NE

GHG Source and sink category		CO_2		CH_4		N_2O		NOx	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
1B2	***Oil and natural gas***										
	a. Oil	T3		T3		T3		NE	NE	NE	
	b. Natural gas	T3		T3		T3		NE	NE	NE	
1B3	***Other emissions from energy production***	T3		T3		NO		NE	NE	NE	NE
1C	**Carbon dioxide transport and storage**										
1C1	***Transport of CO_2***										
	a. Pipelines	NE									
	b. Ships	NE									
	c. Other	NE									
1C2	***Injection and storage***										
	a. Injection	NE									
	b. Storage	NE									
1C3	***Other***	NE									

The changes in Energy sector emissions since 2000, at an aggregated level, are shown in Figure 1.11. The impact of stringent lockdown restrictions in 2020, due to the COVID-19 pandemic, is seen in the drop in emissions. Thereafter emissions increased in 2021 as less stringent measures were put in place in the first half of the year and all restrictions were then revoked for the remainder of the year.

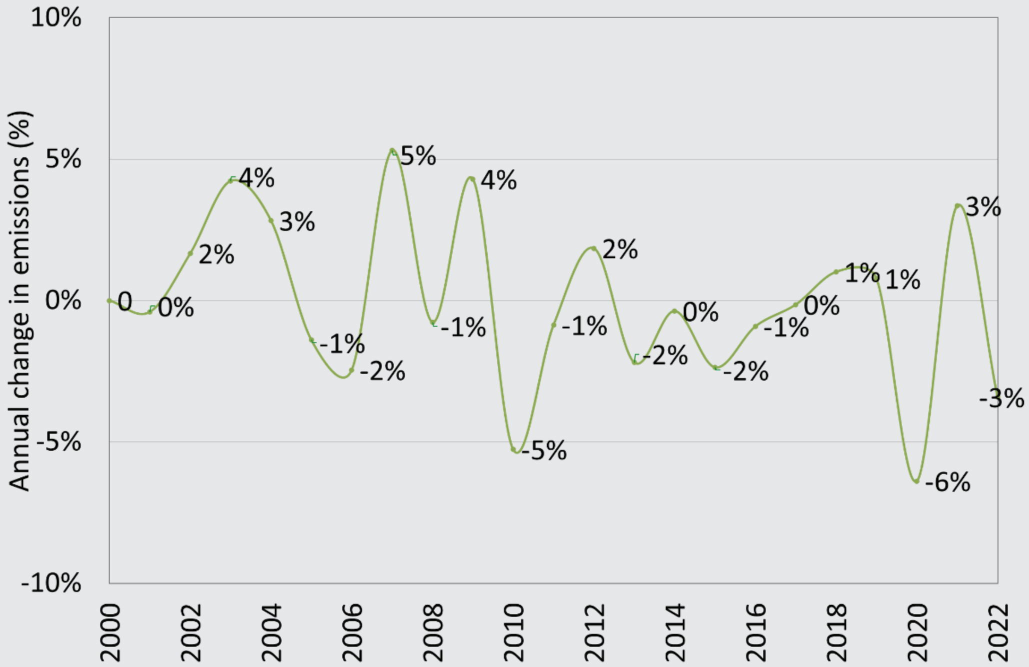


Figure 1.11. Trend in annual change in the total energy emissions in South Africa, 2000 – 2022.

The highest percentage increase in emissions since 2000 was experienced by the *Transport* and the *Manufacturing industries and construction* sub-sectors. This is due to a growing population and to growth in the manufacturing industry resulting in increased energy demand. Similarly, since 2020 the *Manufacturing industries and construction* sub-sector experienced the highest increase in emissions. This was because of increased demand in production following a temporary drop in 2020 caused by stringent lockdown restrictions.

The highest percentage decrease in emissions since 2000 was experienced by the *Other Sectors* sub-sector mainly due to a significant decrease in emissions from households due to increased electrification across the country since 2000 as well as an increase in residential solar installations.

1.14.1.2 Methods and data

Emissions for the *Energy* sector was estimated with a sectoral approach. Table 1.9 is a summary of the methods and emission factors applied to each subsector.

Table 1.8: Summary of methods and emission factors for the energy sector and an assessment of the completeness of the energy sector emissions.

GHG Source and sink category		CO_2		CH_4		N_2O		NOx	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
1A	**Fuel combustion activitie**										
1A1	Energy industries										
	a. Main activity electricity and heat production	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Petroleum refining	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Manufacture of solid fuels and other energy industries	T3	CS	T3	CS	T3	CS	NE	NE	NE	NE
1A2	Manufacturing industries and construction	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
1A3	Transport										
	a. Civil aviation	T1	CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Road transportation	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Railways	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	d. Water-borne navigation	T2	CS	T1	DF	T1	DF	NE	NE	NE	NE
	e. Other transportation	NO		NO		NO		NO	NO	NO	NO
1A4	Other sectors										
	a. Commercial/ Institutional	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Residential	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	c. Agriculture/ Forestry/ Fishing/ Fish farms	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
1A5	Non-specified										
	a. Stationary	T1, T2	DF, CS	T1	DF	T1	DF	NE	NE	NE	NE
	b. Mobile	IE		IE		IE		IE	IE	IE	IE
1B	**Fugitive emissions from fuels**										
1B1	Solid fuels										
	a. Coal mining and handling	T2	CS	T2	CS						
	b. Uncontrolled combustion and burning coal dumps	NE		NE		NE		NE	NE	NE	NE
	c. Solid fuel transformation	T1	DF	T1	DF	T1	DF	NE	T1	NE	NE

GHG Source and sink category		CO_2		CH_4		N_2O		NOx	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
1B2	Oil and natural gas										
	a. Oil	T3		T3		T3		NE	NE	NE	
	b. Natural gas	T3		T3		T3		NE	NE	NE	
1B3	Other emissions from energy production	T3		T3		NO		NE	NE	NE	NE
1C	**Carbon dioxide transport and storage**										
1C1	Transport of CO_2										
	a. Pipelines	NE									
	b. Ships	NE									
	c. Other	NE									
1C2	Injection and storage										
	a. Injection	NE									
	b. Storage	NE									
1C3	Other	NE									

1.14.1.3 Reference and sectoral approach comparison

The emissions reported for *Fuel combustion* activities are estimated using the Sectoral Approach. The Reference Approach was also used estimate emissions and the comparison of the two approaches is shown in Figure 1.12. The comparison is done until 2020 in accordance with the latest energy balance data from the DMRE. The Reference Approach resulted in higher estimates than the Sectoral Approach, as was the case with previous inventories. On average the Sectoral Approach has resulted in estimates that are 19% lower since 2000.

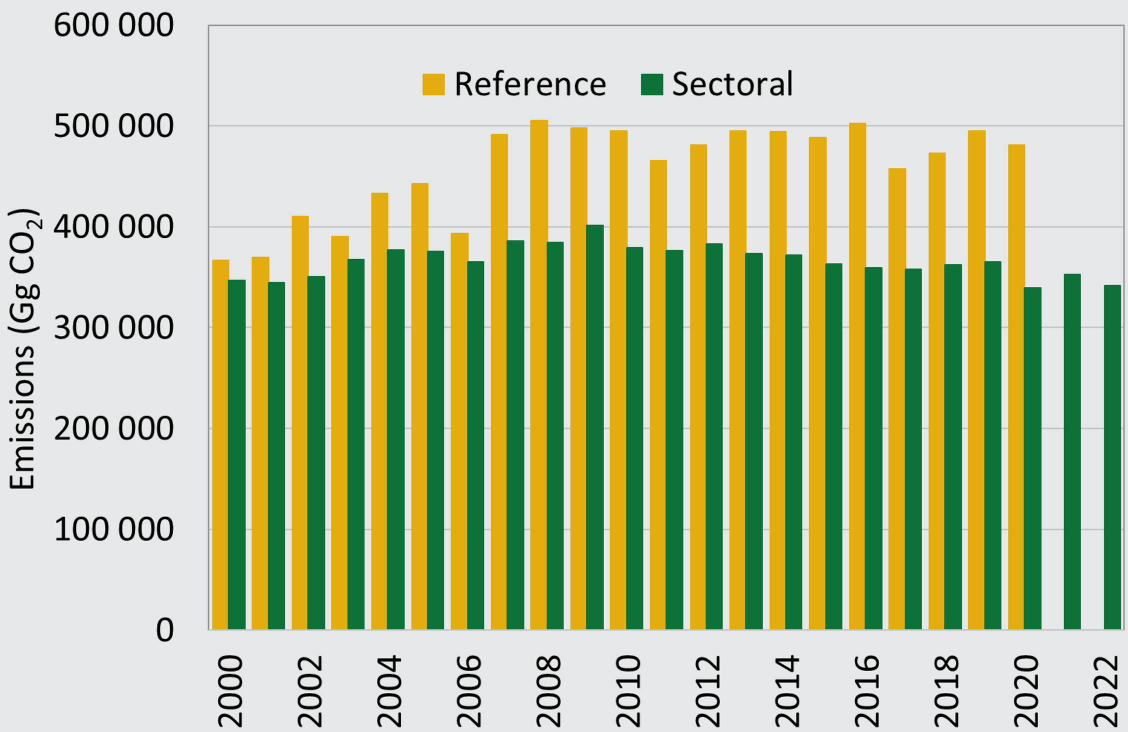


Figure 1.12. Comparisons between the reference and sectoral approach of determining the CO_2 emissions for the energy sector for South Africa.

1.14.1.4 Recalculations

Recalculations were performed for the Energy sector because of the following reasons:

- The use of country-specific emission factors for commonly used liquid and gas fuels. The emission factors result from a study that was completed in 2022. Emissions from the entire time-series were recalculated for the applicable *Fuel combustion* activities.
- Estimates from 1A2 were recalculated based on data from SAGERS and disaggregated to include emissions from 1A2a *Iron & Steel*, 1A2b *Non-ferrous Metals* and 1A2-ab the remainder of 1A2.
- Inclusion of emissions from charcoal and coke production under 1B1c for the entire time-series.
- Recalculation of 2019 and 2020 emissions estimates, where applicable[1], based on the updated activity data from the energy balance.

The improvements mentioned above resulted in the current inventory being 2.3% lower than the previous inventory estimates (Figure 1.13).

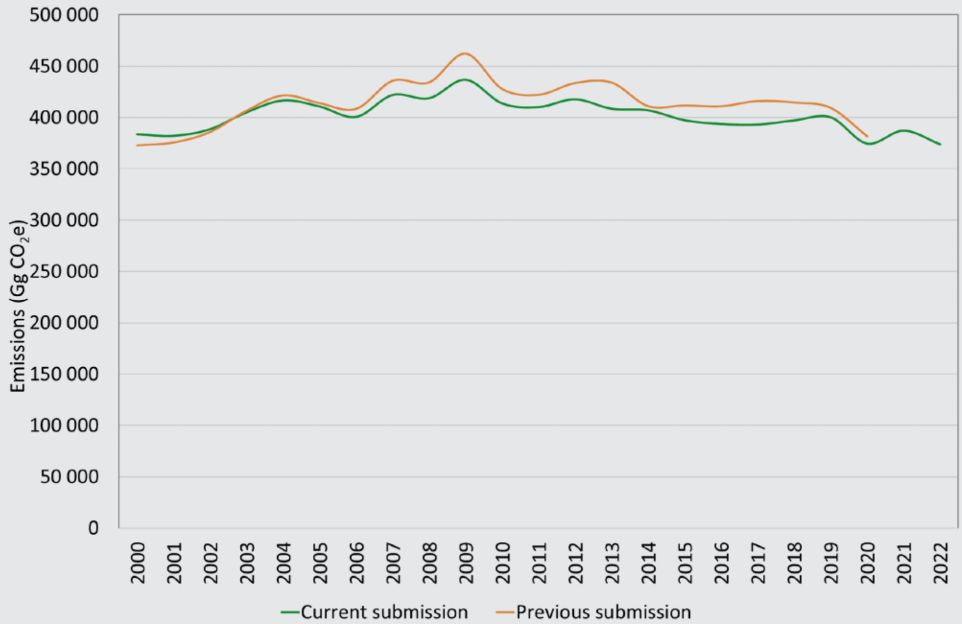


Figure 1.13: Recalculations for the Energy sector between 2000 and 2022.

1.14.1.5 Planned improvements

Improvements planned for the Energy sector are as follows:

- Moving to country-specific CO_2 factors for key solid fuels. A study was initiated in 2023 to determine the country-specific carbon contents, NCVs and emission factors for commonly used solid fuels.
- Improving activity data for fuel wood consumption in different sub-sectors.
- Including emissions from abandoned mines and spontaneous combustion.
- Disaggregating the uncertainty assessment to align with the disaggregation used for key category analysis.

1.14.2 IPPU

The IPPU sector includes non-energy related emissions from industrial processing plants. The main emission sources are released from industrial processes that chemically or physically transform raw materials and thereby release GHGs, (e.g., ammonia products manufactured from fossil fuels), GHG emissions released during these processes are CO_2, CH_4, N_2O, HFCs, PFCs and SF_6.

1 This only affects categories 1A4 and 1A5

The following industrial processes are included in the estimation of emissions from South Africa's IPPU sector:

Cement Production	Hydrogen Production
Lime Production	Other Chemicals
Glass Production	Production of steel from iron and scrap steel
Other Product Uses of Carbonates	Ferroalloys Production
Ammonia Production	Aluminium Production
Nitric Acid Production	Lead Production
Carbide Production	Zinc Production
Titanium Dioxide Production	Vanadium Production
Soda Ash Production	Lubricant Use
Petrochemical and carbon black production	Paraffin Wax Use
Product Uses as Substitutes for Ozone Depleting Substances	

HFCs and PFCs are used in many products and in refrigeration and air conditioning equipment. PFCs are also emitted because of anode effects in aluminium smelting. Therefore, the IPPU sector includes estimates of PFCs from aluminium production, and HFCs from refrigeration and air conditioning. SF_6 is also included in IPPU due to the use of electrical equipment.

The estimation of GHG emissions from non-energy sources is often difficult because they are widespread and diverse. The difficulties in the allocation of GHG emissions between fuel combustion and industrial processes arise when by-product fuels or waste gases are transferred from the manufacturing site and combusted elsewhere in different activities.

The performance of the economy is the key driver for trends in the IPPU sector. The South African economy is directly related to the global economy, mainly through exports and imports. South Africa officially entered an economic recession in May 2009, which was the first in 17 years. Until the global economic recession affected South Africa in late 2008, economic growth had been stable and consistent.

As a result of the recession, GHG emissions during that period decreased across almost all categories in the IPPU sector. Since then, GDP annual growth has slowed compared to growth before the recession. The Covid 19 pandemic caused economic growth to decline during 2020, especially during the second half of the year when lockdown measures where stricter. During 2021 and 2022 economic growth recovered to pre-covid figures.

During 2022 South Africa moved away from Tier 1 reporting towards Tier 2 and Tier 3 calculations. In certain sectors, this made quite a difference. The Metal Industry was affected most, but the accuracy has improved. The 2023 Verification programme also enhanced accuracy of Tier 3 reporting. Due to these changes, comparison with historical figures is compromised in the short term.

The largest source of emissions in the IPPU sector in South Africa is the production of ferroalloys, iron and steel followed by cement production.

1.14.2.1 Trends

In 2022 the IPPU sector produced 30 598 Gg CO_2e which is 6.4% of South Africa's emission (excl. LULUCF). The IPPU sector produces CO_2 emissions (78.4%), fluorinated gases (20.0%) and smaller amounts of CH_4 (0.4%) and N_2O (1.2%) (Table 1.10). Carbon dioxide and any other emissions from combustion of fuels in these industries are reported under the Energy sector. The largest source category is the *Metal industry* category. which contributes 51.2% to the total IPPU sector emissions.

The *Mineral industry* and the *Product used as substitutes for ozone depleting substances* subsectors contribute 19.8% and 19.4%, respectively, to the IPPU sector emissions. *Iron and steel production* and *Ferroalloys production* are the biggest CO_2 contributors to the *Metal industry* subsector, producing 6 307 Gg CO_2 (40.3%) and 8 081 Gg CO_2 (51.6%) respectively to the total metal industry GHG emissions.

Table 1.9: Summary of the estimated emissions from the IPPU sector in 2022 for South Africa

GHG source categories	Emissions (Gg CO_2e)			Difference (Gg CO_2e)		Change (%)	
	2000	2020	2022	2000-2022	2020-2022	2000-2022	2020-2022
2.IPPU	**32 781**	**24 858**	**30 598**	**-2 183**	**5 740**	**-6,7**	**23,1**
2.A Mineral industry	**4 371**	**4 774**	**6 055**	**1 684**	**1 281**	**38,5**	**26,8**
2A1 Cement Production	3 871	3 796	5 023	1 152	1 227	29,8	32,3
2A2 Lime Production	426	715	694	268	-21	62,8	-3,0
2A3 Glass Production	74	154	191	117	37	157,5	23,9
2A4 Other Process Uses of Carbonates	NE	109	147		38		34,7
2.B Chemical industry	**2 557**	**2 247**	**1 753**	**-804**	**-494**	**-31,4**	**-22,0**
2B1 Ammonia Production	C	C	C				
2B2 Nitric Acid Production	C	C	C				
2B5 Carbide Production	C	C	C				
2B6 Titanium Production	C	C	C				
2B7 Soda Ash Production	NE	C	C				
2B8f Petrochemical and Black Carbon Production	C	C	C				
2B8g Hydrogen Production	NE	C	C				
2B10 Other	NE	C	C				
2.C Metal industry	**25 658**	**12 391**	**15 655**	**-10 003**	**3 263**	**-39,0**	**26,3**
2C1 Iron and Steel Production	15 334	3 854	6 307	-9 027	2 453	-58,9	63,6
2C2 Ferroalloy Production	8 084	7 233	8 081	-3	848	0,0	11,7
2C3 Aluminium Production	2 116	1 261	1 259	-857	-2	-40,5	-0,1
2C5 Lead Production	15	7	7	-8	1	-52,4	9,0
2C6 Zinc Production	108	37	0	-108	-37	-100,0	-100,0
2.D Non-energy products from fuels and solvents	**196**	**84**	**1 125**	**929**	**1 041**	**474,1**	**1 245,5**
2D1 Lubricant Use	189	82	516	327	434	173,6	527,5
2D2 Paraffin Wax Use	7	1	609	602	608	8 091,2	43 042,8
2.E Electronic industry	NE	NE	NE				
2.F Product uses as substitute ODS	NE	**5 284**	**5 945**	**5 945**	**661**		**12,5**
2F1 Refrigeration and Air Conditioning	NE	5 187	5 837		650		12,5
2F2 Foam Blowing Agents	NE	2	2		0		0,0
2F3 Fire Protection	NE	76	88		11		15,0
2F4 Aerosols	NE	18	18		0		0,0
2.G Other product manufacture and use	NE	**78**	**66**	**66**	**-12**		**-15,5**
2.H Other	NE	NE	NE				

Even though the South African economy recovered after the COVID-19 pandemic, estimated emissions from the IPPU sector are 2 183 Gg CO_2e (-6.7%) lower than the emissions in 2000 (Table 1.10). The decline can be attributed to the decline in metals production (-39.0%), specifically *Iron and Steel production* and *Aluminium production*. This can be ascribed to a decrease in global demand. The decline in the chemicals industry also made a huge difference (-31.4%). *Cement production* and *Non-energy product use from fuels and solvents* increased emissions from 2000 by 2 081 Gg CO_2e. The local demand for cement increased dramatically from 2000.

Table 1.10 shows that IPPU emissions increased by 18.0% between 2000 and 2006, after which there was a 13.6% decline to 2009. This decrease was mainly due to the global economic recession and the electricity crisis that occurred in South Africa during this period. From 2010 emissions increased due to an increase in the *metal industry* and *products used as substitutes for ozone depleting substances* subsectors. The economy was also beginning to recover from the global recession.

Emissions decreased from 2016 as demand for South African chemical and metals dropped. COVID-19 also had a major local and international impact between 2020 and 2021.

Table 1.10: Summary of the change in emissions from the IPPU sector between 2000 and 2022

GHG source categories	Emissions ($Gg\ CO_2e$)			Difference ($Gg\ CO_2e$)		Change (%)	
	2000	2020	2022	2000-2022	2020-2022	2000-2022	2020-2022
2.IPPU	32 781	24 858	30 598	-2 183	5 740	-6,7	23,1
2.A Mineral industry	4 371	4 774	6 055	1 684	1 281	38,5	26,8
2A1 Cement Production	3 871	3 796	5 023	1 152	1 227	29,8	32,3
2A2 Lime Production	426	715	694	268	-21	62,8	-3,0
2A3 Glass Production	74	154	191	117	37	157,5	23,9
2A4 Other Process Uses of Carbonates	NE	109	147		38		34,7
2.B Chemical industry	2 557	2 247	1 753	-804	-494	-31,4	-22,0
2B1 Ammonia Production	C	C	C				
2B2 Nitric Acid Production	C	C	C				
2B5 Carbide Production	C	C	C				
2B6 Titanium Production	C	C	C				
2B7 Soda Ash Production	NE	C	C				
2B8f Petrochemical and Black Carbon Production	C	C	C				
2B8g Hydrogen Production	NE	C	C				
2B10 Other	NE	C	C				
2.C Metal industry	25 658	12 391	15 655	-10 003	3 263	-39,0	26,3
2C1 Iron and Steel Production	15 334	3 854	6 307	-9 027	2 453	-58,9	63,6
2C2 Ferroalloy Production	8 084	7 233	8 081	-3	848	0,0	11,7
2C3 Aluminium Production	2 116	1 261	1 259	-857	-2	-40,5	-0,1
2C5 Lead Production	15	7	7	-8	1	-52,4	9,0
2C6 Zinc Production	108	37	0	-108	-37	-100,0	-100,0
2.D Non-energy products from fuels and solvents	196	84	1 125	929	1 041	474,1	1 245,5
2D1 Lubricant Use	189	82	516	327	434	173,6	527,5
2D2 Paraffin Wax Use	7	1	609	602	608	8 091,2	43 042,8

GHG source categories	Emissions (Gg CO_2e)			Difference (Gg CO_2e)		Change (%)	
	2000	2020	2022	2000-2022	2020-2022	2000-2022	2020-2022
2.E Electronic industry	NE	NE	NE				
2.F Product uses as substitute ODS	NE	5 284	5 945	5 945	661		12,5
2F1 Refrigeration and Air Conditioning	NE	5 187	5 837		650		12,5
2F2 Foam Blowing Agents	NE	2	2		0		0,0
2F3 Fire Protection	NE	76	88		11		15,0
2F4 Aerosols	NE	18	18		0		0,0
2.G Other product manufacture and use	NE	78	66	66	-12		-15,5
2.H Other	NE	NE	NE				

1.14.2.2 Methods and data

A summary of the methods and emission factors applied to each subsector of IPPU is shown in Table 1.12 below.

Table 1.11: Summary of methods and emission factors for the IPPU sector and an assessment of the completeness of the IPPU sector emissions

GHG Source and sink category		CO_2		CH_4		N_2O		HFCs		PFCs		SF6		NOx	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
A	Mineral industry																
1	Cement production	T2	CS	NE										NE	NE	NE	NE
2	Lime production	T3	CS	NE										NE	NE	NE	NE
3	Glass production	T3	CS	NE										NE	NE	NE	NE
4	Other process uses of carbonates	T3	CS	NE										NE	NE	NE	NE
B	Chemical industry																
1	Ammonia production	T3	CS	T3	CS	NE								NE	NE	NE	NE
2	Nitric acid production	NE		NE		T3	CS							NE	NE	NE	NE
3	Adipic acid production	NO		NO		NO								NO	NO	NO	NO
4	Caprolactam, glyoxal and glyoxylic acid production	NO		NO		NO								NO	NO	NO	NO
5	Carbide production	T3	CS	T1	DF	NE								NE	NE	NE	NE
6	Titanium dioxide production	T3	CS	NE		NE								NE	NE	NE	NE
7	Soda Ash production	T3	CS	NE		NE								NE	NE	NE	NE
8a	Methanol	IE		IE		IE								NE	NE	NE	NE
8b	Ethylene	IE		IE		IE								NE	NE	NE	NE
8c	Ethylene Dichloride and Vinyl Chloride Monomer	NO		NO		NO								NO	NO	NO	NO
8d	Ethylene Oxide	IE		IE		IE								NE	NE	NE	NE
8e	Acrylontrile	NO		NO		NO								NO	NO	NO	NO
8f	Petrochemical and carbon black production	T1	DF	T1	DF	NE								NE	NE	NE	NE
8g	Hydrogen Production	T3	CS	NE		NE								NE	NE	NE	NE
9	Fluorochemical production							NO		NO		NO		NO	NO	NO	NO
11	Other	T2	CS	T2	CS	NE		NE		NE		NE		NE	NE	NE	NE

	GHG Source and sink category	CO_2		CH_4		N_2O		HFCs		PFCs		SF6		NOx	CO	NMVOC	SO_2
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
C	Metal industry																
1	Iron and steel production	T3	CS	NE		NE								NE	NE	NE	NE
2	Ferroalloy production	T3	CS	T3	CS	NE								NE	NE	NE	NE
3	Aluminium production	T3	CS	NE						T3	CS			NE	NE	NE	NE
4	Magnesium production	NO						NO		NO		NO		NO	NO	NO	NO
5	Lead production	T1	DF											NE	NE	NE	NE
6	Zinc production	T1	DF											NE	NE	NE	NE
D	Non-energy products from fuels and solvents																
1	Lubricant use	T1	DF											NE	NE	NE	NE
2	Paraffin wax use	T1	DF	NE		NE								NE	NE	NE	NE
3	Solvent use													NE	NE	NE	NE
E	Electronics industry																
1	Integrated circuit or semiconductor	NE				NE		NE		NE		NE		NE	NE	NE	NE
2	TFT flat panel display							NE		NE		NE		NE	NE	NE	NE
3	Photovoltaics							NE		NE		NE		NE	NE	NE	NE
4	Heat transfer fluid													NE	NE	NE	NE
F	Product uses as substitute ODS																
1	Refrigeration and air conditioning	NE						T2a, T2b	DF	NE				NE	NE	NE	NE
2	Foam blowing agents	NE						T1	DF	NE				NE	NE	NE	NE
3	Fire protection	NE						T1	DF	NE				NE	NE	NE	NE
4	Aerosols							T1a, T2a	DF	NE				NE	NE	NE	NE
5	Solvents							NE		NE				NE	NE	NE	NE
G	Other product manufacture and use																
1	Electrical equipment									NE		NE		NE	NE	NE	NE
2	SF6 and PFCs from other product uses									NE		NE		NE	NE	NE	NE
3	N_2O from product uses					NE								NE	NE	NE	NE
H	Other																
1	Pulp and paper industry	NE		NE										NE	NE	NE	NE
2	Food and beverage industry	NE		NE										NE	NE	NE	NE

1.14.2.3 Recalculations

Through the introduction of the NGER in 2017 (DEA, 2017a), amendments to these regulation in 2020 (DEFF, 2020) as well as the introduction of the SAGERS, the GHG reporting tool, there have been various additions to the inventory as well as recalculations up to 2020. During 2020 a major change was the introduction of Tier 2 and Tier 3 calculation methods as far as possible. This did lead to improved accuracy of the inventory. An external verification process was launched for key emission contributors which increased the level of accuracy. The accuracy improvement has not been quantified. No categories were added from 2020.

1.14.3 Agriculture

1.14.3.1 Trends

In 2022, the Agriculture sector produced 52 890 Gg CO_2e which is 11% of South Africa's total emissions. The largest source category in 2022 is Enteric fermentation category which contributed 36 351.4 Gg CO_2e 68% to the total agricultural sector emissions. Overall decreasing trend, the total emissions were 9% lower in 2022 compared to 2000 levels, this is due to decrease in livestock population numbers (Figure 1.14).

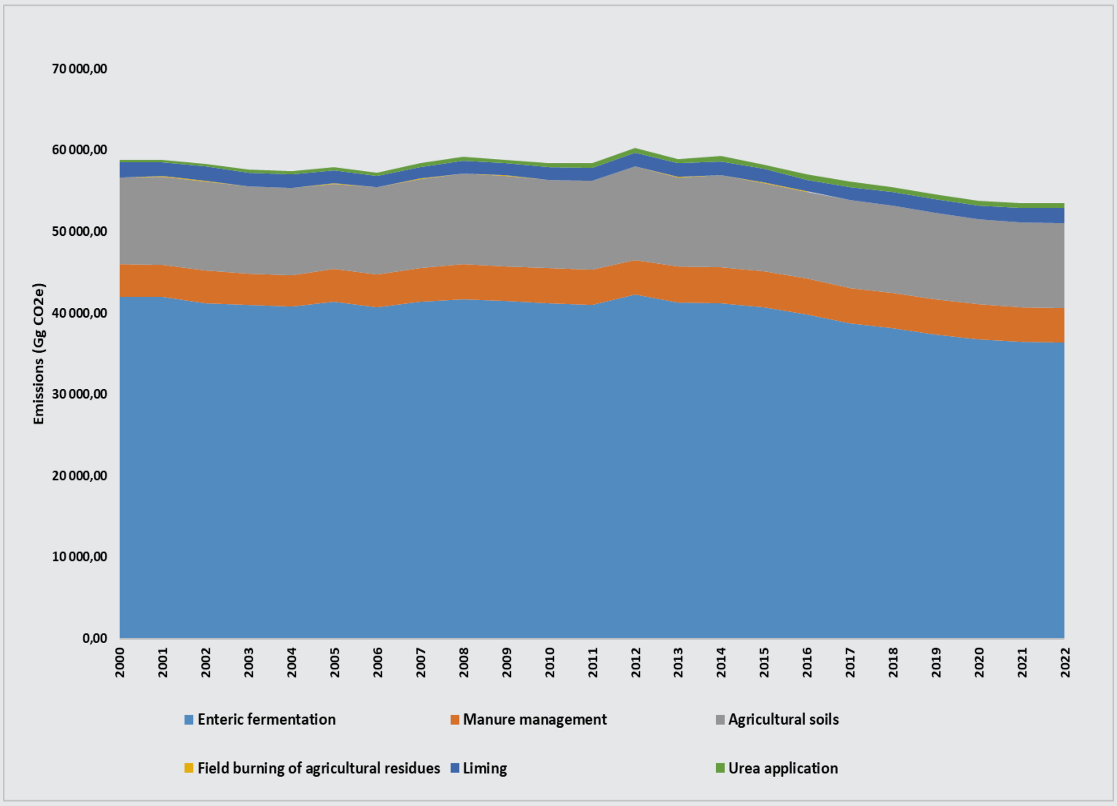


Figure 1.14: The overall AFOLU emissions for South Africa between 2000 – 2022

GHG emissions and removals from Agriculture sector are reported separately. The main categories included in the emission estimates for the agriculture sector are shown in Table 1.13. These are based on the IPCC 2006 Guidelines.

Table 1.12: List of IPCC categories included in AFOLU sector emissions inventory

IPCC Category	Category name	Included	
3A	Enteric fermentation	√	
3B	Manure management	√	
3C	Rice cultivation	NE	
3D1	Direct N_2O emissions from managed soils	√	
3D2	Indirect N_2O from managed soils	√	
3E	Prescribed burning of savannahs	IE	
3F	Field burning of agricultural residues	√	
3G	Liming	√	
3H	Urea application	√	
3I	Other carbon containing fertilisers	NE	
3J		Other	NO

Livestock included are dairy cattle, other cattle, sheep, goats, horses, mules and asses, swine and poultry. Emissions from ruminants in privately owned game parks were excluded due to comments made during the UNFCCC review.

Rice cultivation is not included. Food and Agriculture Organization (FAO) statistics indicate that there is a small area of rice cultivation in South Africa and therefore in the UNFCCC review it was indicated that this should be investigated and included if necessary. Discussions with various experts at the ARC suggests that there have been some small experimental plots for rice cultivation, but the precise area was not known but it is thought to be less than 50 ha. For this reason, rice cultivation is considered insignificant.

Emissions from fuel combustion in this sector are not included here as these falls under Transport (category 1A4c *Agriculture/forestry/fisheries*) in the Energy sector subsector.

1.14.3.2 Methods and data

The IPCC 2006 methodology (IPCC, 2006) is applied in this sector, with a few updated methodologies being taken from the IPCC 2019 Refinement of the 2006 Guidelines (IPCC, 2019). Default constants and emission factors are also sourced from these two guideline documents, with details being provided in the methodology sections within each category section. Table 1.14 shows the methods and types of emission factors used in the Agriculture inventory.

Table 1.13: Summary of methods and emission factors for the Agriculture sector and an assessment of the completeness of the Agriculture sector emissions

	GHG Source and sink category	CO_2		CH_4		N_2O		NO_x	CO	NMVOC	NH_3
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
3A LIVESTOCK	3.A Enteric fermentation										
	3.A.1- Cattle										
	3.A.1.a - Dairy cows	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.1.b - Other cattle	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.2 - Sheep	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.3 - Swine	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.4 - Other										
	3.A.4.a - Buffalo	NA	NA	NO	NO	NA	NA	NA	NA	NA	NA
	3.A.4.b - Camels	NA	NA	NO	NO	NA	NA	NA	NA	NA	NA
	3.A.4.d - Goats	NA	NA	T2	CS	NA	NA	NA	NA	NA	NA
	3.A.4.e - Horses	NA	NA	T1	DF	NA	NA	NA	NA	NA	NA
	3.A.4.f – Mules and Asses	NA	NA	T1	DF	NA	NA	NA	NA	NA	NA
	3.B Manure management										
	3.B.1- Cattle										
	3.B.1.a - Dairy cows	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
	3.B.1.b - Other cattle	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
	3.B.2 - Sheep	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE
	3.B.3 - Swine	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
	3.B.4 - Other										
	3.B.4.a - Buffalo	NA	NA	NO	NO	NO	NO	NE	NA	NA	NE
	3.B.4.b - Camels	NA	NA	NO	NO	NO	NO	NE	NA	NA	NE
	3.B.4.d - Goats	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE
	3.B.4.e - Horses	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE
	3.B.4.f – Mules and Asses	NA	NA	T2	CS	NO	NO	NE	NA	NA	NE
	3.B.4.g - Poultry	NA	NA	T2	CS	T2	CS	NE	NA	NA	NE
	3.B.5-Indirect N_2O emissions										
	3.C – Rice cultivation	NE		NE		NE					
	3.D –Agricultural soils										
	3.D.1 – Direct N_2O Emissions from managed soils										
	Synthetic fertilizers	NA		NA		T1	DF		NA	NA	
	Animal waste added to soils	NA		NA		T2	CS		NA	NA	
	Other organic fertilizers	NA		NA		T1	DF		NA	NA	
	Urine and dung deposited by grazing livestock	NA		NA		T2	CS		NA	NA	
	Crop residues	NA		NA		T1	DF		NA	NA	

GHG Source and sink category		CO_2		CH_4		N_2O		NO_x	CO	NMVOC	NH_3
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
3A LIVESTOCK	3.D.2 – Indirect N_2O Emissions from managed soils										
	Atmospheric deposition	NA		NA		T1	DF				
	Nitrogen leaching and runoff	NA		NA		T1	DF				
	3.E – Prescribed burning of savannas										
	Prescribed burning of savannas	NE		NE		NE					
	3.F – Field burning of Agricultural residues										
	Field burning of Agricultural residues	T2	DF, CS	T2	DF, CS	T2	DF, CS				
	3.G - Liming										
	Liming	T1	DF	NA		NA		NA	NA	NA	NA
	3. H - Urea application										
	Urea application	T1	DF	NA		NA		NA	NA	NA	NA
	3.I – Other carbon containing fertilisers										
	Other carbon containing fertilisers	NE		NE		NE					
	3.J - Other										
	Other	NO		NO		NO					

1.14.3.3 Recalculations

Agriculture and LULUCF were split into separate chapters within the NIR. All the other land category (*Forest land, Grassland, Wetland and Settlement*) non-CO_2 biomass burning emissions were removed from agriculture sector and incorporated into the LULUCF sector. The main inventory improvements that were carried out and which led to recalculations were:

- The agriculture sector is under continual improvement which leads to recalculations. Agriculture and LULUCF were split into separate chapters. All the other land category (*Forest land, Grassland, Wetland and Settlement*) non-CO_2 biomass burning emissions were removed from agriculture sector and incorporated into the LULUCF sector.
- For NEpreg for Beef mature cattle for different breed types, in 2020 Inventory it was assumed that all cows get pregnant, but in 2022 this was changed since ARC report indicates 80% get pregnant. For Beef mature cattle subsistence, in 2020 it was assumed that all cows get pregnant but this was changed in 2022 since ARC report indicates 60% subsistence cattle get pregnant.
- Sheep classification was changed. In the previous inventory (2020), the classification included (Total commercial sheep, Sheep slaughtered, and Total subsistence sheep). In 2022 the classification included (Merino (wool), Other wool, Dual purpose (Karakul), Non-wool, and Sheep slaughtered).
- In 2020 inventory, for Total commercial sheep, the fractions from the ARC report (2021) were used to get the total population numbers of the commercial sheep subcategories. The subcategories included Merino wool (0,53), Other wool (0,19), Dual purpose (0,14), Non-wool (0,14). In 2022 Inventory, the fractions based on the ARC report was not used as the actual data from Abstracts has been incorporated instead.
- In 2020 the Ratio of subsistence to commercial sheep (1.6) was used to multiply by the total Sheep slaughtered to get the Total subsistence sheep. In 2022 this was changed since ARC report indicates a value of 0.56; Meissner et al (2013) gives a value of 0.123.
- In the last inventory feedlot Sheep were assumed to be 50% dual purpose and 50% meat sheep, but in 2022 inventory this has been changed to 100% non-wool (meat) sheep.

- In 2020 Inventory it was assumed that all cows get pregnant. This was changed in 2022 Inventory since the ARC report indicates that only 80% get pregnant.
- For Direct Manure N_2O ER for dairy mature female cow, in 2020 inventory 1,08 kg N_2O/head/yr was used (IPCC 2019 Refinement). In 2022 inventory, country specific 1,00 kg N_2O/head/yr. So, in 2022 for all dairy subcategories, Added country specific.
- Country specific Nretention were added in 2022 inventory. In 2020 inventory, the Nexcretion rate values from the 2019 refinements were used (e.g. 144,83 (Kg N/head/yr) for mature female cow) was used. The value was very high compared to 79.98 kg N/head/year - Moeletsi & Tongwane, 2015; IPCC 2019 Africa default is 40.2 kg N/head/year if using 250kg as weight. For all subcategories, the value were very high compared to the values by Moeletsi & Tongwane, 2015; IPCC 2019 Africa defaults.
- In the 2020 inventory, the Nexcretion rate values were changed (e.g. 27,87(Kg N/head/yr) from (Weighted based on the percentage Holstein and Jersey cattle) was used. These values were low compared to 63.9 kg N/head/year - Moeletsi & Tongwane, 2015; IPCC 2019 Africa default is 40.2 kg N/head/year if using 250kg as weight. This was changed in 2022 Inventory, Added country specific Nexcretion rates.
- The agricultural burning emissions, which in this inventory were assumed to be emissions from pre-harvest burning sugarcane, were incorporated into category 3F (*Field burning of agricultural residues*). For field burning of agricultural residues, the cropland area was assumed not to burn except for sugarcane, therefore, burnt area is assumed to be 90% of sugarcane area. It was assumed that 90% of the sugarcane area is burnt and tis was based on the study by Shikwambana et al., 2021. Sugarcane Planted area data Abstracts of Agricultural Statistics 2022 (DALRRD, 2022), was used.
- Emissions from lime application were estimated per crop type using crop area data and application rates. The calculation was derived from crop areas and application rates, employing estimates from Tongwane et al. (2016).

The specific details of these improvements are discussed in the relevant category or sub-category sections within this report. The recalculations indicated a consistent trend; however, they also indicated a shift in the trend across the entire time series (Figure 115). After the recalculations, emissions are higher than those recorded in the previous inventory (Figure 115).

The improvements and their impact on the total changes in the 2022 estimates are detailed below (Figure 1.15). The recalculations indicated a consistent trend; however, they also indicated a shift in the trend across the entire time series. After the recalculations, emissions are higher than those recorded in the previous inventory.

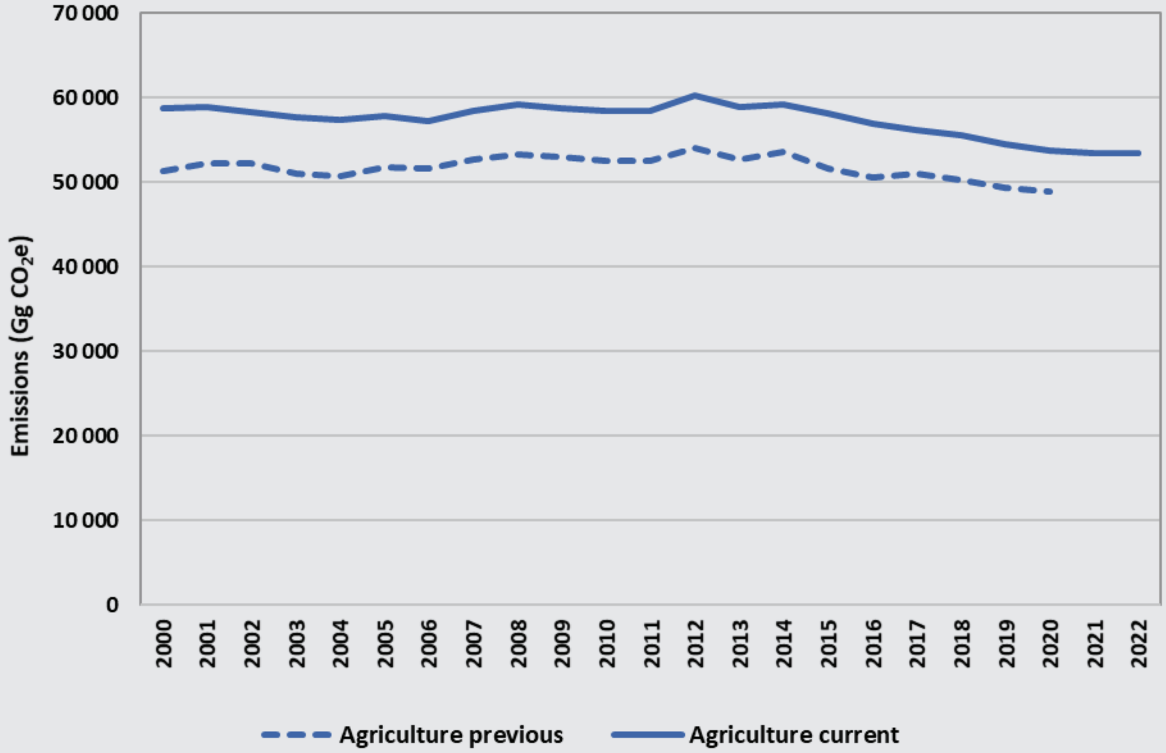


Figure 1.15: Change in Agriculture emission estimates due to recalculations since 2020 submission.

1.14.3.4 Planned improvements

The following are planned improvements and recommendations for agriculture sector to improve estimates in the future:

a) Improve livestock population data: There have been several studies on the emission factors and now the population data is the most uncertain component. Setting up a Livestock Estimates Committee could assist with this, although this has been mentioned before and not much progress has been made in terms of the committee. Further engagement is required between DFFE and the Department of Agriculture. It could also be an activity to discuss with the Agricultural Research Council which has a livestock division.

b) National data set on manure management systems: This data seems to be highly variable depending on where the information comes from. In addition, data on the amount of manure being diverted to biogas needs to be included as this is a mitigation option and has been highlighted in previous inventory reviews. It is recommended to find a mechanism to track manure management practices or systems used in South Africa, as this could allow for incorporation of dynamics driven by changes in management regimes, and thus improve the accuracy of manure related emissions.

c) A detailed study on the herd composition of the various livestock and the number of days each livestock sub-category is alive in a year would contribute to a reduction in uncertainty.

d) Collect and include in NIR background information of the livestock population original data sources (surveys, questionnaires etc.)

e) Use appropriate MCFs depending on the average temperature for each year of the time series. Stratify the estimates depending on the average temperature in different regions in South Africa.

f) Investigate if there are studies available about the burning of manure in South Africa.

g) There is a need for alternate data source for lime data

h) Collect data for Tier 2 approach on soil management category since as a key category

i) Investigate the presence of carbon-containing fertilizers in South Africa and Collect data to Estimate emissions from carbon-containing fertilizers.

1.14.4 Land use, Forestry and Land Use Change (LULUCF)

In the previous NIR the LULUCF sector was referred to as the FOLU sector (Forestry and Other Land Use) and it formed part of the AFOLU (Agriculture, Forestry and Other Land Use) sector. In the 2022 NIR the Agriculture and LULUCF sectors have been separated to bring the inventory into alignments with the Common Reporting Table (CRT) reporting requirements under the Enhanced Transparency Framework (ETF). In the LULUCF sector South Africa reports on the emissions (positive) and removals (negative) of CO_2 from the following carbon pools:

Above-ground biomass:
- Includes all living biomass above the soil including stem, stump, branches, bark, seeds, and foliage.
- Included for all land categories.

Below-ground biomass:
- Includes all biomass of live roots.
- Included for all land categories.

Litter:
- Included all non-living biomass, lying dead, in various states of decomposition above the mineral or organic soil.

Included for all land categories.

Dead wood:
- Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil.
- Only included for the Forest land category.

Mineral soils:
- Includes organic carbon in mineral soils to a depth of 30cm.
- Included for all land categories.

Harvested wood products (4.G.).

Organic soils were assumed to be negligible (Moeletsi et al., 2015).

The carbon pools are reported for the following land-use categories:
- Forest land (4.A.)
- Cropland (4.B.)
- Grassland (4.C.)
- Wetlands (4.D.)
- Settlements (4.E.)
- Other land (4.F.)

As well as the relevant land-use changes between these categories. A distinction is made between areas which, during the reporting period:
- undergo no land-use changes, and thus remain, in unchanged form, in the land-use category they are in ("land remaining" categories 4.A.1 – 4.F.1)
- undergo land-use changes: From the time of conversion onward, these areas are reported in the category to which they were converted. Within those land-use categories, the converted areas are then reported in conversion categories ("land conversion" categories 4.A.2 – 4.F.2) for a total of 20 years. After 20 years in a conversion category, the areas are reported under the relevant remaining categories.

Within each land category Direct and Indirect N_2O emissions from emissions from mineralisation due to land changes were included. In alignment with the new CRT reporting format, Direct and Indirect N_2O from nitrogen inputs to soils was considered in each land class but insufficient data was available to separate nitrogen inputs by land class so all emissions were included in the Agriculture sector (3.D Agricultural soils).

The reporting of non-CO_2 emissions from biomass burning was incorporated into the Agriculture component of the AFOLU sector in the previous inventory (under the *Aggregated and non-CO_2 emissions* category (3.C)), however due to the adjusted reporting requirements these non-CO_2 emissions are now included within each land use category under the LULUCF sector. Non-CO_2 gases emitted from biomass burning are included for *Forest land*, *Grassland*, *Wetlands*, and *Settlements*. In *Croplands* the burning is due to pre-harvest burning of sugarcane and this is included under Agriculture in category 3.F. Other lands are assumed not to burn due to the absence of biomass. *Wetlands* also include the emissions of CH_4 from wetlands and flooded lands. Emissions from humus mineralisation in mineral soils as a result of land use change and/or land management for Cropland remaining Croplands and Grasslands remaining Grasslands are reported in the *Agriculture* sector under category 3.D.1. but for all other land classes emissions are included here.

1.14.4.1 Trends

The LULUCF sector was a sink in 2022 (Table 1.15) with *Forest lands* being the largest contributor to the sink. All other land categories were a source of emissions in 2022, with *Other lands* being the largest.

Table 1.14: Summary of emissions from the LULUCF sector in 2022

Greenhouse gas source and sink categories	CO_2	CH_4		N_2O		Total
	Gg CO_2	Gg	Gg CO_2e	Gg	Gg CO_2eq	Gg CO_2e
4. LULUCF	-56 707.3		11 495.4		2 030.5	-43 181.3
4.A. Forest land	-85 684.3	76.4	2 138.2	4.5	1 204.9	-82 341.1
4.B. Cropland	3 496.9	IE	IE	1.4	376.5	3 873.4
4.C. Grassland	10 427.5	16.7	467.2	1.5	406.1	11 300.8
4.D. Wetlands	746.9	317.5	8 889.2	0.2	42.3	9 678.4
4.E. Settlements	-2 369.8	0.0	0.8	0.0	0.7	-2 368.3
4.F. Other land	19 022.0	NA	NA	NA	NA	19 022.0
4.G. Harvested wood products	-2 346.5	NA	NA	NA	NA	-2 346.5

Figure 1.16 provides an overview of the LULUCF emission trends for South Africa over the time-series 2000-2022. The time-series reflects the trends in land-use changes. The land-use changes have been determined based on South African National Land Cover (SANLC) data sets for the reference years 1990, 2014, 2018 and 2020. Between the reference years, the land-use changes have been linearly interpolated, hence the larger changes after each refence year and the constant average land-use changes between reference periods. A map is being developed for 2022 but was not finalised before the preparation of this inventory and so the data was not included in this inventory. Data for the period 2020-2022 was extrapolated based on the change area provided between 2018 and 2020.

Forest lands were the largest contributor to the sink across the time-series. The dominant *Forest land* sinks were thickets and woodlands. The increasing *Forest land* sink between 2014 and 2022 is due to an increasing woodland sink because of an increase in the conversion of grassland to woodland. The increasing woodland sink was reduced slightly between 2017 and 2022 by the decreasing thicket sink caused by a reduction in the thicket area. The overall variation in the *Forest land* category follows a similar pattern to the burnt area data. For example, the years 2005 and 2021 were high burn years which meant an increase in emissions and an increase in disturbance losses in *Forest lands* therefore a reduced sink in 2005 and 2021.

Croplands showed an increase in emissions between 2015 and 2018 due to the conversion of perennial crops to annual crops and the conversion of woodlands to subsistence crops. These emissions were reduced between 2019 and 2022 as these conversions were reduced and there was some conversion of annual crops to perennial crops.

The change in *Grasslands* is what was causing the reduced sink between 2017 and 2022. Between 2015 and 2018 there is an increase in the conversion of low shrublands to grasslands, while between 2019 and 2022 there is an increase in the conversion of woodland to grassland leading to an increased source.

Converted lands were the largest contributors to all land categories except *Wetlands* where non-CO_2 emissions from wetlands play a role. Overall, the LULUCF sector increased its sink by 56.3% since 2000 and by 17.9% since 2020. *Grasslands* changed from a small sink in 2000 to a large source in 2020 and 2022. Changes were large between 2000 and 2020 with part of the reason being that the data for these years came from two different land change maps, however change is small between 2020 and 2022 as would be expected from a shorter change period and where the comparison is between two maps produced in the same way.

Biomass is the dominant carbon pool. Soils remain a small sink throughout the time-series, while The DOM pool increases its sink strength between 2019 and 2022.

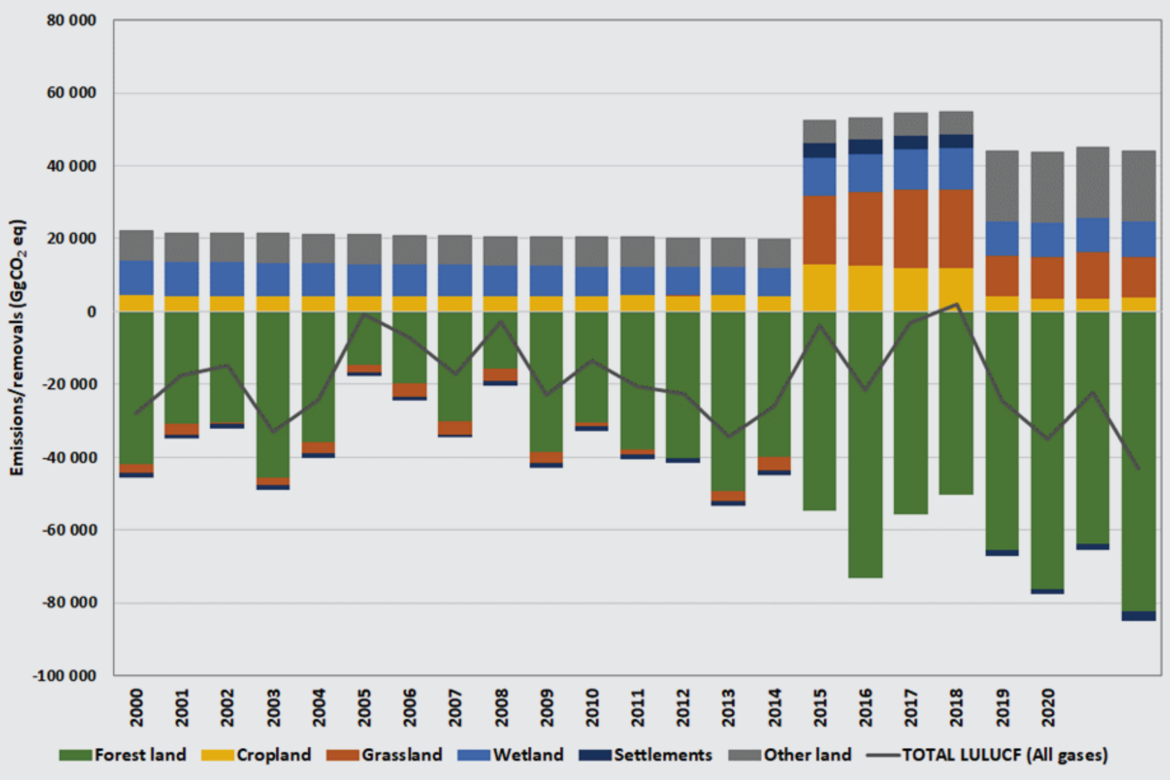


Figure 1.16: Time series for GHG emissions and removals by land type in the LULUCF sector in South Africa, 2000 - 2022

1.14.4.2 Methods and data

A summary of the tier level of the methods and types of emission factors incorporated into the inventory are provided in Table 1.16.

Table 1.15: Summary of methods and emission factors for the LULUCF sector and an assessment of the completeness of the sector

GHG Source and sink category	CO_2		CH_4		N_2O		NO_x	CO	NMVOC	NH_3
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor				
4A Forest land										
4.A.1. Forest land remaining forest land	Biomass: T2 Litter: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	T1	DF	T1	DF	T1/DF	T1/DF	T1/DF	NE
4.A.2. Land converted to forest land	Biomass: T2 Litter: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	T1	DF	T1	DF	T1/DF	T1/DF	T1/DF	NE
4B Cropland										
4.B.1. Cropland remaining cropland	Biomass: T1 (annuals), T2 (perennials) Litter: T1/T2 Soil: T2	Biomass: DF/CS Litter: DF/CS Soil: CS	IE		IE		IE	IE	IE	NE
4.B.2. Land converted to cropland	Biomass: T2 Litter: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	IE		T1	DF	IE	IE	IE	NE
4C Grassland										
4.C.1. Grassland remaining grassland	Biomass: T1 (grasslands), T2 (low shrubland) Litter: T1/T2 Soil: T2	Biomass: DF/CS Litter: DF/CS Soil: CS	T1	DF	T1	DF	T1/DF	T1/DF	T1/DF	NE
4.C.2. Land converted to grassland	Biomass: T2 Litter: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	T1	DF	T1	DF	T1/DF	T1/DF	T1/DF	NE
4D Wetland										
4.D.1. Wetland remaining wetland	Biomass: T1/T2 Litter: T1/T2 Soils: T2	Biomass: DF/CS Litter: DF/CS Soil: CS	T1	DF/CS	T1	DF/CS	T1/DF	T1/DF	T1/DF	NE
4.D.2. Land converted to wetland	Biomass: T2 Litter: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	T1	DF	T1	DF	T1/DF	T1/DF	T1/DF	NE
4E Settlements										
4.E.1. Settlements remaining settlements	Biomass: T2 Litter: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	T1	DF	T1	DF	T1/DF	T1/DF	T1/DF	NE
4.E.2. Land converted to settlements	Biomass: T2 DOM: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	T1	DF	T1	DF	T1/DF	T1/DF	T1/DF	NE
4F Other land										
4.F.1. Other land remaining other land	Biomass: NA Litter: NA Soil: T2	Soil: CS	NA		NA		NA	NA	NA	NA
4.F.2. Land converted to other land	Biomass: T2 Litter: T2 Soil: T2	Biomass: CS Litter: CS Soil: CS	NA		NA		NA	NA	NA	NA
4G Harvested wood products										
Harvested wood products	T2	DF	NA		NA		NA	NA	NA	NA

1.14.4.3 Recalculations

The main inventory improvements that were carried out and which led to recalculations were:

- Inclusion of the three separate land change maps:
    - 1990-2014
    - 2014-2018
    - 2018-2020
- Updated corrections and assumptions for the 2014-2018 change to correct for the change in land classification due to improved resolution of the maps
- Removal of "unlikely" conversions from all land change matrix
- Removal of potential seasonal variation for the conversion between forest lands and grasslands
- Inclusion of corrections for conversions from converted lands
- Inclusion of country specific BCEF factors for plantations
- Inclusion of disturbance matrix for plantations
- Updated the household fuelwood consumption factor
- Updated carbon stock data for the various land categories
- Movement of cropland burning to the agriculture sector (category 3.F)
- Inclusion of the growth of biomass of the last 5 years of the maturity cycle in the cropland remaining cropland category
- Implementation of a corrected CH_4 emission factor for wetlands and inclusion of emissions from flooded land
- Inclusion of N_2O emissions from mineralisation
- Incorporation of non-CO_2 emissions from biomass burning into LULUCF to align with ETF reporting requirements
- A change from the KP methodology for HWP to the IPCC 2006 productions approach as recommended by UNFCCC
- Change from SAR to AR5 GWPs

The recalculations showed the same trend between 1990 and 2014 as the previous data except that the sink was enhanced in this inventory. After 2014, with the introduction of the new land change maps, the LULUCF sector sink was reduced compared to the previous inventory. The sink then returned to previous levels in 2014 by 2019. In the previous inventory the 2020 estimated sink was -27 321 Gg CO_2, and in this inventory the LULUCF sink was estimated at -36 891 Gg CO_2 in 2020 (Figure 1.17).

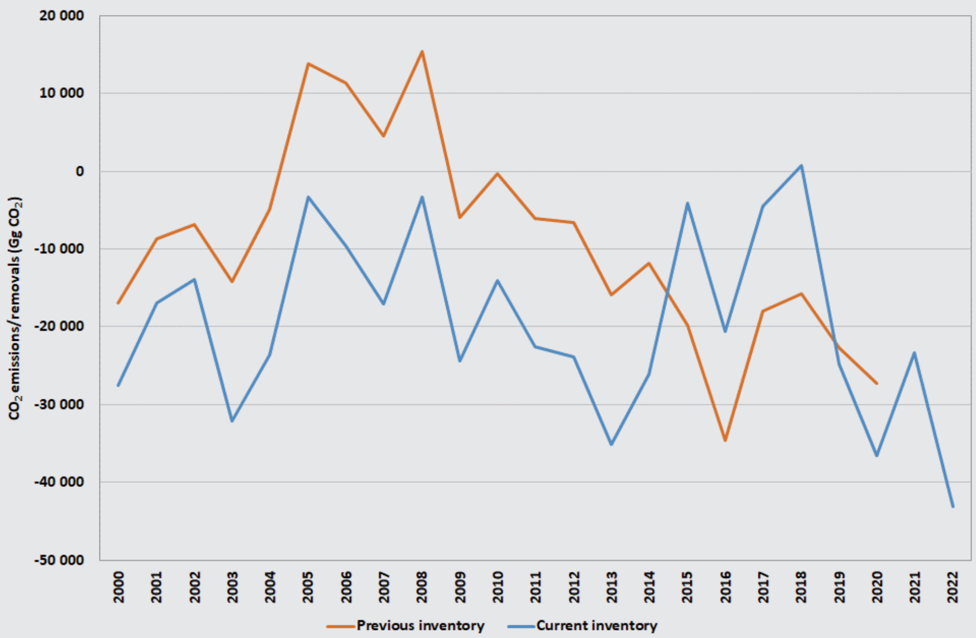


Figure 1.17: Change in LULUCF emission estimates due to recalculations since 2020 submission

1.14.4.4 Planned improvements

The major uncertainty in the LULUCF sector is related to the land conversion areas. Currently there are various corrections that are being applied to distinguish seasonal change from actual change and to estimate which fraction of land conversion are occurring on "land remaining". An additional land change map for the period 2020-2022 will be available in the next year and along with this will be the basic 8 class maps for each year between 2018 and 2022. These additional data sets could assist in reducing uncertainty on these land conversion corrections and areas. A detailed plan is being implemented to improve the land change data in a systematic manner and to incorporate all corrections spatially to ensure consistency in the overlays. The aim is to obtain a better understanding of actual change. This will involve a more detailed analysis of the land change data that will take time to complete, so the improvement plan for this component will run over the next 3 years. The initial phases of the improvement plan will be focused on forest land and grasslands as these are the key categories, after which the other categories will be addressed. As part of this improvement plan the difference between the SANLC cropland area and the reported agricultural area in the Agricultural Abstracts will be investigated. As part of this improvement plan the difference between the SANLC cropland area and the reported agricultural area in the Agricultural Abstracts will be investigated. Incorporated into the plan will be the use of Collect Earth to verify land use change and assist in tracking these changes.

These planned land change mapping improvements will also lead to an improved soil overlay, thereby allowing for an improvement in the SOC data. The overall improvement would mean a reducing in the uncertainty about the SOC data. The incorporation of organic soils remains on the improvement list, but the priority is lower than that of the improvements to the land change analysis.

The other proposed improvement is a more detailed analysis of the HWP. This was proposed in the last inventory; however, the incorporation of the additional land change maps and the more detailed analysis of the land change took preference because this data influenced the key categories. The HWP analysis will need to be done as a project and funds will need to be sought to complete this improvement.

Lastly, it is of high importance to improve the transparency of the LULUCF calculation files and the report, and this process has already started but will continue to be improved for the next inventory cycle.

1.14.5 Waste

The waste sector is a significant contributor to the rising levels of GHGs in the atmosphere. This section details the GHG emissions from managed landfills, open burning of waste, and wastewater treatment systems in South Africa, based on estimates using the IPCC 2006 Guidelines and the 2019 refinements for National Greenhouse Gas Inventories.

In South Africa's national Inventory, the waste sector includes the main sources:

- 4A Solid waste disposal
- 4C Open burning of waste
- 4D Wastewater treatment and discharge
- 4B Biological treatment of solid waste, including CH_4 and N_2O emissions

For a comprehensive account, emissions from waste incineration also need to be addressed. Additionally, emissions from using solid waste as fuel in energy industries and manufacturing industries are reported in the energy sector.

1.14.5.1 Trends

In South Africa, the waste sector emitted a total of 20 698.43Gg CO_2e in 2022 (Table 1.17), representing a significant portion of the national emissions. Most of the waste sector emissions are from wastewater treatment and discharge accounting for 45% of the emissions, followed by solid waste disposal accounting for 42%. Emissions from biological treatment of solid waste and open burning of waste only contribute 12% and 2%, respectively.

Waste sector emissions have increased by 44.1% since 2000. For wastewater treatment and discharge while the overall emissions increased, emissions for industrial wastewater treatment and discharge have decreased by 8.6%. Emissions increased steadily between 2000 and 2022 (Figure 1.18).

Table 1.16: Summary of the estimated emissions from the Waste Sector in 2022

Categories	Emissions [Gg]							Total emissions
	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2	(Gg CO_2e)
5 - Waste	**28.91**	**682.05**	**5.93**	**NE**	**NE**	**NE**	**NE**	**20 698.43**
5A - Solid Waste Disposal		307.00		NE	NE	NE	NE	8 596.00
5A1 - Managed Waste Disposal Sites		307.00		NE	NE	NE	NE	8 596.00
5A2 - Unmanaged Waste Disposal Sites		NE		NE	NE	NE	NE	NE
5A3 - Uncategorised Waste Disposal Sites		NE		NE	NE	NE	NE	NE
5B - Biological Treatment of Solid Waste		61.99	3.00	NE	NE	NE	NE	2 530.38
5C - Incineration and Open Burning of Waste	28.91	8.69	0.20	NE	NE	NE	NE	325.37
5C1 - Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE
5C2 - Open Burning of Waste	28.91	8.69	0.20	NE	NE	NE	NE	325.37
5D - Wastewater Treatment and Discharge	0.00	304.37	2.73	NE	NE	NE	NE	9 246.69
5D1 - Domestic Wastewater Treatment and Discharge		125.25	2.73	NE	NE	NE	NE	4 231.15
5D2 - Industrial Wastewater Treatment and Discharge		179.13		NE	NE	NE	NE	5 015.54
5E - Other (please specify)				NE	NE	NE	NE	NE

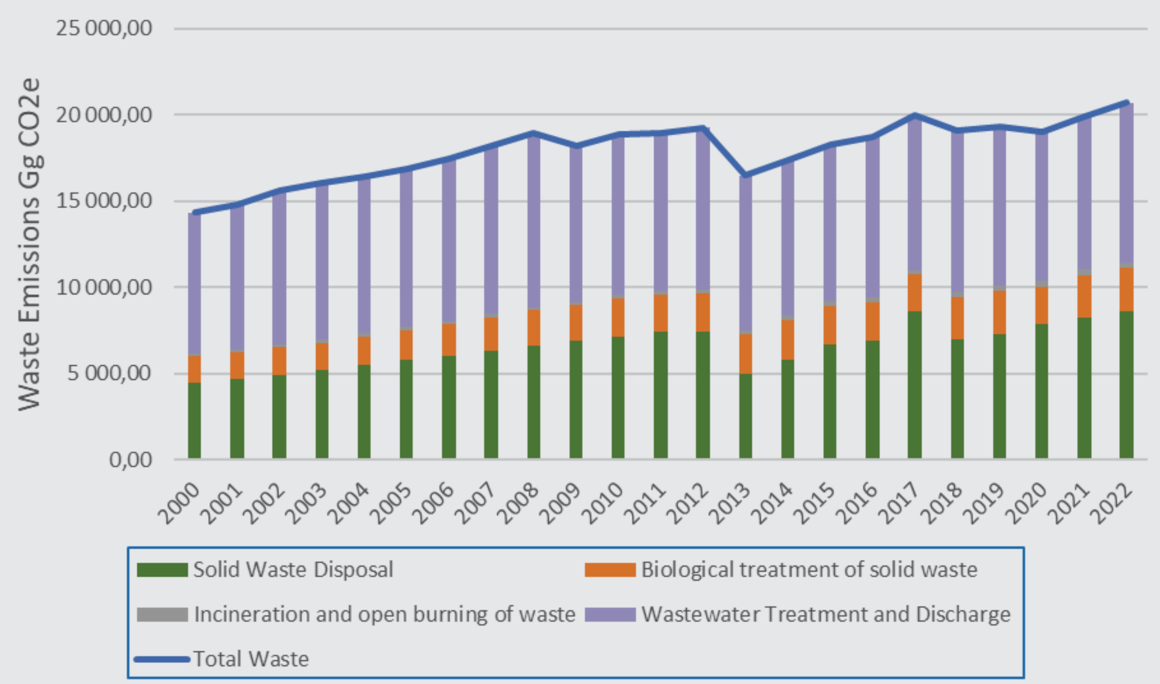


Figure 1.18: Trend in emissions from waste sector, 2000 – 2022

1.14.5.2 Recalculations

Recalculations were conducted for the Solid waste disposal category for all years from 2000 to the most recent inventory year (2022) due to the following updates:

- Updated the population data with the latest Statistics South Africa data
- Change from SAR to AR5 GWPs
- Updated COD values for various industries by reverting back to IPCC defaults due to variability in country-specific COD
- Correction of units for biological treatment of solid waste category

1.14.5.3 Methods and data

The emissions for the waste sector were calculated using available data or estimates based on surrogate data from the scientific literature.

Table 1.18 outlines the methods and emission factors used for this sector. A major challenge in quantifying GHG emissions from various waste streams is the absence of regularly updated national inventory data. This includes data on the amounts of organic waste deposited in well-managed landfills, annual methane recovery from these landfills, the quantities of anaerobically decomposed organic matter from treated wastewater, and per capita annual protein consumption in South Africa.

Table 1.17: Summary of methods and emission factors for the Waste sector and an assessment of the completeness of the Waste sector emissions

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	
A	Solid waste disposal	NA	NA	T1	DF	NA	NA	Tier 1 FOD model was used.
B	Biological treatment of solid waste	NA	NA	T1		T1		2006 IPCC GL
C	Incineration and open burning of waste	T1	DF	T1	DF	T1	DF	2006 IPCC GL
D	Wastewater treatment and discharge	NA		T1	DF, CS	T1	DF	2006 IPCC GL

1.14.5.4 Planned improvements

Estimating GHG emissions in South Africa has been particularly challenging due to the lack of specific activity and emission factor data. Consequently, emissions from both solid waste and wastewater sources were primarily calculated using default values from the IPCC 2006 Guidelines, resulting in substantial margins of error. While no specific improvements are currently planned, South Africa has identified the following areas for potential enhancement in the improvement plan:

- Obtain data on the quantities of waste disposed of into managed and unmanaged landfills including its composition.
- Improve the classification of landfill sites.
- Improve the reporting of economic data (e.g. annual growth) to include different population groups. The assumption that GDP growth is evenly distributed (using a computed mean) across all the population groups is highly misleading and leads to exacerbated margins of error.
- Obtain information on population distribution trends between rural and urban settlements as a function of income; and
- Conduct a study to trace waste streams and obtain more information on the bucket system which is still widely used in South Africa.
- Collect data on CH_4 recovery at SWDS based on metering data.

1.15 SUPPLEMENTARY INFORMATION TO FACILITATE TRACKING PROGRESS ON IMPLEMENTATION AND ACHIEVEMENT OF SOUTH AFRICA'S NDC

South Africa's updated NDC outlines a framework for tracking progress on emission reductions in accordance with information for Clarity, Transparency and Understanding. Progress will be assessed by comparing emissions in 2025 and 2030 with annual data from South Africa's Greenhouse Gas (GHG) inventory, excluding emissions from natural disturbances in the land sector. Emissions from natural disturbances will be reported separately in the NIR by sector (Forest lands, Grasslands, Wetlands, Settlements) and disaggregated by relevant IPCC categories. The methodology for estimating these emissions is described in detail in the NIR. The uncertainty around separating wildfires from controlled fires due to data limitations is noted. Emissions from both wildfires and controlled fires include vegetation disturbance losses and non-CO_2 emissions. GHG emissions data from natural disturbances is provided in Table 1.19 below.

Table 1.1.18 GHG emissions from natural disturbances (including controlled fires), and total GHG emissions (including land use) with and without natural disturbances (including controlled fires)

	2021	2022
GHG emissions from natural disturbances (including controlled fires)	52 251.31 Gg CO_2e	40 863.66 Gg CO_2e
Total LULCF emissions INCLUDING emissions from natural disturbances (including controlled fires)	-22 408.56 Gg CO_2e	-43 181.30 Gg CO_2e
Total LULCF emissions EXCLUDING emissions from natural disturbances (including controlled fires)	-74 659.88 Gg CO_2e	-84 044.96 Gg CO_2e

02

INFORMATION NECESSARY TO TRACK PROGRESS MADE IN IMPLEMENTING AND ACHIEVING NDCS UNDER ARTICLE 4 OF THE PARIS AGREEMENT

2. Information necessary to track progress made in implementing and achieving NDCs under Article 4 of the Paris Agreement

2.1 NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

This section provides an overview of South Africa's population, economy, and climate variability impacts, offering context for the country's opportunities and challenges in addressing climate change. The institutional arrangements in place to track progress made in implementing and achieving the country's Nationally Determined Contributions (NDC) and the progress made in implementing and achieving the NDC targets are presented in this chapter.

2.1.1 Government structure

The Republic of South Africa (RSA) is a constitutional democracy with a three-tiered system of government and an independent judiciary. The national, provincial and local levels of government all have legislative and executive authority in their respective spheres and the Constitution of the Republic of South Africa (RSA, 1996) defines them as distinct, interdependent and interrelated. This government structure outlines legislation is developed and how the authority for implementation is assigned across the different spheres of government.

The Constitution of the Republic of South Africa (RSA, 1996) and all other relevant legislation and policies applicable to government to address environmental management. These include the National Development Plan (NDP), the National Environmental Management Act (NEMA) (Act 107 of 1998), National Environmental Management: Air Quality Act (NEM: AQA) (Act 39 of 2004), the NCCRP and any other relevant legislation and policies related to climate change.In particular the Climate Change Act 22 of 2024 addresses issues related to institutional and coordination arrangements across the three spheres of government, namely national, provincial, and local.

The Department of Forestry, Fisheries and Environment (DFFE) provides leadership in promoting sustainability in environmental management, conservation, and protection for the benefit of all South Africans. The DFFE is mandated by the country's constitution to uphold citizens' right to a healthy environment and to protect the environment for both current and future generations. The department is responsible for monitoring national environmental information, policies, programs, and legislation related to climate change, ensuring alignment with climate change policies and international obligations. Additionally, the DFFE coordinates and manages all climate change-related information, including but not limited to mitigation, adaptation, and monitoring and evaluation programs.

The DFFE has developed several systems and tools to facilitate access to data and information to track progress towards achieving the country's NDC. The key system that has been developed in this regard is the National Climate Change Information System (NCCIS), which is fully operational and institutionalised. The NCCIS resides within the DFFE web environment with a systems administrator who manages the system and thus the DFFE has developed institutional capacity in support of hosting and maintaining the NCCIS.

The Tracking and Evaluation (T&E) Portal and the National Climate Change Response Database (NCCRD) are examples of the existing hard linked tools to the NCCIS. It is expected that as other modules, tools or sub-systems are uploaded, the system will be expanded.

2.1.2 Population profile

In 2017, the population stood at 56.52 million, growing to 62.02 million in 2022. During the same period, the unemployment rate reached 33% in 2022. The country's real GDP expanded by 2,0% between 2021 and 2022, from R 4,50 trillion to R 4,60 trillion in its recovery post the global COVID-19 pandemic (Stats SA, 2023).

In 2022, the total energy system demand was similar to 2021, but still 5.2 TWh (2.2%) less than the pre-lockdown levels of 2019. In the early stages of the COVID-19 pandemic, particularly in 2020, South Africa's strict lockdown led to a significant decline in economic activity which affected industrial production, transportation, and energy use, resulting in a notable decrease in greenhouse gas emissions (GHG) across various sectors. While COVID-19 led to short-term reductions in emissions, South Africa's reliance on coal means that the carbon intensity of energy production remains high.

By 2022 in terms of service delivery in South Africa, 80% of households had access to electricity, with 66% having access to refuse removal and 82% of the population having access to piped water according the 2022 census.

South Africa is characterized by its emerging economy and holds the distinction of being the world's largest exporter of gold, platinum, and natural resources. The country's GDP and economic growth are primarily driven by mining, finance, trade, and government services.

With a human population of 62.02 million (Section 2.12) and total carbon dioxide (CO_2) emissions, including LULUCF, at 335,766,900 tCO_2 (Table 1.6 of Section 1.13.1) in 2022, South Africa has the highest per capita CO_2 emissions in Africa, reported at 5.414 CO_2/capita. This distinction primarily stems from the country's heavy reliance on fossil fuel-based energy systems, notably coal and diesel thermal power generation. Substantial emissions from the transportation sector also occur as the transport sector is responsible for approximately 11% of the country's CO_2 emissions (Nthuli et al, 2024).

The population of South Africa is distributed across nine provinces. Despite being the smallest of South Africa's nine provinces, Gauteng is home to 15.1 million people, making up 24.3% of the total population, the largest share among the provinces. KwaZulu-Natal follows with an estimated 12.4 million people, comprising 20% of the population, while the Free State has the smallest population share at about 3 million people (4.8%) (Stats SA, 2022).

In 2022, 88,5% of households resided in formal dwellings, 3,1% in traditional dwellings and 8.1% in informal dwellings. Gauteng and the Western Cape received the largest numbers of migrants, approximately 1,553,162 and 468,568 respectively (Stats SA, 2021). The trend of rural to urban migration is expected to persist, exerting additional strain on urban governance and service delivery amid the challenges posed by climate change (DPSA, 2016). This further strain on service delivery puts climate mitigation initiatives on the backburner as meeting basic needs of the country are prioritised. The potential result of which is a lag in meeting existing NDC targets.

2.1.3 Geographical profile

South Africa, situated at the southernmost point of the African continent, boasts a coastline spanning over 3,000 km. This coastal stretch runs from the Namibian desert border in the west to the Mozambique border in the east, flanked by the Atlantic Ocean on the west coast and the Indian Ocean on the east. South Africa borders Botswana, Namibia, and Zimbabwe, with Mozambique and Eswatini to the northeast. Additionally, the landlocked kingdom of Lesotho is surrounded by South African territory.

South Africa spans an area of 1,219,602 square kilometers, stretching from 22°S to 35°S latitude and 17°E to 33°E longitude (GCIS, 2020). The country is characterized by three main geographical regions: a wide central plateau, surrounded by mountain ranges to the west, south, and east, and a narrow coastal plain. The Central Plateau dominates nearly two-thirds of South Africa's landmass (GCIS, 2020). Rising abruptly from the plateau are various mountain ranges that gradually slope down to sea level. This transition is marked by the Great Escarpment, which ranges in elevation from 2,000 to 3,300 meters (GCIS, 2020). Figure 2.1 illustrates the location map of the Republic of South Africa, depicting the Great Escarpment and the central plateau.

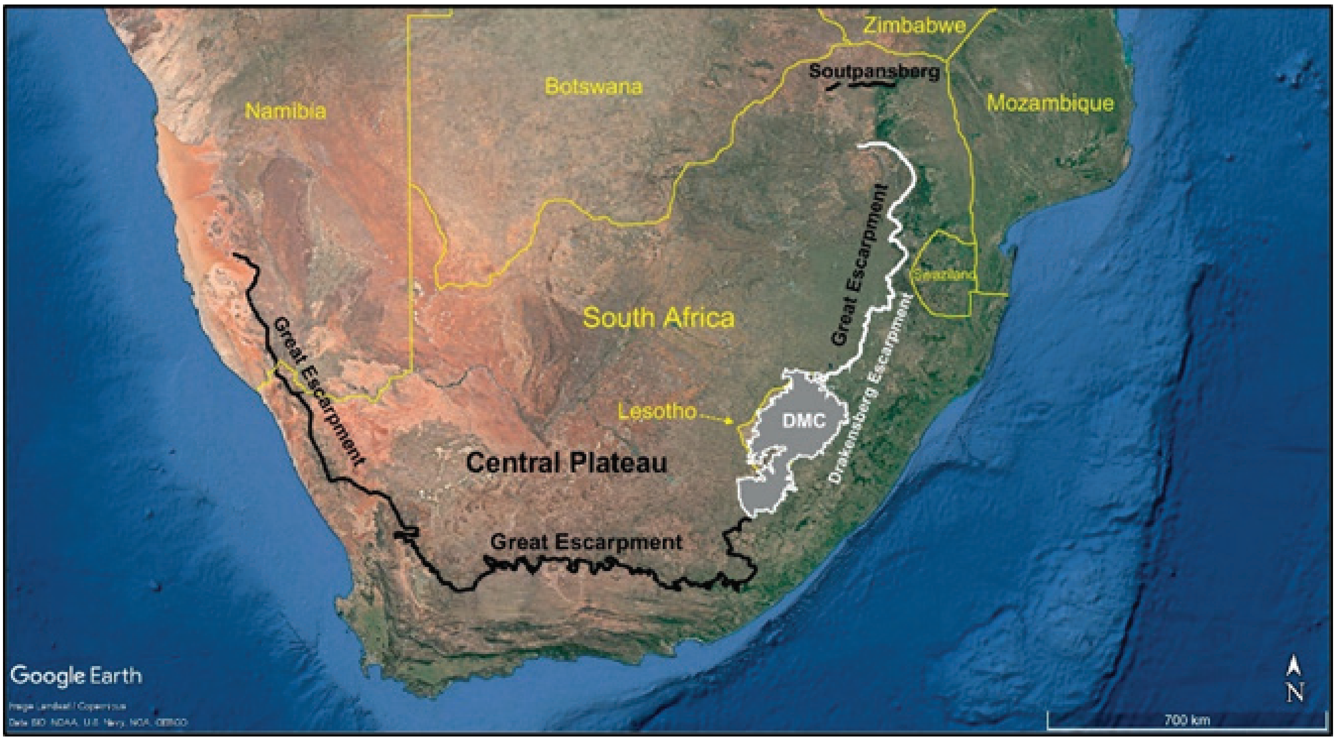
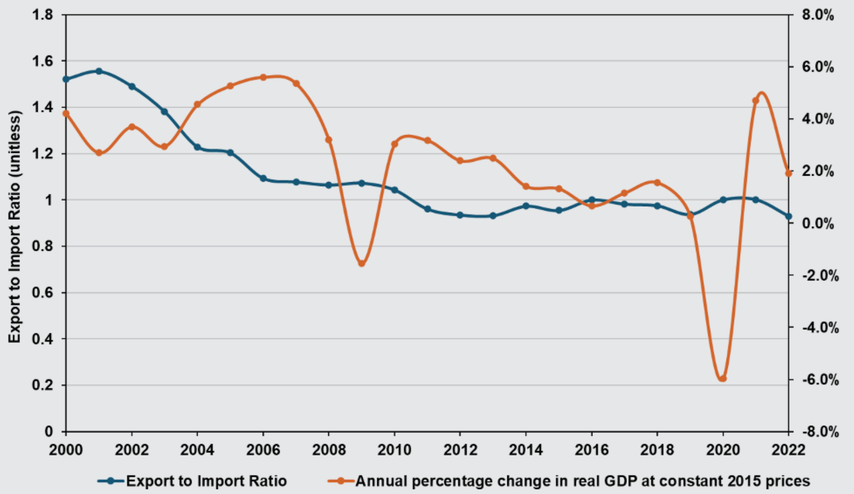


Figure 2.1: Google earth image of Southern African Central Plateau and Great escarpment. Source: CARBUTT (2019)

2.1.4 Economic Profile

South Africa is classified as an upper middle-income country according to the World Bank income group classification. The primary economic sectors include mining, transportation, energy, manufacturing, tourism, and agriculture. The country's GDP has increased from 2.8 trillion rands in 2000 to 4.6 trillion rands in 2022 as shown in Figure 2.2 (Stats SA, 2022).



Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
GDP at constant 2015 prices in R trillions	2.83	2.90	3.01	3.10	3.24	3.41	3.60	3.80	3.92	3.86	3.97	4.10	4.20	4.30	4.36	4.42	4.45	4.50	4.57	4.58	4.31	4.51	4.60

Figure 2.2: Timeseries of annual percentage change in GDP and the export to import ratio as macro-economic indicators (Source: Stats SA)

While the country is small in terms of the GHG emissions embodied within its goods and services, South Africa is a leading net exporter of GHG emissions which constitute a large share of the economy wide emissions (Trade & Industrial Policy Strategies - TIPS, 2020). The country's more GHG emission intensive exports are heavily concentrated around a few value chains including passenger cars, trucks, automotive parts, Platinum Group Metals, coal and petroleum products. Other key exports are less GHG emission intensive including iron ore, gold, manganese, chromium, diamonds and ferroalloys (TIPS, 2020).

South Africa's economy is highly vulnerable to shifts in the global economy aimed at reducing the impact of climate change (TIPS, 2020). South Africa faces substantial challenges to remain competitive in a carbon-constrained world. Contributing factors include high socio-economic inequality, which complicates policy consensus, and the country's small, open economy, which limits bargaining power and increases the risk of capital flight. South Africa's sprawling cities and limited public transport lead to a dependency on fossil fuels, further hindering economic transformation. These factors collectively make it challenging for South African businesses to reduce fossil fuel reliance, threatening future growth and job creation under mounting climate constraints.

2.1.5 Climate Profile

South Africa experiences a semi-arid climate, with an average annual precipitation of approximately 500 mm (GCIS, 2020). The Western Cape receives most of its rainfall during winter, while the rest of the country is characterized by summer rainfall. The country's subtropical position, influenced by its three-sided ocean exposure and the altitude of the central plateau, contributes to its warm temperate climate. Compared to other regions at similar latitudes, South Africa generally has cooler temperatures due to its higher elevation above sea level. On the central plateau, where Johannesburg lies at an altitude of 1,694 meters, average summer temperatures remain below 30°C. Winter nights can be frosty in some areas due to the elevation. Coastal regions of South Africa enjoy relatively mild winters. The east and west coasts experience distinct temperature variations due to the warm Agulhas Current and the cold Benguela Current, respectively (GCIS, 2020).

South Africa exhibits a diverse range of climatic conditions, transitioning from Mediterranean in the southwest to temperate across the central plateau and subtropical in the northeast (GCIS, 2020). A desert climate is present in a small area in the northwest of the country (GCIS, 2020). The country's varied geographical landscapes play a crucial role in shaping these distinct climates (GCIS, 2020), with elevation, terrain, and ocean currents exerting more influence on temperatures than latitude alone. South Africa typically enjoys warm, sunny days and cool nights (GCIS, 2020).

Currently, South Africa is experiencing increased occurrences of extreme weather events, attributed to observed changes in the climate system. The year 2020 was notably warm compared to previous years, partly due to above-average rainfall across much of the country. Data from 26 climate stations indicate that the annual mean temperature anomalies in 2020 were slightly higher on average than during the reference period (1981-2010), ranking it as the 13th warmest year since 1951. The country is undergoing a warming trend of 0.16°C per decade, a statistically significant change at the 5% level (SWS, 2021). The annual mean surface temperature deviation for South Africa is illustrated in Figure 2.3 below.

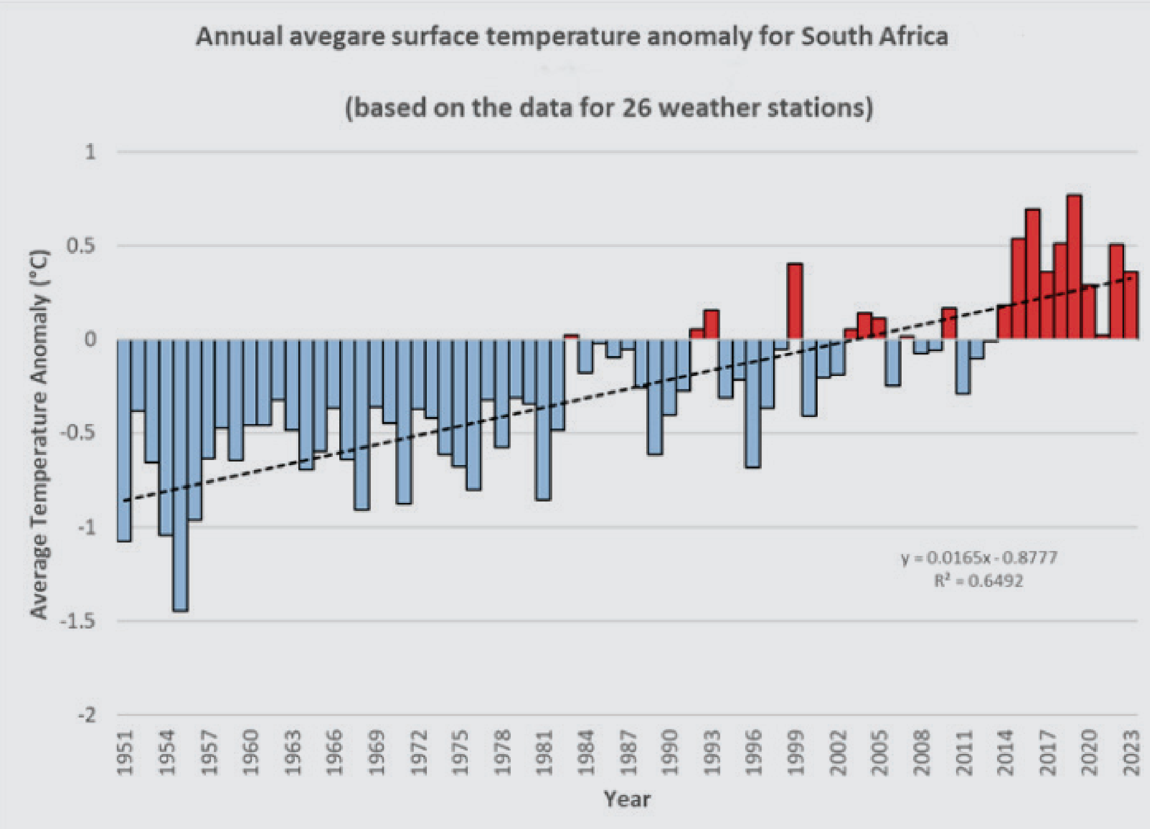


Figure 2.3: Annual average surface temperature deviation for South Africa.
Source: SAWS (South African Weather Services) (2023)

South Africa has witnessed a notable increase in the frequency and severity of extreme weather events. Since 2013, the country has faced prolonged and intensified drought conditions, alongside devastating flash floods in various regions. One of the most severe droughts occurred in 2018, prompting cities like Cape Town to implement water restrictions in anticipation of a potential "day zero" crisis, where water sources would be insufficient to meet demand.

In the Eastern Cape and Northern Cape regions, recurring droughts from 2015 to 2018 led to crop failures and significant livestock losses, impacting farmers' livelihoods and the nation's food and water security. The Knysna fires of 2017, exacerbated by droughts and strong winds linked to climate change (Le Maitre et al., 2019), were among the worst fire disasters in South Africa's history. These fires displaced over 10,000 people and caused extensive damage to both natural habitats and properties.

The insurance and forestry sectors, along with government, incurred direct costs of at least ZAR 3 billion due to the fire disaster. Additionally, the Cape Storm of June 2017 brought unprecedented winds of 120 km/h and 12-meter-high waves, resulting in severe damage to over 100 schools, widespread flooding of homes, and at least 8 fatalities.

More recently, in April 2022, flash floods and landslides in KwaZulu-Natal Province caused by extreme rainfall resulted in 448 fatalities, displaced over 40,000 people, and destroyed at least 12,000 homes. These extreme weather events are increasingly attributed to global climate changes driven by global warming (Engelbrecht et al., 2022).

2.1.6 Sector details

In line with South Africa's 9th National Inventory Report (NIR) the key sectors for which GHG emissions in South Africa are estimated are Energy, IPPU, LULUCF, Agriculture and Waste. Sector details and emission trends are outlined in Chapter 1 of this Biennial Transparency Report (BTR).

2.1.7 Effect of national circumstances on GHG emissions and removals over time

According to the World Bank, South Africa is classified as an upper-middle income country and is the largest economy on the African continent. South Africa's Gross Domestic Product (GDP) has grown steadily in the years post the COVID 19 pandemic, expanding by 2,0% between 2021 and 2022, from R4,50 trillion to R4,60 trillion. However, South Africa faces persistent challenges of high unemployment, poverty, and inequality, which are deeply entrenched in its socio-economic fabric. With an unemployment rate exceeding 30%, especially among the youth, and a substantial portion of the population living in poverty, the country struggles with low economic mobility and widening income disparities. These issues are compounded by slow economic growth, exacerbating the socio-economic divide.

South Africa continues to be one of the leading suppliers of mineral commodities globally. Consequently, its overall energy consumption per unit of GDP is approximately 50% higher than the worldwide average. This elevated consumption is fuelled by energy-intensive sectors and the specific type of coal utilized in the energy supply system. According to the 2021 South African Energy Balance, South Africa's total primary energy supply (TPES) is dominated by coal, which constituted 71% of the TPES, followed by crude oil with 23% and nuclear with 3%. Renewables account for less than 1% of TPES.

The energy sector in South Africa is of vital importance to the economy as it creates jobs and value by extracting, transforming and distributing energy goods and services throughout the economy. As a carbon-intensive economy, heavily reliant on coal for energy production, South Africa's economic model is vulnerable to both environmental and economic pressures. The country's dependence on fossil fuels for industrial activity, energy generation, and exports not only contributes significantly to global carbon emissions but also exposes it to risks associated with the global transition to cleaner energy.

2.1.8 Institutional arrangements in place to track progress made in implementing and achieving its NDC under Article 4

South Africa has taken significant steps to establish the legal and institutional arrangements for the Measurement, Reporting and Verification (MRV) of GHG emissions to track the implementation of its NDC. These arrangements are complemented by an independent, statutory, multistakeholder body established by President Cyril Ramaphosa, that is the Presidential Climate Commission (PCC). The purpose of the PCC is to oversee and facilitate a just transition to a low-emissions and climate-resilient economy and support the policy aspects of the Just Transition associated with Climate Change Mitigation. These include conducting the National Employment Vulnerability Assessment Sectors Jobs Resilience

Plans (SJRPs) and supporting the Presidency with the Just Energy Transition Implementation Plan. The PCC further engage a wide range of stakeholders, including all spheres of government, business, labour, academia, communities, and civil society, towards creating a social partnership around a just transition. This approach ensures that the implementation of the NDC is viewed through the lens of a just transition.

South Africa has previously reported on its institutional arrangements in the submission of its Biennial Update Reports, with the last iteration submitted in 2023. A brief summary of previously reported information with updated information on the key legal, institutional, administrative and procedural arrangements for domestic implementation, monitoring, reporting, archiving of information and stakeholder engagement related to the implementation and achievement of the NDC are discussed below.

2.1.9 Legal, institutional, administrative and procedural arrangements for domestic implementation, monitoring, reporting, archiving of information and stakeholder engagement related to the implementation and achievement of its NDC under Article 4

2.1.9.1 Institutional arrangements for Measurement Reporting and Verification (MRV)

The DFFE is responsible for co-ordinating and policymaking with respect to environmental conservation. The National Environmental Management: Air Quality Act (NEM: AQA) (Act 39 of 2004) provides the mandate to the DFFE to formulate, co-ordinate and monitor national environmental information, policies, programmes, and legislation. The DFFE (Figure 2.4). The DFFE is responsible for co-ordination and management of all climate change-related information, including the compilation and update of National GHG Inventories (discussed in Chapter 1 of this BTR) The compilation of the GHG emissions inventory and the NIRs are managed through the National Greenhouse Gas Information System (NGHGIS) and are the responsibility of the Climate Change Mitigation and Specialist Monitoring Services Chief Directorate in DFFE. The UNFCCC focal point sits within the International Climate Change Relations and Reporting Chief Directorate in DFFE and is responsible for the compilation and submission of the NIR, BTR and National Communication (NC) reports to the UNFCCC.

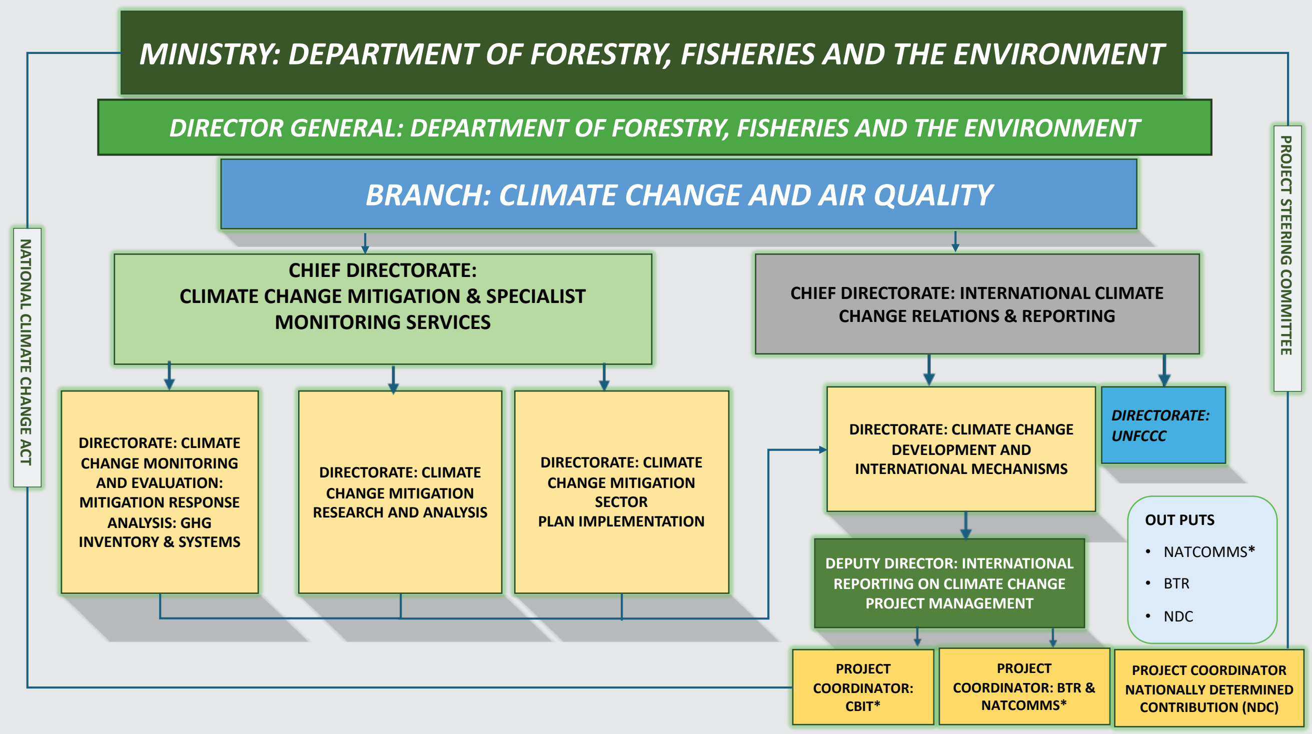


Figure 2.4: Overview of the DFFE Climate Change and Air Quality Branch

The South African Climate Change Information System (NCCIS) is a web-based platform for tracking, analysis, and enhancement of country's progress towards a climate resilient society and low carbon economy. The platform offers a series of decision support tools to inform policy and decision-making including a database of adaptation and mitigation actions undertaken by stakeholders across the country. The NCCIS includes sub-national systems and sector specific systems building on the work that has already been done on the NCCIS.

The NCCIS is supported by national, provincial, and local scale systems of data-collection to provide detailed, complete, accurate and up to date data that ranges across adaptation and mitigation related topics (Figure 2.5). The information is contained within the themes of:

- Climate Information.
- Climate Services.
- Tracking and Evaluation (T&E) Portal.
- Carbon Sinks Atlas.

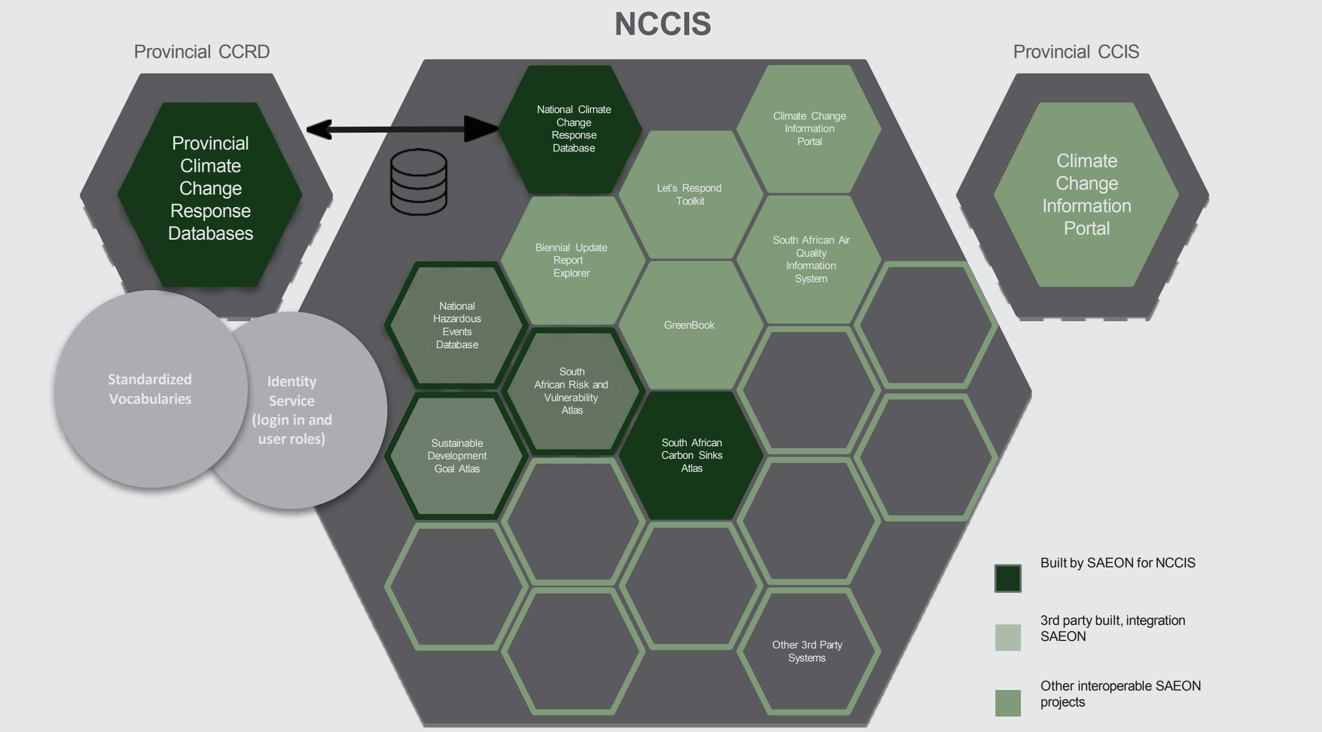


Figure 2.5: A diagram of the South African National Climate Change Information System (NCCIS) and its various expandable components

DFFE has in previous GHG emission inventories been responsible for collecting all the data from the various data providers for all the sectors covered. The National Greenhouse Gas Emission Reporting Regulations (NGERs) allows for the collection of data from the energy sector and industries (including plantation industries and certain agricultural industries). The NGERs were promulgated in fulfilment of the implementation of the regulatory framework to support the collection of the requisite activity and GHG emissions data necessary for the compilation of the National GHG emissions Inventory. In doing so, the data collected through the NGERS will improve the quality, sustainability, accuracy, completeness and consistency of the National GHG Inventories. In accordance with regulation 7(1) of the NGERS the initial reporting cycle commenced on 31 March of 2018 requiring data providers to register and submit activity and GHG emissions data to the competent authority, namely DFFE.

As required in the 2011 White Paper (DEA, 2011), the DFFE has subsequently developed the South African Greenhouse Gas Emissions Reporting System (SAGERS) which is the GHG module of the National Atmospheric Emissions Inventory System (NAEIS). The SAGERS module helps to facilitate the process of enabling Industry to meet its GHG reporting requirements in a web-based secure environment and facilitates the data collection process for energy related activities and Industrial Processes and Product Use (IPPU). The DFFE Climate Change Mitigation and Specialist Monitoring Services Unit is responsible for managing the SAGERS system.

The NCCIS is managed by DFFE Climate Change Mitigation and Specialist Monitoring Services who has the responsibility of ensuring that various tools on the system are updated and that the various data providers update their information on the system. This includes drawing the information from the NCCIS to the inventory and initiating projects to update the tools on the NCCIS. This should be done every few years and will require financial support to complete.

The South African Weather Service is responsible for updating the climate data on the Climate Information Portal (CIP) and National Hazardous Events Database (NHED). The National Climate Change Response Database is currently updated by DFFE Climate Change Mitigation and Specialist Monitoring Services Unit. In future a system can be setup to automatically filter data from the Provincial Climate Change Response Databases (PCCRD) to the national system since similar vocabularies have been used to allow for integration. It is the responsibility of the provinces to update the PCCRDs. In the future it could be setup such that data is collected at the local municipality level and filtered through to the PCCRD and then to the NCCRD.

The DFFE Climate Change Mitigation and Specialist Monitoring Services unit is responsible for updating mitigation, adaptation and finance data to T&E system. The T&E Portal is a sub-module of the NCCIS specifically designed as a platform for tracking South Africa's progress towards NDC goals and commitments. The T&E Portal tracks South Africa's climate action and transparency under the Climate Change Paris Agreement in a transparent, simple, interactive, dynamic and informative manner to inform both the domestic and international audience.

Financial data is requested from donor organisations by DFFE Climate Change Mitigation and Specialist Monitoring Services who are also responsible for uploading the data to the T&E system. The DFFE together with National Treasury and other stakeholders collaborated on the development of a National Climate Finance Support Strategy that will enhance tracking climate finance.

The Climate Change Monitoring and Evaluations System supports regular production of communication material that describes South Africa's climate change actions for local and international audiences. Once the information is analyzed it is shared with the Climate Change Development and International Mechanisms Directorate to be included in the Biennial Transparency Report.

The overall institutional arrangements and data flows for the MRV of GHG emissions, mitigation, adaptation, and support are shown in Figure 2.6. The components of South Africa's Tracking and Evaluation System is shown in Figure 2.7. These systems and tools provide a means for the country to continuously collect and store climate change information that is necessary to track progress on implementing the country's NDC and report progress within National Communications and the BTR.

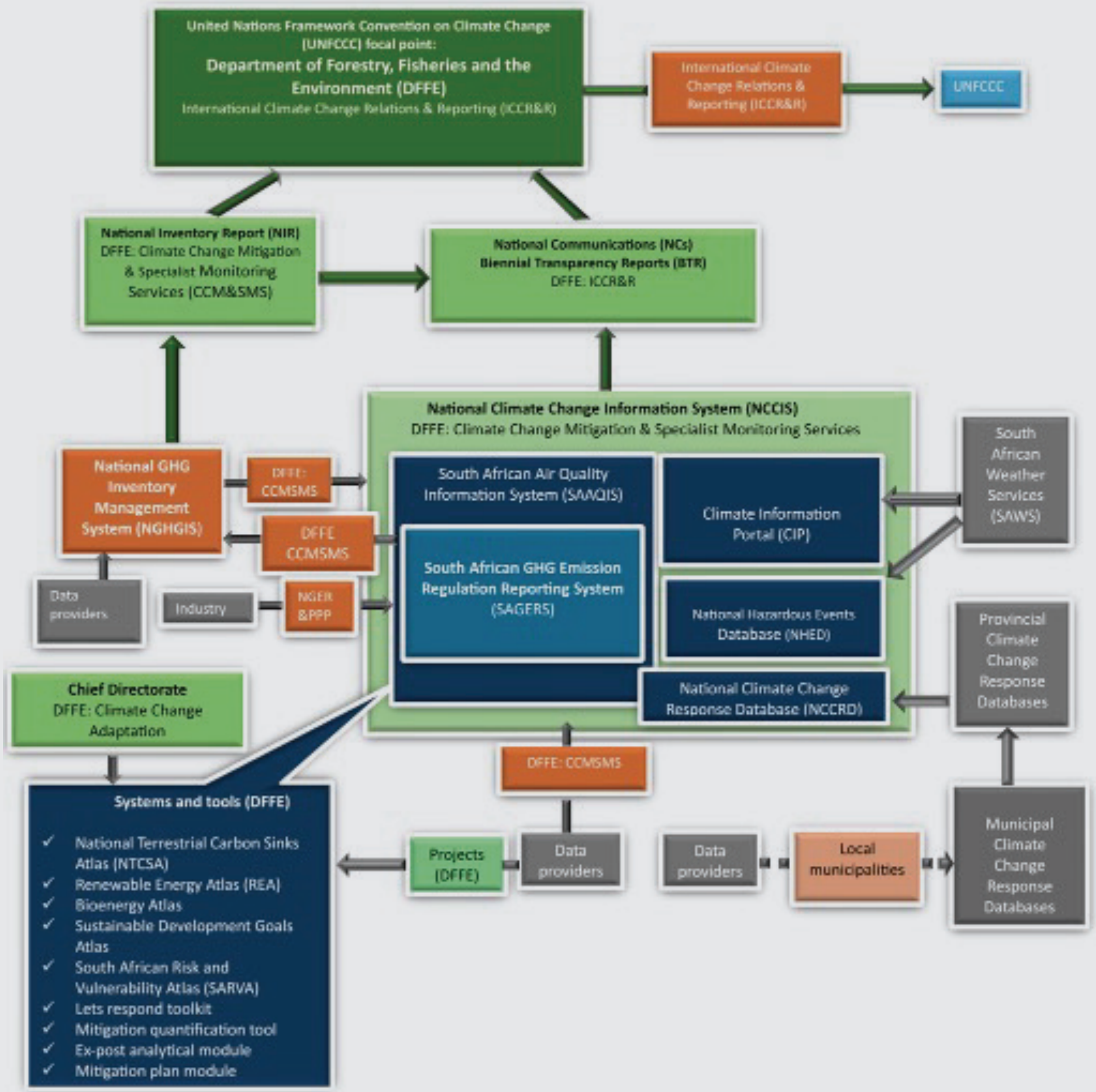


Figure 2.6: Diagram of the institutional arrangements and data flows for MRV in South Africa

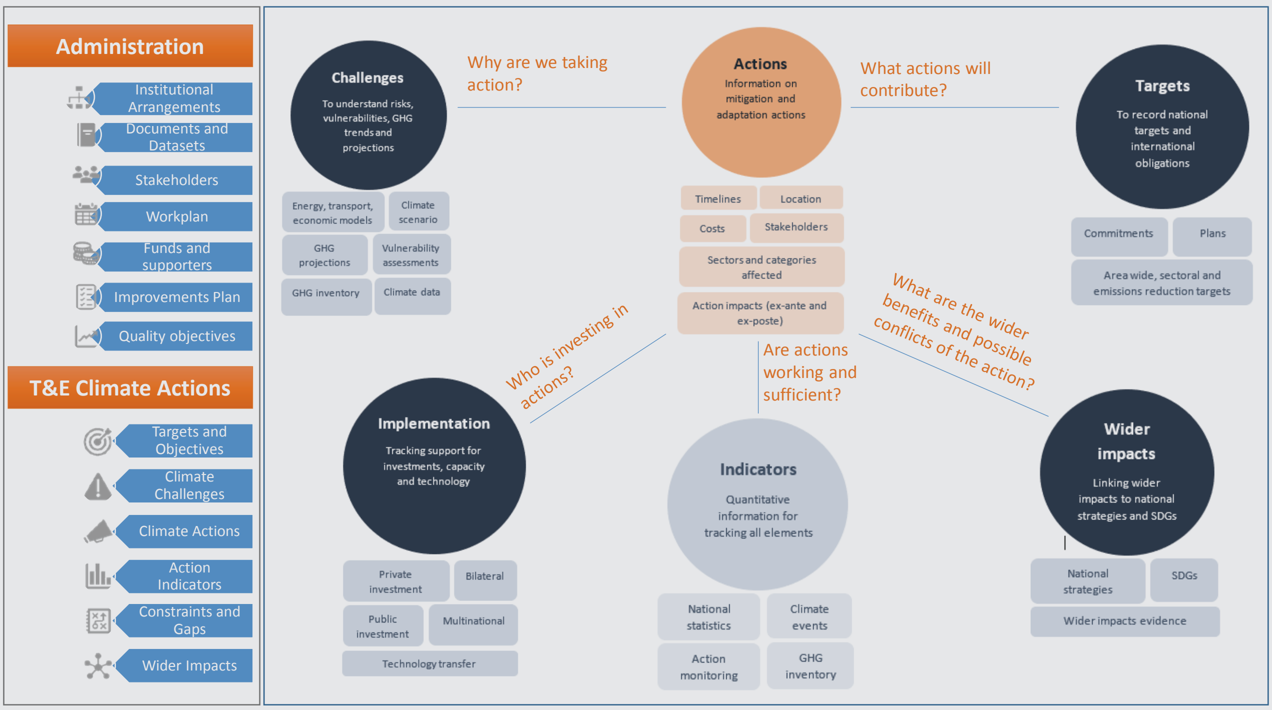


Figure 2.7: Components of South Africa's Tracking and Evaluation System

Sub-national frameworks at a provincial level have institutionalised, with the Initiative for Climate Action Transparency (ICAT) guide on non-state and sub-national action developed by ICAT also being used to support sub-national entities. Through the support of external donor funding the Mpumalanga Climate Change Response Database (https://mccrd.environment.gov.za/s) has been developed. Similar processes are also underway in three other provinces namely KwaZulu-Natal, Western Cape and Northern Cape.

2.1.9.2 Climate mitigation system

The implementation of the mitigation elements of the National Climate Change Response Policy and the Climate Change Act is achieved by allocating Sectoral Emissions Targets (SETs) to public sectors, assigning Carbon Budgets and associated mitigation plans to industry (see Figure 2.8 for structure of the climate mitigation system). The verification process for the Carbon Tax regime administered by the National Treasury and the South African Revenue Service (SARS) is also supported. A framework has been developed outlining the approach that the DFFE would follow when coordinating the process towards the allocation and implementation of SETs with the line sector departments, provinces and local governments. With the implementation of the Climate Change Act 22 of 2004, the elements of the system will be legally enforceable.

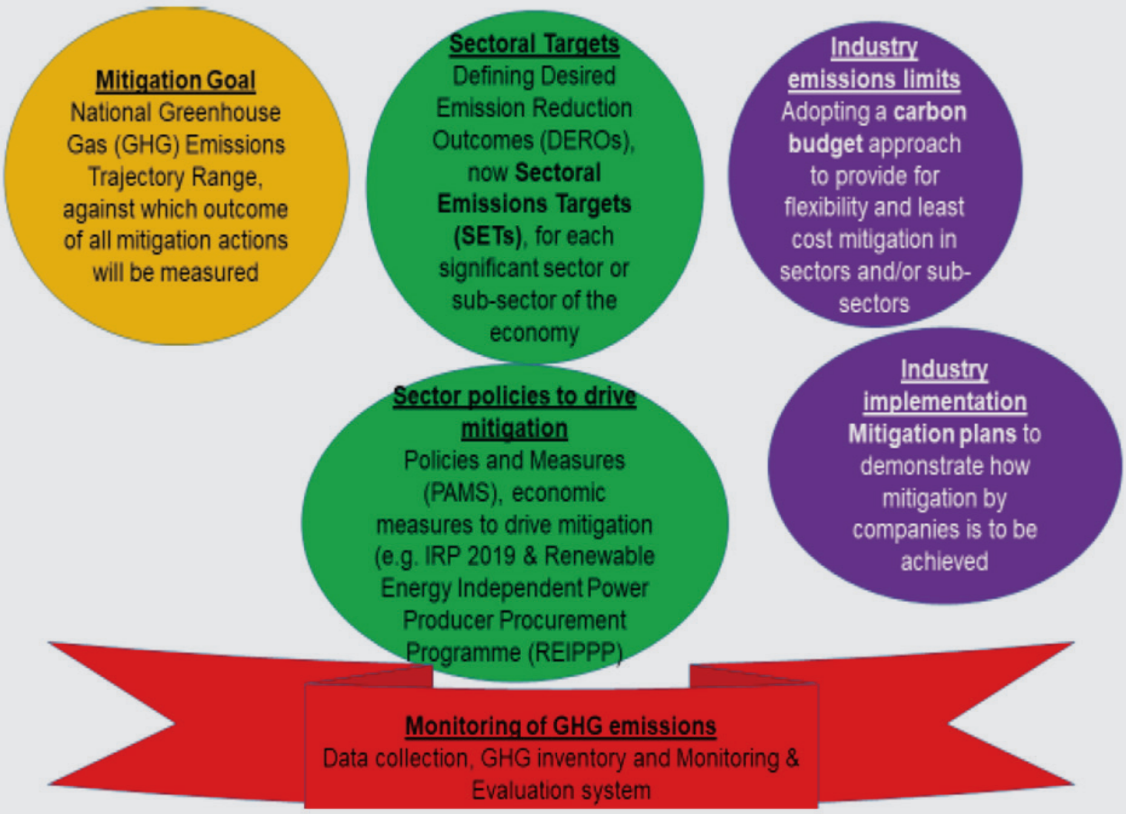


Figure 2.8: Climate mitigation system being developed for South Africa

Stakeholder engagement is an important process that supports the climate mitigation system. Currently climate related policies, regulations and communications (such as the NIR and BTR) undergo a process of public consultation and commenting. Specifically draft reports are published as a Notice in the Government Gazette or newspaper and the public are invited to submit written comments within given a specified time.

2.2 DESCRIPTION OF A PARTY'S NATIONALLY DETERMINED CONTRIBUTION UNDER ARTICLE 4 OF THE PARIS AGREEMENT, INCLUDING UPDATES

South Africa has set economy-wide goals for reducing GHG emissions in its updated first NDC, with specific targets for the years 2025 and 2030, submitted to the UNFCCC secretariat in 2021. The NDC does not use reference points, levels, baselines, base years, or starting points - the NDC targets for these years are defined as fixed-level target ranges. In 2025, annual GHG emissions will be between 398 and 510 million tonnes of CO_2-eq (Mt CO_2-eq). In 2030, annual GHG emissions will be between 350 and 420 Mt CO_2-eq. Both target ranges exclude GHG emissions from natural disturbances.

The South African first updated NDC is structured into two five-year periods of implementation: the first from January 1, 2021, to December 31, 2025, and the second from January 1, 2026, to December 31, 2030, and progress in implementation and achievement of the NDC will be reported accordingly.

South Africa will use a GHG inventory-based accounting process in accounting for its NDC, using the most recently available national GHG inventory (South Africa's ninth national inventory report, submitted with this BTR, and summarised above). South Africa hosts several Clean Development Mechanism (CDM) projects under the Kyoto Protocol. The transition of these projects to the Article 6.4 mechanism of the Paris Agreement is still under negotiation. It is expected that South Africa will host Article 6.4 projects and may enter into cooperative approaches with other countries under Article 6.2, but currently South Africa is not participating in any Article 6 activities under the Paris Agreement, and therefore no corresponding adjustments have been undertaken in this BTR.

2.3 INFORMATION NECESSARY TO TRACK PROGRESS MADE IN IMPLEMENTING AND ACHIEVING ITS NATIONALLY DETERMINED CONTRIBUTION UNDER ARTICLE 4 OF THE PARIS AGREEMENT

Narrative information has been provided in responding to paragraphs 65-78 of the annex to decision 18/CMA.1 below for selected elements of the structured summary. Tables 1-4 of the structured summary as contained in decision 5/CMA.3 have been included below; where applicable information is not contained in the narrative summary below, it is contained in the tables below.

2.3.1 Identification of the indicator which South Africa will use to track its NDC

The indicator South Africa will use to track its NDC is as identified in CTF Table 1: South Africa will track progress of its updated first NDC using a GHG inventory-based approach - therefore this indicator is defined as total GHG emissions including LULUCF as reported in the most recent national GHG inventory (contained in the relevant National Inventory Document), and included all gases, sectors and sources estimated in that GHG inventory, excluding GHG emissions from natural disturbances. In this BTR, this comprises total GHG emissions including LULUCF, reported in Table 2.2 of the NID (communicated with this BTR), minus GHG emissions from natural disturbances, reported in Table A.VII of the NID.

2.3.2 Relation of the indicator to NDC under Article 4

South Africa's updated first NDC defines its NDC target in Table 3 ("Information to facilitate clarity, transparency and understand of South Africa's updated NDC") as an absolute economy-wide target, consisting of all gases, sectors and sources reported in the most recent national GHG inventory, excluding GHG emissions from natural disturbances. The chosen indicator is therefore completely consistent with how South Africa defines its NDC target in its NDC.

2.3.3 Definitions needed to understand South Africa's NDC

South Africa's NDC, and the indicator described above which will be used to track progress, excludes emissions from natural disturbances. The term "natural disturbances" is used in the national GHG inventory consistent with the relevant IPCC guidelines used by the inventory. Approaches to natural disturbances are documented in section 6.3.3 of the NID, and data on natural disturbances is provided, with information on sources and data limitations, in Annex VII of the NID.

2.3.4 Accounting approach, and consistency of accounting approach with Article 4, paragraphs 13 and 14

Progress in implementation and achievement of South Africa's NDC will be accounted for using the indicator described above, using a GHG-inventory-based approach, based on the NID submitted with this BTR and summarised in Chapter 1. Detailed descriptions of methodology, QA/QC processes and other relevant information on the use of IPCC guidelines is contained in the NID. Specific information on information on natural disturbances used to account for the NDC is contained in Annex VII of the NID, and in section 1.15 above.

2.3.5 Most recent information for the indicator

The most recent information for the indicator, and the values for the indicator in the years 2021 and 2022 is provided in Table 2.1 below:

Table 2.1 Most up-to-date information for the indicator, and indicator values for the years 2021-2022

	2021	2022
Total GHG emissions including LULUCF (sourced from Table 2.2 in the NID submitted with this BTR and summarised in Chapter 1 of the BTR) - Gg CO_2-eq	465347	435120
Total GHG emissions from natural disturbances (sourced from Table A.VII in the NID submitted with this BTR and summarised in Chapter 1 of the BTR) - Gg CO_2-eq	52251	40864
Most recent value of indicator in Gg CO_2-eq	413095	394256
Most recent value of indicator in Mt CO_2-eq	413.1	394.3

2.3.6 Consistency of the methodologies used when communicating the NDC

In terms of coverage, scope and methodological approaches, the NDC targets are consistent with the 2017 NIR. Coverage of the NDC is economy-wide, including the land sector and includes the five gases CO_2, CH_4, N_2O, HFCs and PFCs. GWP metrics from the IPCC's 5th Assessment Report has been used. The energy, IPPU, AFOLU and waste sectors are covered in the NDC target. The 2017 NIR which is the basis for the accounting methodology of the NDC target has been compiled in accordance with the guidelines provided by the UNFCCC and follows the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (IPCC, 2006), IPCC Good Practice Guidance (GPG) (IPCC, 2000; IPCC, 2003; IPCC, 2014); and the 2019 Refinement to the 2006 IPCC Guidelines (IPCC, 2019).

In terms of coverage, scope and methodological approaches, the indicator is consistent with the 2022 NIR. Coverage of the indicator is also economy-wide, including the land sector and includes the five gases CO_2, CH_4, N_2O, HFCs and PFCs. GWP metrics from the IPCC's 5th Assessment Report has been used. The energy, IPPU, AFOLU and waste sectors are covered in the indicator. The 2022 NIR which is the basis for the accounting methodology of the indicator has been compiled in accordance with the guidelines provided by the UNFCCC and follows the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (IPCC, 2006), IPCC Good Practice Guidance (GPG) (IPCC, 2000; IPCC, 2003; IPCC, 2014) and the 2019 Refinement to the 2006 IPCC Guidelines (IPCC, 2019)

In the accounting methodology of the NDC target; to account for emissions and removals from HWPs, South Africa employs a production approach, following the updated guidance in the 2013 IPCC Kyoto Protocol Supplement (IPCC, 2014). In the accounting methodology of the indicator, to account for emissions and removals from HWPs, the country employs a production approach, following the IPCC 2006 guidelines. The core principles of the production approach described in the 2013 IPCC Kyoto Protocol Supplement (IPCC, 2014) and the IPCC 2006 guidelines are the same.

Table 2.2 Structured summary: Description of selected indicators

Indicator(s) selected to track progress[a]	Description
Total annual national GHG emissions and removals including LULUCF, excluding GHG emissions from natural disturbances.	South Africa will track progress of its updated first NDC using a GHG inventory-based approach - therefore this indicator is defined as total GHG emissions including LULUCF as reported in the most recent national GHG inventory (contained in the relevant National Inventory Document), and included all gases, sectors and sources estimated in that GHG inventory, excluding GHG emissions from natural disturbances. In this BTR, this comprises total GHG emissions including LULUCF, reported in Table 2.2 of the NID (communicated with this BTR), minus GHG emissions from natural disturbances, reported in Table A.VII of the NID.
Information for the reference point(s), level(s), baseline(s), base year(s) or starting point(s), as appropriate[b]	Not applicable
Updates in accordance with any recalculation of the GHG inventory, as appropriate[b]	No updates
Relation to NDC[c]	South Africa's updated first NDC defines its NDC target in Table 3 ("Information to facilitate clarity, transparency and understand of South Africa's updated NDC") as an absolute economy-wide target, consisting of all gases, sectors and sources reported in the most recent national GHG inventory, excluding GHG emissions from natural disturbances. The chosen indicator is therefore completely consistent with how South Africa defines its NDC target in its NDC.

Table 2.3 Structured summary: Definitions needed to understand NDC

Definition needed to understand each indicator:	
Natural disturbances	The term "natural disturbances" is used in the national GHG inventory consistent with the relevant IPCC guidelines used by the inventory. Approaches to natural disturbances are documented in section 6.3.3 of the NID, and data on natural disturbances is provided, with information on sources and data limitations, in Annex VII of the NID.

Table 2.4 Structured summary: Methodologies and accounting approaches – consistency with Article 4, paragraphs 13 and 14, of the Paris Agreement and with decision 4/CMA.1

Reporting requirement	Description or reference to the relevant section of the BTR
For the first NDC under Article 4:[a]	
Accounting approach, including how it is consistent with Article 4, paragraphs 13–14, of the Paris Agreement (para. 71 of the MPGs)	Progress in implementation and achievement of South Africa's NDC will be accounted for using the indicator described above, using a GHG-inventory-based approach, based on the NID submitted with this BTR. Detailed descriptions of methodology, QA/QC processes and other relevant information on the use of IPCC guidelines is contained in the NID. Specific information on information on natural disturbances used to account for the NDC is contained in Annex VII of the NID.

Reporting requirement	Description or reference to the relevant section of the BTR
For each NDC under Article 4:[c]	
Accounting for anthropogenic emissions and removals in accordance with methodologies and common metrics assessed by the IPCC and adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement:	
Each methodology and/or accounting approach used to assess the implementation and achievement of the target(s), as applicable (para. 74(a) of the MPGs)	South Africa's accounting approach is described above.
Each methodology and/or accounting approach used for the construction of any baseline, to the extent possible (para. 74(b) of the MPGs)	Not applicable, South Africa's NDC target is not defined in terms of a baseline
If the methodology or accounting approach used for the indicator(s) in table 1 differ from those used to assess the implementation and achievement the target, describe each methodology or accounting approach used to generate the information generated for each indicator in the tables 4 and 5 (para. 74(c) of the MPGs)	Not applicable.
Any conditions and assumptions relevant to the achievement of the NDC under Article 4, as applicable and available (para. 75(i) of the MPGs)	South Africa's NDC does not have a conditional or unconditional component but the NDC is based on the assumption that the Paris Agreement will be fully implemented.
Key parameters, assumptions, definitions, data sources and models used, as applicable and available (para. 75(a) of the MPGs)	The sole data source for accounting for South Africa's NDC is the NID. "Natural disturbances" is described in Table 2.
IPCC Guidelines used, as applicable and available (para. 75(b) of the MPGs)	The NID has been compiled in accordance with the guidelines provided by the IPCC: the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (IPCC, 2006), IPCC Good Practice Guidance (GPG) (IPCC, 2000; IPCC, 2003; IPCC, 2014); and the 2019 Refinement to the 2006 IPCC Guidelines (IPCC, 2019).
Report the metrics used, as applicable and available (para. 75(c) of the MPGs)	GWP values used as specified in the NID (IPCC AR5, as referenced in the Annex to decision 18/CMA.1)
For Parties whose NDC cannot be accounted for using methodologies covered by IPCC guidelines, provide information on their own methodology used, including for NDCs, pursuant to Article 4, paragraph 6, of the Paris Agreement, if applicable (para. 1(b) of annex II to decision 4/CMA.1)	Not applicable
Provide information on methodologies used to track progress arising from the implementation of policies and measures, as appropriate (para. 1(d) of annex II to decision 4/CMA.1)	Not applicable
Where applicable to its NDC, any sector-, categoryor activity-specific assumptions, methodologies and approaches consistent with IPCC guidance, taking into account any relevant decision under the Convention, as applicable (para. 75(d) of the MPGs)	Not applicable

Reporting requirement	***Description or reference to the relevant section of the BTR***
For Parties that address emissions and subsequent removals from natural disturbances on managed lands, provide detailed information on the approach used and how it is consistent with relevant IPCC guidance, as appropriate, or indicate the relevant section of the national GHG inventory report containing that information (para. 1(e) of annex II to decision 4/CMA.1, para. 75(d)(i) of the MPGs)	South Africa's NDC target range is defined excluding GHG emissions from natural disturbances. Information on GHG emissions from natural disturbances is contained in the NID in section 6.3.3 of the NID, and data on natural disturbances is provided, with information on sources and data limitations, in Annex VII of the NID.
For Parties that account for emissions and removals from harvested wood products, provide detailed information on which IPCC approach has been used to estimate emissions and removals (para. 1(f) of annex II to decision 4/CMA.1, para. 75(d)(ii) of the MPGs)	Emissions and removals from harvested wood products are reported in the NID, with the relevant methodology, in sections 6.3.4 and 6.10. The NID uses a production approach, using the methodology specified in the 2006 IPCC guidelines.
For Parties that address the effects of age-class structure in forests, provide detailed information on the approach used and how this is consistent with relevant IPCC guidance, as appropriate (para. 1(g) of annex II to decision 4/CMA.1, para. 75(d)(iii) of the MPGs)	This approach is not used in the NID.
How the Party has drawn on existing methods and guidance established under the Convention and its related legal instruments, as appropriate, if applicable (para. 1(c) of annex II to decision 4/CMA.1)	Not applicable.
Any methodologies used to account for mitigation cobenefits of adaptation actions and/or economic diversification plans (para. 75(e) of the MPGs	Not applicable.
Describe how double counting of net GHG emission reductions has been avoided, including in accordance with guidance developed related to Article 6 if relevant (para. 76(d) of the MPGs)	South Africa does not currently host any projects under Article 6, and does not use any ITMOs. South Africa's NDC has not been accounted for in terms of emissions reductions.
Any other methodologies related to the NDC under Article 4 (para. 75(h) of the MPGs)	Not applicable
Ensuring methodological consistency, including on baselines, between the communication and implementation of NDCs (para. 12(b) of the decision 4/CMA.1):	
Explain how consistency has been maintained in scope and coverage, definitions, data sources, metrics, assumptions and methodological approaches including on baselines, between the communication and implementation of NDCs (para. 2(a) of annex II to decision 4/CMA.1)	South Africa's NDC was set on the basis of the 2017 NIR, and will be accounted for using the NID submitted with this BTR. The coverage of both GHG inventories is economy-wide, and the NID also includes estimation of SF_6. The 2017 NIR used GWPs from AR2, whereas the NID uses GWPs from AR6. Other more detailed information on recalculations is contained in the NID.

Reporting requirement	***Description or reference to the relevant section of the BTR***
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7(a), of the Paris Agreement, if applicable (para. 2(b) of annex II to decision 4/CMA.1) and explain methodological inconsistencies with the Party's most recent national inventory report, if applicable (para. 76(c) of the MPGs)	South Africa accounts for its NDC targets using its most recent inventory, so there are no inconsistencies.
For Parties that apply technical changes to update reference points, reference levels or projections, the changes should reflect either of the following (para. 2(d) of annex II to decision 4/CMA.1):	***This section is not applicable to the South African NDC, since the NDC, does not define mitigation targets in relation to a reference point, but as a fixed level GHG emissions range in 2025 and 2030.***
Technical changes related to technical corrections to the Party's inventory (para. 2(d)(i) of annex II to decision 4/CMA.1)	
Technical changes related to improvements in accuracy that maintain methodological consistency (para. 2(d)(ii) of annex II to decision 4/CMA.1)	
Explain how any methodological changes and technical updates made during the implementation of their NDC were transparently reported (para. 2(e) of annex II to decision 4/CMA.1)	
Striving to include all categories of anthropogenic emissions or removals in the NDC and, once a source, sink or activity is included, continuing to include it (para. 3 of annex II to decision 4/CMA.1):	Not applicable to South Africa's first updated NDC.
Explain how all categories of anthropogenic emissions and removals corresponding to their NDC were accounted for (para. 3(a) of annex II to decision 4/CMA.1)	
Explain how Party is striving to include all categories of anthropogenic emissions and removals in its NDC, and, once a source, sink or activity is included, continue to include it (para. 3(b) of annex II to decision 4/CMA.1)	
Provide an explanation of why any categories of anthropogenic emissions or removals are excluded (para. 4 of annex II to decision 4/CMA.1)	

Reporting requirement	***Description or reference to the relevant section of the BTR***
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of its NDC	Not applicable as South Africa has not entered into any co-operative approaches that involve the use of ITMOs
Provide information on any methodologies associated with any cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 (para. 75(f) of the MPGs)	
Provide information on how each cooperative approach promotes sustainable development, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	
Provide information on how each cooperative approach ensures environmental integrity consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	
Provide information on how each cooperative approach ensures transparency, including in governance, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	
Provide information on how each cooperative approach applies robust accounting to ensure, inter alia, the avoidance of double counting, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77(d)(iii) of the MPGs)	

Table 2.5 Structured summary: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement

	Units	***Implementation period of the NDC covering information for previous reporting years and the most recent year, including the end year or end of period {MPGs, p. 68, 77(a)(ii–iii)}***		***Target level[b]***	***Target year or period***	*Progress made towards the NDC, as determined by comparing the most recent information for each selected indicator, including for the end year or end of period, with the reference point(s), level(s), baseline(s), base year(s) or starting point(s) (paras. 69–70 of the MPGs)*
		2021	**2022**			
Indicator(s) selected to track progress towards the implementation and/ or achievement of the NDC under Article 4 of the Paris Agreement[c]: {MPGs, p. 65, 77(a)}						
Total annual national GHG emissions and removals including LULUCF, excluding GHG emissions from natural disturbances.	Mt CO_2-eq	413.10	394.30	510-398 in 2025; 420-350 in 2030	2025 and 2030	South Africa is on track to meet its 2025 and 2030 NDC target.
Where applicable, total GHG emissions and removals consistent with the coverage of the NDC *{MPGs, p. 77(b)}*	Mt CO_2-eq	465.34	435.12			

	Units	*Implementation period of the NDC covering information for previous reporting years and the most recent year, including the end year or end of period {MPGs, p. 68, 77(a)(ii–iii)}*		Target level[b]	Target year or period	*Progress made towards the NDC, as determined by comparing the most recent information for each selected indicator, including for the end year or end of period, with the reference point(s), level(s), baseline(s), base year(s) or starting point(s) (paras. 69–70 of the MPGs)*
		2021	2022			
Contribution from the LULUCF sector for each year of the target period or target year, if not included in the inventory time series of total net GHG emissions and removals, as applicable *{MPGs, p. 77(c)}*	Not applicable					
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 of the Paris Agreement, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of the NDC, shall provide: *{MPGs, p. 77(d)}*	Not applicable as South Africa has not entered into any co-operative approaches that involve the use of ITMOs, or authorised any issuance of 6.4 units.					
Assessment of the achievement of the Party's NDC under Article 4 of the Paris Agreement (para. 70 of the MPGs):	Not applicable for reporting in BTR1					
Restate the target of the Party's NDC:	In 2025, South Africa's annual economy wide GHG emissions including LULUCF and excluding emissions from natural disturbances will be in a range from 398-510 Mt CO_2-eq. In 2030, South Africa's annual economy wide GHG emissions including LULUCF and excluding emissions from natural disturbances will be in a range from 350-420 Mt CO_2-eq			-	-	-
Information for reference point(s), level(s), baseline(s), base year(s), or starting point(s):	Not applicable, South Africa's NDC does not have reference point(s), level(s), baseline(s), base year(s), or starting point(s)					
Final information for the indicator for the target year/period, including the application of the necessary corresponding adjustments consistent with chapter III, annex, decision -/CMA.3 (Corresponding adjustments) and consistent with future decisions from the CMA (para. 23(l), annex to decision -/CMA.3):	Not applicable					
Comparison:	Not applicable					
Achievement of NDC: {yes/no, explanation}	Not applicable for reporting in BTR1; NDC targets are for 2025 and 2030. Achievement can only be assessed in those years.[1]					

2.4 MITIGATION POLICIES AND MEASURES, ACTIONS AND PLANS, INCLUDING THOSE WITH MITIGATION CO-BENEFITS RESULTING FROM ADAPTATION ACTIONS AND ECONOMIC DIVERSIFICATION PLANS, RELATED TO IMPLEMENTING AND ACHIEVING A NATIONALLY DETERMINED CONTRIBUTION UNDER ARTICLE 4 OF THE PARIS AGREEMENT

South Africa has followed the guidance of the CDKN Planning for NDC Implementation Guide (CDKN; 2016) which indicates that mitigation actions and those which are identified as Nationally Appropriate Mitigation Actions "are the key means for delivering the mitigation contributions in the NDCs". The list of mitigation actions reported on in the first BTR has previously been reported on in BURs (as is mentioned in the NDC report). New mitigation actions not reported previously include the JET-IP and the Climate Change Act 22 of 2024.

South Africa has shortlisted mitigation actions focusing on those that have the most significant impact on GHG emissions or removals and those impacting key categories in the national GHG inventory. South Africa followed the guidance in the CDKN Planning for NDC Implementation Guide (CDKN; 2016); to 1) identify PAMs and 2) prioritize PAMs. The identification of PAMs was informed by 1) PAMs that cover the IPCC categories of emissions sources and sinks; 2) National and sub-national PAMs that are most likely to have a significant impact on South Africa's current and expected GHG emissions and 3) PAMs for which mitigation techniques and technologies have been prioritised, piloted or implemented (mitigation potential analysis studies provide this information). The prioritization of PAMs to a shortlist was informed by consideration of the resources, time and practical constraints that do not allow for the monitoring of all identified PAMs. The Multi-Criteria Decision Analysis (MCDA) approach was used to further refine the list of PAMs.

2.4.1 Crosscutting PAMs

Specific crosscutting PAMs have been mentioned in the NDC including the National Development Plan 2030 (NDP 2030); National GHG Reporting Regulations (2017); National Pollution Prevention Plans Regulations (2017); Climate Change Act; Carbon Tax Act; and Hydrogen Commercialisation Strategy (linked to Green Hydrogen – GH_2). An overview of these policy instruments is provided in this section.

2.4.1.1 National Development Plan, 2030

The overall objective of the NDP Vision 2030 is to eliminate poverty and reduce inequality by 2030 (NCP, 2011). Chapter 5 of the NDP aims to ensure that by 2030 South Africa is an environmentally sustainable society, with an expanded low-carbon economy and reduced emissions while at the same time reducing poverty, unemployment and social inequities.

This chapter provides various mitigation objectives and outlines actions for achieving these goals by 2030, such as:

- Achieving the peak, plateau and decline GHG emission trajectory.
- Entrenching an economy-wide carbon price.
- Developing zero-emission building standards.
- Reducing the total volume of waste disposal to landfill each year.

A review of the NDP was completed in 2022 which led to the development of a framework to translating the NDP's top goals into short to medium-term (3-5 years) actions and in this way (NPC, 2022). The framework informs short to medium-term strategic plans such as medium-term strategic frameworks (MTSF) and Annual Performance Plans (APPs). Table 2.6 provides a summary of the NDP and the information for emission reductions is indicated in Table 2.7.

Table 2.6: National Development Plan 2030

No.	Name	Description	Objectives	Type of instrument
1	National Development Plan 2030	A strategic framework aimed at eliminating poverty and reducing inequality by 2030 through inclusive economic growth and development. It outlines a comprehensive approach to improving education, healthcare, infrastructure, and governance while fostering social cohesion and environmental sustainability.	To eliminate poverty and reduce inequality by fostering inclusive economic growth and sustainable development by 2030.	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	All	CO_2; CH_4 and N_2O	2012	National Planning Commission (NPC)

Table 2.7: Estimates of GHG emission reductions of the National Development Plan 2030

Achieved	Expected
Not reported[2]	Not reported

2 Estimates of expected and achieved GHG emission reductions are not reported for the NDP 2030. The NDP 2030 is not a mitigation intervention in itself but underpins the government paradigm for medium term planning in all sectors of the economy to take appropriate actions to reduce GHG emissions. The strategic objectives of the NDP 2030 have contributed to legal and policy development post 2012. Including the emission reductions from NDP 2030 will lead to double counting of GHG emission reductions as the GHG effect of the NDP 2030 cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of NDP 2030 are not reported.

2.4.1.2 National Climate Change Response Policy

The National Climate Change Response Policy (NCCRP) sets out an overall climate change policy framework for South Africa articulating country's vision for an effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society (DEA, 2011a). The objectives and goals of the NCCRP were informed by other national and international commitments, including the South African Constitution (Act No. 108 of 1996), the Bill of Rights, the National Environmental Management Act (Act No. 107 of 1998), the Millennium Declaration (UN Millennium Summit, 2000) and commitments made under the UNFCCC. The objectives of the policy are to effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity. Furthermore, the policy seeks to ensure the country makes a fair contribution to the global effort to stabilise GHG concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner (DEA, 2011a). Table 2.8 provides a summary of the National Climate Change Response Policy and the information for emission reductions is indicated in Table 2.9.

Table 2.8: National Climate Change Response Policy

No.	Name	Description	Objectives	Type of instrument
2	National Climate Change Response Policy	outlines a comprehensive framework to address climate change by balancing the need for economic development with environmental sustainability and social equity. It focuses on both mitigation and adaptation measures, aiming to reduce greenhouse gas emissions, enhance climate resilience, and promote a low-carbon, inclusive economy.	To effectively manage climate change impacts through mitigation and adaptation measures, while fostering sustainable development and transitioning to a low-carbon economy	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	All	CO_2; CH_4 and N_2O	2011	DFFE

Table 2.9: Estimates of GHG emission reductions of the National Climate Change Response Policy

Estimates of GHG emission reductions	
Achieved	Expected
Not reported[3]	Not reported

3 Estimates of expected and achieved GHG emission reductions are not reported for the NCCRP. The NCCRP is the umbrella framework that underpins the country's NDC and all of government's regulatory mitigation instruments. Including the emission reductions from the NCCRP will lead to double counting of GHG emission reductions; as the GHG effect of the NCCRP cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of NCCRP are not reported

2.4.1.3 Climate Change Act 22 of 2024

In June 2018, South Africa released a draft National Climate Change Bill (DEA, 2018b) for public consultation. The Bill was tabled in Parliament in February 2022 (DFFE, 2022a) and underwent legislative processes to become the Climate Change Act in 2024. The Climate Change Act 22 of 2024 provides a regulatory framework for managing climate change impacts by enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change. In doing so, it also aims to make a fair contribution to the global effort to stabilise GHG concentrations in the atmosphere. In terms of the mitigation system, the Act makes provision for the development and review of the national GHG emission trajectory, the setting of sectoral emission targets (SET) to sectors and sub-sectors and allocating carbon budgets to companies. SETs are qualitative or quantitative goals informed by sectoral policies and measures that may lead to greenhouse gas emission reductions for the sector or sub-sector over a defined period. Carbon budgets will be developed to specifically cover industry, and the threshold will be published by DFFE.

The Minister of DFFE is required to publish a list of GHG emitting activities specified in the Climate Change Act 2022 regulations. This list applies to both existing and new GHG emitting activities. The notice must establish specific emission thresholds in CO_2e for identifying individuals that are subject to a carbon budget under the Climate Change Act 2022 regulations. Those individuals are required to submit GHG mitigation plans to the Minister.

Additionally, the notice excludes activities that emit GHGs below the established emission thresholds. Furthermore, the Minister also determines the effective date of this notice. The emission thresholds are expressed in CO_2-eq, applicable at the company level based on operational control, and are influenced by the feasibility of mitigation technology and the practicality of policy implementation. Table 2.10 provides a summary of the Climate Change Act 22 of 2024 and the information for emission reductions is indicated in Table 2.11.

Table 2.10: Climate Change Act 22 of 2024

No.	Name	Description	Objectives	Type of instrument
3	Climate Change Act 22 of 2024	Concerning mitigation, the Act provides for "future review and determination of the national greenhouse gas emissions trajectory; determination of sectoral emissions targets for emitting sectors and subsectors; and allocation of carbon budgets	To enable the development of an effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society	Regulatory
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Regulation promulgated	All	CO_2; CH_4 and N_2O	Not implemented (an implementation date is to be set by the President)	DFFE

Table 2.11: GHG emission reductions of the Climate Change Act 22 of 2024

Estimates of GHG emission reductions	
Achieved	Expected
Not reported[4]	Not reported

4 Estimates of expected and achieved GHG emission reductions are not reported for instruments under the Climate Change Act 22 of 2024 including SETs and carbon budgets. These measures are not mitigation interventions in themselves but incentivise government departments and private companies to take appropriate actions for example energy saving measures. Some of these interventions will also be facilitated by the implementation of sectoral mitigation PAMs as mentioned in this chapter. As such there is double counting of mitigation effects involved should the emission reductions of cross-cutting measures like SETs and carbon budgets as provisioned by the Climate Change Act be included in the accounting of emission reductions alongside sectoral PAMs.

2.4.1.4 National GHG Emission Reporting Regulations

The (NGERs (DEA, 2017a), under Section 53(a), (o) and (p) read with section 12 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), in the Government Gazette of the 3rd April 2017, provides a foundation for the national reporting system for GHG emissions. NGERs introduced a single national reporting system for the transparent reporting of GHG emissions, which will be used (a) to update and maintain an inventory; (b) for the Republic of South Africa to meet its reporting obligations under the UNFCCC and instrument treaties to which it is bound; and (c) to inform the formulation and implementation of legislation and policy. The NGERs were amended in 2020 (DEFF, 2020). Companies will submit emissions data to the South African GHG Emissions Reporting System (SAGERS) (discussed above) which is a component of the National Atmospheric Emissions Inventory System (NAEIS). In accordance with regulation 7(1) of the NGERs the initial reporting cycle commenced on 31 March of 2018 requiring data providers to register and submit activity and GHG emissions data to the competent authority (DFFE). Table 2.12 provides a summary of the NGERS and the information for emission reductions is indicated in Table 2.13.

Table 2.12: National GHG Emission Reporting Regulations

No.	Name	Description	Objectives	Type of instrument
4	National Greenhouse Gas Emission Reporting Regulations (NGERs)	Set of rules that govern how GHG emissions are reported to DFFE	South Africa's NGERS establish a unified national system for transparent reporting of GHG emissions to support the National GHG Inventory and fulfill international reporting obligations under the UNFCCC	Regulatory
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	All	CO_2; CH_4 and N_2O	2017	DFFE

Table 2.13: Estimates of GHG emission reductions of the National GHG Emission Reporting Regulations

Estimates of GHG emission reductions	
Achieved	Expected
Not reported[5]	Not reported[5]

5 Estimates of expected and achieved GHG emission reductions are not reported for the NGERs. The NGERS are applicable for carbon tax, sectoral emission target, carbon budget and pollution prevention plan reporting. Including the emission reductions from the NGERS will lead to double counting of GHG emission reductions as the GHG effect of the NGERS cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of NGERS are not accounted for and not reported.

2.4.1.5 Carbon Tax Act

The Carbon Tax Act No 15 of 2019 (RSA, 2019a) has been implemented since the 1 June 2019. The carbon tax regulations were amended since 2020 included in the Taxation Laws Amendment Act, 2021, Act No. 20 of 2021 (RSA, 2022) and the Taxation Laws Amendment Act, 2022, Act No. 20 of 2022. The Act sets out how the tax will be managed for Phase 1 (initially due to end on 31 December 2022). Supplementary instruments under the Carbon Tax Act are reported on after this summary. Table 2.14 provides an overview of the carbon tax and the information for emission reductions is indicated in Table 2.15.

Table 2.14: Carbon Tax Act

No.	Name	Description	Objectives	Type of instrument
5	Carbon Tax Act	Gives effect to the polluter-pays-principle for large emitters and helps to ensure that firms and consumers take the negative adverse costs (externalities) into account in their future production, consumption and investment decisions.	Makes provision for the imposition of taxes for South African taxpayers who conducts a listed activity with above threshold GHG emissions.	Economic
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	All	CO_2; CH_4 and N_2O	2019	South African Revenue Service (SARS)

Table 2.15: Estimates of GHG emission reductions of the carbon tax act

Estimates of GHG emission reductions	
Achieved	Expected
Not reported[6]	Not reported[6]

a. Carbon Offset Regulations

Carbon offsetting allows registered tax paying organisations to compensate for their GHG emissions by supporting projects that reduce emissions elsewhere in the country. It is a regulated activity under section 19(c) of the Carbon Tax Act, 2019 (Act No.15 of 2019). The regulations explain who can participate in these projects and what they need to do to be eligible and outlines how taxpayers can claim the carbon offset allowance. Additionally, the regulations cover the management and organisation of the carbon offset system to ensure it runs smoothly and fairly.

The carbon offset tax-free allowance assists tax paying organisations to cost-effectively reduce their emissions and carbon tax liability by up to 10% of their total GHG emissions by investing in GHG emissions mitigation projects.

The National Treasury gazetted amendments to the Carbon Offsets Regulations in terms of Section 19 (c) of the Carbon Tax Act on 8 July 2021 (National Treasury, 2021a).

The Department of Mineral Resources and Energy (DMRE) is currently working on releasing a preliminary plan for local standards that can be used to determine whether a project qualifies as a carbon offset project. This plan was developed with the support of the World Bank's Partnership for Market Readiness project and will be made available for public input and feedback (DMRE, 2022). The department will also explore the possibility of including offset projects from other African countries as part of the second phase of the carbon tax review and design process.

6 The tax is integrated with other tools like sectoral emission targets and carbon budgets mentioned in the sub-section about the Climate Change Act 22 of 2024. Including the emission reductions from the carbon tax will lead to double accounting of GHG emission reductions as the GHG effect of the tax cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of the carbon tax are not reported.

The National Treasury has proposed that the utilisation period in the Carbon Offsets Regulations should be changed to align with the first phase of the Carbon tax from 1 January 2023 to 31 December 2025, which will take effect from 1 January 2023 (National Treasury, 2023a). Furthermore, the National Treasury plans to evaluate stakeholder feedback in 2023 regarding the feasibility of establishing a domestic marketplace for trading tax credits generated by the carbon tax. The consultation will specifically address various essential components needed for smooth trading, such as determining the financial asset status of carbon credits, establishing trading and post-trade market structures, issuing licenses for private carbon credit funds and implementing carbon credit certification.

b. Carbon Sequestration in the Carbon Tax Act

In terms of the Carbon Tax Act, Section 4(1) and 4(2)(a) defines the carbon tax base that is, fuel combustion, fugitive and industrial process emissions that are determined using the Tier 3 company-based emissions methodologies or the Tier 1 and 2 emission factors as per Schedule 1 of the Carbon Tax Act, respectively.

The Carbon Tax Act allows taxpayers to deduct sequestered emissions as verified and certified by DFFE from their energy combustion related greenhouse gas emissions for a tax period as determined in Section 4 of the Act. DFFE gazetted the regulations which set out methodological guidelines for quantifying carbon sequestration in the forestry sector on 28 January 2022.

Sequestrated emissions cover carbon capture and storage (CCS) in geological reservoirs and biological sequestration including forests.

c. Trade Exposure Allowance Regulations

The maximum trade exposure allowance available to entities that are trade exposed and sensitive to international competitiveness has been increased from 30% to 50% from 1 January 2023.

d. GHG Emission Intensity Benchmark Regulations

The Regulations for the Greenhouse Gas Emissions Intensity Benchmarks were gazetted in 2020 under section19 (a) of the Carbon Tax Act, 2019 (Act No.15 of 2019) for purposes of Section 11 for the Performance Allowance (National Treasury, 2020). The performance allowance aims to incentivise companies to decrease the carbon intensity of their production processes compared to their industry counterparts. It also aims to enhance the competitiveness of local products. The gazetted Regulations for the GHG Emissions intensity benchmarks sets out the emissions intensity benchmarks for sectors and subsectors that submitted benchmark proposals during the period 2016 to 2020. The date of commencement of the regulation is 1 June 2019.

e. Renewable Energy Premium

Section 6(2)(c) of the Carbon Tax Act outlines a provision allowing electricity generators who are subject to carbon tax to reduce their carbon tax liability by accounting for the expenses associated with acquiring additional renewable energy. Initially, this deduction was limited to Eskom and its renewable energy purchases within the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) framework. However, it has now been broadened to encompass other electricity generators, making renewable energy purchases through either the REIPPPP or private transactions.

To address this expansion, a proposal is being made to restrict eligibility for the tax deduction. Eligibility would be limited to entities that meet the following criteria: they are liable for carbon tax, they engage in electricity generation activities, and they directly procure primary renewable energy, either through the REIPPPP or from private independent power producers (IPPs). This proposed tax deduction for renewable energy purchases would only apply to those made within the REIPPPP or through private transactions that involve a power purchase agreement (PPA). (National Treasury, 2022a). For purposes of Section 6(2)(c) of the Carbon Tax Act, a power purchase agreement (PPA) is a long-term electricity supply agreement between a renewable power producer and electricity consumer (buyer or off taker). PPAs can exist for onsite renewable electricity purchases where there is direct supply of electricity to the buyer and offsite electricity purchases where the producer supplies electricity to the buyer through the national grid (National Treasury, 2022a).

2.4.1.6 Hydrogen Commercialisation Strategy

In the NDC, GH_2; is mentioned as a future fuel medium for electric vehicles and public transport. In the draft SETs report; The Hydrogen Commercialisation Strategy aims to position GH_2 as an early contributor to decarbonization within the Just Energy Transition Implementation Plan. It prioritizes executing the green hydrogen strategy and developing a national GH_2 infrastructure plan. The strategy also focuses on driving policy and regulatory changes for long-term industry growth and mobilizing government support for the new hydrogen industry in South Africa. The hydrogen production target in the commercialisation strategy is to produce 7 million tonnes of GH_2 per annum by 2050. The Hydrogen Commercialisation Strategy is a cross-cutting policy because the production of GH_2 and its applications in manufacturing and transport are considered. Table 2.16 provides a summary of the Hydrogen Commercialisation Strategy and the information for emission reductions is indicated in Table 2.17.

Table 2.16: Hydrogen Commercialisation Strategy

No.	Name	Description	Objectives	Type of instrument
5	Hydrogen Commercialisation Strategy	Focuses on leveraging the country's abundant platinum group metals and renewable energy potential to develop a competitive hydrogen economy. It outlines pathways to integrate hydrogen technologies into existing industries, promote innovation, and attract investments for sustainable energy solutions	To position the country as a global leader in green hydrogen production, drive economic growth, reduce greenhouse gas emissions, and create sustainable job opportunities.	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy; IPPU; Transport; Waste	CO_2; CH_4 and N_2O	2023	DTIC

Table 2.17: Estimates of GHG emission reductions of the Hydrogen Commercialisation Strategy

Estimates of GHG emission reductions	
Achieved	Expected
Not reported[7]	Not reported[7]

7 GHG emission reductions from 2010 to 2022 are reported in this BTR. As the strategy was implemented in 2023; there are no emissions in the years before this.

2.4.1.7 Just Energy Transition Implementation Plan

The Just Energy Transition Implementation Plan (JET IP) will steer South Africa towards a low-carbon economy by expanding renewable energy sources. This plan outlines the necessary interventions and investments for South Africa to achieve a low-carbon and climate-resilient economy, in line with its NDC. Key investment areas include electricity, New Energy Vehicles (NEVs), and GH_2, with additional investments required in skills development and municipalities (The Presidency; 2023).

The JET-IP specifies short- and medium-term goals across six portfolios: Electricity, Mpumalanga Just Transition, New Energy Vehicles (NEVs), GH_2, Skills, and Municipalities. In 2024, three more portfolios will be introduced for JET financing support: the South African Renewable Energy Masterplan, Energy Efficiency, and Road-to-Rail. The plan identifies specific challenges in each focus area and outlines pathways to transform these priorities into actionable and tangible results, highlighting the need for resources and capacity building. Table 2.18 provides a summary of the JET-IP and the information for emission reductions is indicated in Table 2.19.

Table 2.18: Just Energy Transition Implementation Plan (JET-IP) 2023–2027

No.	Name	Description	Objectives	Type of instrument
5	Just Energy Transition Implementation Plan (JET-IP) 2023–2027	Outlines the scope of the country's needs; the foundational investments required and planned projects in the medium term for advancing a Just Transition toward a low-carbon and climate-resilient economy, aligned with its updated NDC.	Aims to decarbonize the energy sector by transitioning from coal to renewable energy sources while ensuring energy security and economic growth. It also seeks to promote a just and inclusive transition by addressing social challenges, protecting jobs, and fostering industrial development in green sectors such as renewable energy, new energy vehicles, and green hydrogen	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy; IPPU; Transport; Waste	CO_2; CH_4 and N_2O	2023	PCC

Table 2.19: Estimates of GHG emission reductions for Just Energy Transition Implementation Plan (JET-IP) 2023–2027

Estimates of GHG emission reductions	
Achieved	Expected
Not reported[8]	Not reported[8]

8 GHG emission reductions from 2010 to 2022 are reported in this BTR. As the JET-IP was implemented in 2023; there are no emissions in the years before this.

2.4.2 Sectoral Mitigation Policies and Measures

2.4.2.1 Energy

(a) 12L Tax Incentive Program

The South African 12L tax incentive program is designed to encourage businesses to implement energy efficiency measures by providing tax deductions for verified energy savings. Its main objectives are to promote energy conservation, reduce operational costs for businesses, and support the national agenda for sustainable development. By incentivizing the reduction of energy consumption, the program helps to lower overall demand for electricity, leading to a decrease in the use of fossil fuels for power generation. Consequently, this reduction in energy usage contributes to a significant decrease in GHG emissions, aiding South Africa in its efforts to combat climate change and meet its environmental commitments. Table 2.20 provides a summary of the Section 12L Tax Incentive Program and the information for emission reductions is indicated in Table 2.21.

To claim benefits under Section 12L, a South African taxpayer must implement energy efficiency measures within their business operations and engage a SANAS-accredited Measurement and Verification (M&V) professional to establish baseline and post-implementation energy savings. The M&V professional will compile a report detailing the verified energy savings, which must then be submitted to SANEDI for approval. Upon approval, SANEDI will issue a certificate confirming the verified energy savings. This certificate must be submitted with the taxpayer's annual tax return to SARS to process the tax incentive claim. Section 12L became effective on 1 November 2013 and applies to years of assessment ending before 1 January 2026.

Table 2.20: Summary of Section 12L Tax Incentive Program

No.	Name	Description	Objectives	Type of instrument
1	12L Tax Incentive Program	The 12L tax incentive program allows eligible businesses to receive a tax deduction for their confirmed energy savings resulting from energy efficiency upgrades. Managed by the South African National Energy Development Institute (SANEDI), this initiative encourages investment in energy-efficient projects across multiple industries.	To incentivise companies to implement energy-saving measures and technologies, thereby contributing to a more sustainable and environmentally friendly economy.	Economic
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2013	South African National Energy Development Institute (SANEDI)

Table 2.21: GHG emission reductions of the 12L Tax Incentive Program

Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	
2010	0	Not reported[9]
2011	0	
2012	0	
2013	0	
2014	5.71	
2015	0.97	
2016	4.11	
2017	4.54	
2018	2.16	
2019	6.19	
2020	1.34	
2021	0.48	
2022	0.9	
Total	26.4	

9 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide GHG effect of these policies.

a. Eskom Integrated Demand Management (IDM) Programme

The Eskom Integrated Demand Management (IDM) Programme is an initiative aimed at optimizing electricity consumption across South Africa by promoting energy efficiency and demand-side management among consumers, businesses, and industries.. Its main objectives are to alleviate the strain on the national power grid, especially during peak demand periods, and to reduce overall energy consumption. By encouraging the adoption of energy-saving technologies and practices, the IDM Programme helps lower electricity demand, leading to a more stable and reliable power supply. Additionally, the reduction in energy consumption contributes to the decrease of GHG emissions, supporting South Africa's efforts to mitigate climate change and move towards a more sustainable energy future. Table 2.22 provides a summary of the Eskom Integrated Demand Management (IDM) Programme and the information for emission reductions is indicated in Table 2.23.

Table 2.22: Eskom Integrated Demand Management (IDM) Programme

No.	Name	Description	Objectives	Type of instrument
2	Eskom Integrated Demand Management (IDM) Programme	Promotes energy efficiency and load management. The programme has promoted the implementation of energy efficiency technologies by providing various rebates for energy efficiency; management and conservation measures, as well as solar water heater installations.	Provides for the efficient use of energy resources and related incentives / rebates.	Economic
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2005	Eskom IDM team

Table 2.23: GHG emission reductions of the Eskom Integrated Demand Management (IDM) Programme

Estimates of GHG emission reductions		
Achieved		**Expected**
Year	Emission Reduction (Mt CO_2-eq)	Not reported[10]
2010	0.53	
2011	1.33	
2012	1.35	
2013	1.83	
2014	1.36	
2015	0.82	
2016	0.54	
2017	0.54	
2018	0.13	
2019	0.13	
2020	0.13	
2021	0.13	
2022	0.13	
Total	8.95	

10 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

b. Municipal Energy Efficiency and Demand Side Management programme

The South African Municipal Energy Efficiency and Demand Side Management (EEDSM) programme aims to enhance energy efficiency and manage electricity demand within municipalities.. Its main objectives are to reduce energy consumption in municipal operations, lower electricity costs, and improve the overall efficiency of municipal infrastructure such as street lighting, water pumping, and public buildings. By implementing energy-saving technologies and practices, the EEDSM programme helps municipalities decrease their electricity usage, thereby reducing the demand on the national power grid. This reduction in energy consumption leads to fewer GHG emissions from power generation, supporting South Africa's efforts to mitigate climate change and promote sustainable development. Table 2.24 provides a summary of the Municipal Energy Efficiency and Demand Side Management programme and the information for emission reductions is indicated in Table 2.25.

Table 2.24: Municipal Energy Efficiency and Demand Side Management programme

No.	Name	Description	Objectives	Type of instrument
3	Municipal Energy Efficiency and Demand Side Management programme	Allocation of grant funds to municipalities for the purpose of carrying out energy-efficient upgrades to their infrastructure	Facilitates the effective utilization of energy resources and offers associated incentives or rebates	Economic
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
c. Implemented	Energy	CO_2	2011	South African National Energy Development Institute (SANEDI)

Table 2.25: GHG emission reductions of the Municipal Energy Efficiency and Demand Side Management programme

Estimates of GHG emission reductions		
Achieved		**Expected**
Year	Emission Reduction (Mt CO_2-eq)	Not reported[11]
2010	0	
2011	0.39	
2012	0.43	
2013	0.49	
2014	0.61	
2015	0.85	
2016	1.33	
2017	2.26	
2018	4.1	
2019	4.1	
2020	4.1	
2021	4.1	
2022	4.1	
Total	26.86	

11 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

d. The National Cleaner Production Centre South Africa program

The National Cleaner Production Centre South Africa (NCPC) program is a key initiative focused on promoting cleaner production techniques and sustainable practices across various industries. Its main objectives are to enhance resource efficiency, reduce waste, and minimize the environmental impact of industrial processes. By offering support and guidance on adopting energy-efficient technologies and waste reduction strategies, the NCPC program helps businesses improve their operational performance while lowering their environmental footprint. This leads to a reduction in energy consumption and GHG emissions, contributing significantly to South Africa's efforts to combat climate change and advance towards a more sustainable and environmentally responsible industrial sector. Table 2.26 provides a summary of the National Cleaner Production Centre South Africa (NCPC) program and the information for emission reductions is indicated in Table 2.27.

Table 2.26: The National Cleaner Production Centre South Africa (NCPC) program

No.	Name	Description	Objectives	Type of instrument
4	The National Cleaner Production Centre South Africa (NCPC) program	Implementation of projects within the private sector that enhance energy efficiency and boost the economic competitiveness of South African businesses by optimizing resources and processes	The action aims to facilitate energy efficiency measures, particularly in the industrial and commercial sectors, to mitigate GHG emissions related to the energy sector and stimulate job creation in the green economy.	International Agreements and Cooperation
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2011	National Cleaner Production Centre

Table 2.27: GHG emission reductions of The National Cleaner Production Centre South Africa (NCPC) program

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[12]
2010	0	
2011	0.09	
2012	0.22	
2013	0.59	
2014	0.59	
2015	0.6	
2016	0.07	
2017	0.29	
2018	0.41	
2019	0.49	
2020	0.34	
2021	0.34	
2022	0.34	
Total	4.37	

12 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.1.1 Private Sector Energy Efficiency Programme

The South African Private Sector Energy Efficiency (PSEE) Programme is designed to support and incentivize businesses in adopting energy-efficient practices and technologies. Its main objectives are to enhance energy performance, reduce operational costs, and encourage the implementation of energy-saving measures across various industries. By providing resources, technical assistance, and financial incentives, the PSEE Programme helps businesses decrease their energy consumption, which in turn reduces the demand for electricity from fossil fuel sources. This reduction in energy use leads to lower GHG emissions, supporting South Africa's broader climate goals and contributing to a more sustainable and environmentally friendly economy. Table 2.28 provides a summary of the Private Sector Energy Efficiency (PSEE) Programme and the information for emission reductions is indicated in Table 2.28.

Table 2.28: Private Sector Energy Efficiency (PSEE) Programme

No.	Name	Description	Objectives	Type of instrument
5	Private Sector Energy Efficiency (PSEE) Programme	Implement projects in the private sector that achieve energy savings and improved economic competitiveness in South African businesses through resource and process efficiency.	The action aims to facilitate energy efficiency measures, particularly in the industrial and commercial sectors, to mitigate greenhouse gas emissions related to the energy sector and stimulate job creation in the green economy.	International Agreements and Cooperation
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2013	National Business Initiative (NBI)

Table 2.29: Estimates of GHG emission reductions of the Private Sector Energy Efficiency (PSEE) Programme

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[13]
2010	0	
2011	0	
2012	0	
2013	0	
2014	0.15	
2015	0.15	
2016	0.14	
2017	0.14	
2018	0.14	
2019	0.15	
2020	0.16	
2021	0.16	
2022	0.16	
Total	1.35	

13 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

e. Private sector embedded solar generation

Private Sector Embedded Solar Generation Initiative in South Africa encourages businesses to generate their own electricity using solar power systems installed on their premises. A summary of the program is provided in Table 2.30. Its main objectives are to enhance energy security, reduce reliance on the national power grid, and lower electricity costs for private sector entities. By promoting the adoption of solar energy, the initiative facilitates a shift towards renewable energy sources, significantly decreasing the consumption of fossil fuels. This transition to solar power leads to a substantial reduction in GHG emissions, contributing to South Africa's efforts to combat climate change and move towards a more sustainable and low-carbon energy future. From 2010 to 2022; the program has contributed to reducing South Africa's GHG emissions cumulatively by 1.45 Mt CO_2-eq (shown in Table 2.31).

Table 2.30: Private sector embedded solar generation

No.	Name	Description	Objectives	Type of instrument
6	Private sector embedded solar generation	Installation of embedded solar PV for electricity generation.	Solar photovoltaic (PV) generation, which can be quickly deployed, is expected to be the key technology behind small-scale embedded generation.	Technology and Innovation Measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2018	Private sector

Table 2.31: Estimates of GHG emission reductions of private sector embedded solar generation

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[14]
2010	0	
2011	0	
2012	0	
2013	0	
2014	0	
2015	0	
2016	0	
2017	0	
2018	0.21	
2019	0.31	
2020	0.31	
2021	0.31	
2022	0.31	
Total	1.45	

14 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

f. Renewable Energy Independent Power Producer Procurement programme

The South African Renewable Energy Independent Power Producer Procurement (REIPPP) programme is a government initiative aimed at increasing the country's renewable energy capacity by engaging private sector investment. A summary of the program is provided in Table 2.32. Its main objectives are to diversify the energy mix, enhance energy security, and stimulate economic growth through the development of renewable energy projects such as wind, solar, and hydro power. By facilitating the procurement of clean energy from independent power producers, the REIPPP programme significantly reduces the reliance on fossil fuels for electricity generation. This transition to renewable energy sources leads to a marked decrease in GHG emissions, supporting South Africa's efforts to mitigate climate change and achieve its environmental sustainability targets. From 2010 to 2022; the program has contributed to reducing South Africa's GHG emissions cumulatively by 101.99 Mt CO_2-eq (shown in Table 2.33).

Table 2.32: Renewable Energy Independent Power Producer Procurement (REIPPP) programme

No.	Name	Description	Objectives	Type of instrument
7	Renewable Energy Independent Power Producer Procurement (REIPPP) programme	Competitive procurement programme, where prospective power producers submit bids to supply Eskom with renewable energy. The Department of Mineral Resources and Energy adjudicates the bids according to various criteria, price being the most critical.	The Integrated Resource Plan makes provision for the generation of 17.8 GW of renewable energy by 2030, to be commissioned under the Programme.	Economic
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2011	Eskom

Table 2.33: Estimates of GHG emission reductions of the Renewable Energy Independent Power Producer Procurement (REIPPP) programme

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[15]
2010	0	
2011	0	
2012	0	
2013	0	
2014	5.21	
2015	7.01	
2016	8.91	
2017	11.81	
2018	12.81	
2019	13.31	
2020	14.31	
2021	14.31	
2022	14.31	
Total	101.99	

15 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.1.2 Natural Gas Fuel Switch Programmes

The South African Natural Gas Fuel Switch programme is an initiative designed to promote the transition from coal and oil to natural gas as a cleaner energy source for industrial and power generation processes. A summary of the program is provided in Table 2.34. Its main objectives are to reduce GHG emissions, improve air quality, and enhance energy efficiency. By encouraging industries to adopt natural gas, which burns more cleanly and efficiently than coal and oil, the programme aims to lower carbon dioxide and other harmful emissions. This shift helps to mitigate climate change, as natural gas produces significantly fewer GHGs compared to traditional fossil fuels, supporting South Africa's efforts to reduce its carbon footprint and advance towards a more sustainable energy future. Emission reductions are not reported (see footnote 16 for Table 2.35).

Table 2.34: Natural Gas Fuel Switch Programmes

No.	Name	Description	Objectives	Type of instrument
8	Natural Gas Fuel Switch Programmes	Switch to natural gas from emission intensive fuels.	To provide an economical and eco-friendly energy, by supplying natural gas to Compressed Natural Gas (CNG) refuelling stations, gas distribution networks, industries and power generation systems and to customers who are not on the existing gas network. CNG is transported by road to customers not on the existing gas pipeline and CNG equipment, advice and support provided to help industrial users and transport owners convert	Technology and Innovation Measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2000	Department of Mineral Resources and Energy

Table 2.35: Estimates of GHG emission reductions of Natural Gas Fuel Switch Programmes

Estimates of GHG emission reductions	
Achieved	**Expected**
Not reported[16]	Not reported[16]

16 To avoid double accounting as there are projects registered under carbon credit mechanisms

g. Energy Efficiency Standards and Appliance Labelling project

The regulations mandate that several appliances must display the South African Energy Efficiency Label. These Appliance Standards and Labelling Regulations have been established to ensure compliance. The primary goal of the South African Energy Efficiency Label is to provide consumers with information about an appliance's energy efficiency before purchase. Consequently, this label must be clearly visible on all designated appliances in both physical and online stores. To facilitate understanding of these labelling requirements, a comprehensive guide has been developed (DMRE, 2022). Table 2.36 provides an overview of the project. Table 2.37 provides the information for the GHG emission reductions of the project.

Since 2015, the Program has targeted large residential appliances. It has introduced Minimum Energy Performance Standards (MEPS), appliance standards, labelling regulations, and energy efficiency labelling requirements. According to a 2021 study by SANEDI on residential energy consumption, the program likely reduced electricity use by approximately 3.5% in 2020. The majority of these savings came from refrigerators, which are widely owned across all household groups and consume a significant amount of energy. By 2030, electricity savings could reach 10%.

Table 2.36: Energy Efficiency Standards and Appliance Labelling project

No.	Name	Description	Objectives	Type of instrument
8	Energy Efficiency Standards and Appliance Labelling project	The aim of this project is to educate consumers about the energy efficiency of appliances before they make a purchase. By reducing energy consumption, it will lower electricity costs and decrease GHG emissions.	To ensure that consumers are informed about the relative energy efficiency of an appliance before purchasing.	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2015	SANEDI

Table 2.37: Estimates of GHG emission reductions of Natural Gas Fuel Switch Programmes

Estimates of GHG emission reductions	
Achieved	**Expected**
Not reported[17]	Not reported[16]

17 No ex-post evaluation of the project has been undertaken to measure its impact on energy savings and GHG emissions. Therefore achieved emission reductions cannot be reported on.

16 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies. Therefore the data for expected emission reductions is not available and cannot be reported on.

2.4.2.2 Transport

(a) Bus Rapid Transport System

The South African Bus Rapid Transit (BRT) programme, funded through the Public Network Transport Grant, aims to improve urban public transportation by developing efficient, high-capacity bus networks in major cities. Its main objectives are to reduce traffic congestion, enhance mobility, and provide reliable and affordable public transport options. A summary of the program is provided in Table 2.38. The purpose of the Public Network Transport Grant is to support the National Land Transport Act (Act No. 5 of 2009) and the Public Transport Strategy (PTS) and Action Plan in advancing the delivery of accessible, reliable, and affordable integrated municipal public transport services. Functional BRT systems have been implemented in cities such as Johannesburg (Rea Vaya), Cape Town (MyCiTi), and Pretoria (A Re Yeng). By prioritizing bus lanes and streamlining routes, the BRT programme encourages more people to use public transportation instead of private vehicles. This shift reduces the number of cars on the road, leading to lower fuel consumption and a significant decrease in GHG emissions. Consequently, the BRT programme helps mitigate climate change, promotes sustainable urban development, and improves air quality in South African cities. From 2010 to 2022; the program has contributed to reducing South Africa's GHG emissions cumulatively by 0.63 Mt CO_2-eq (shown in Table 2.39).

Table 2.38: Bus Rapid Transport (BRT) System

No.	Name	Description	Objectives	Type of instrument
9	Bus Rapid Transport (BRT) System	An urban public transportation initiative aimed at improving the efficiency, reliability, and affordability of bus services in major cities. Funded through the Public Network Transport Grant, the program focuses on developing high-capacity bus networks with dedicated lanes, streamlined routes, and modern infrastructure.	Its main objectives are to reduce traffic congestion, enhance mobility, and provide accessible public transport options for all citizens	Economic
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2007	DoT

Table 2.39: Estimates of GHG emission reductions of the Bus Rapid Transport (BRT) System

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[18]
2010	0	
2011	0	
2012	0.05	
2013	0.05	
2014	0.05	
2015	0.05	
2016	0.05	
2017	0.05	
2018	0.05	
2019	0.07	
2020	0.07	
2021	0.07	
2022	0.07	
Total	0.63	

18 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.2.1 Transnet Road-to-Rail Programme

The Transnet Road-to-Rail Programme is an initiative aimed at shifting freight transportation from road to rail networks. Its main objectives are to alleviate road congestion, reduce road maintenance costs, and enhance the efficiency and reliability of the country's freight transport system. A summary of the program is provided in Table 2.40. By promoting the use of rail for transporting goods, the programme significantly reduces the number of heavy trucks on the roads, which in turn decreases fuel consumption and lowers GHG emissions. This transition not only helps mitigate climate change but also contributes to improved air quality and a reduction in the environmental impact of freight transport in South Africa. From 2010 to 2022; the program has contributed to reducing South Africa's GHG emissions cumulatively by 3.2 Mt CO_2-eq (shown in Table 2.41).

Table 2.40: Transnet Road-to-Rail Programme

No.	Name	Description	Objectives	Type of instrument
10	Transnet Road-to-Rail Programme	The Programme is designed to shift freight transportation from road to rail, aiming to enhance rail infrastructure and reduce road congestion. By increasing the use of rail for cargo transport, the programme seeks to lower transportation costs, improve logistics efficiency, and decrease GHG emissions, supporting the country's climate goals and promoting more sustainable transport solutions.	The main objectives of the Transnet Road-to-Rail Programme are to enhance rail infrastructure and shift freight transportation from road to rail. This shift aims to reduce road congestion, lower transportation costs, and decrease greenhouse gas emissions, supporting more sustainable and efficient transport solutions.	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy	CO_2	2012	Transet

Table 2.41: Estimates of GHG emission reductions of the Transnet Road-to-Rail Programme

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[19]
2010	0	
2011	0	
2012	0	
2013	0	
2014	0.48	
2015	0.31	
2016	0.64	
2017	0.86	
2018	0.11	
2019	0.2	
2020	0.32	
2021	0.2	
2022	0.08	
Total	3.2	

19 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.2.2 Electric Vehicles

There are over 2000 electric motor vehicles (motorcars) recorded in South Africa as of 2022. New energy vehicles that include electric vehicles and fuel cell electric vehicles are considered a priority investment sector in the Just Energy Transition Implementation Plan (JET-IP) published in 2022. Preceding the DTIC 2023 Electric Vehicle White Paper was the DTIC 2021 Green Paper that was a roadmap for the manufacturing of electric vehicles. These policy reports communicate the government's medium-term plans for broadening the production of electric vehicles and their future predominance within South Africa's vehicle fleet. Fuel cell electric vehicles which are powered by hydrogen gas are in the early stages of adoption with 3 vehicles recorded in South Africa as of 2022. Ahjum et al. (2018) show that GHG emissions from transport in 2030 can be halved by 2045 with an 80% adoption rate of electric vehicles. Cumulative GHG emissions from the usage of electric vehicles in the country from 2010 to 2022 amount to 0.06 Mt CO_2-eq. Lower emission reductions from electric vehicles is attributed to the low adoption rate of electric vehicles in the country (Scholtz et al. 2023). Scholtz et al. 2023 indicates that greater adoption of electric vehicles is dependant on building domestic production capacity and support for expanding charging infrastructure, both activities supported by the DTIC 2023 Electric Vehicle White Paper and JET-IP. A summary of the electric vehicles measure is provided in Table 2.42 and the information for emissions reductions is provided in Table 2.43.

Table 2.42: Electric vehicles

No.	Name	Description	Objectives	Type of instrument
11	Electric vehicles	Policy measure that seeks to drive the transition from the predominant use of internal combustion engines in road transportation to electric vehicles. Government policies promoting EVs include the GTS 2018 (DoT; 2018); The EV White paper (DTIC; 2023) and the JET-IP (The Presidency, 2023).	Common objectives of government policies such as the GTS 2018 (DoT; 2018); The EV White paper (DTIC; 2023) and the JET-IP (The Presidency, 2023) seek to implement actions which will radically transition the country's road transportation with mainly internal combustion engines with electric vehicles. To achieve this, the policies seek to transform local automotive manufacturing to mainly produce EVs including co	Other

Status	Sector affected	Gases affected	Start year of implementation	Implementing entity
Implemented	Transport	$CO_{2;}$ CH_4; N_2O	2023	DTIC (through automotive industry policy) and PCC (through the JET-IP)

Table 2.43: Estimates of GHG emission reductions of Electric Vehicles

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[20]
2010	0.00	
2011	0.00	
2012	0.00	
2013	0.00	
2014	0.00	
2015	0.00	
2016	0.00	
2017	0.01	
2018	0.01	
2019	0.01	
2020	0.01	
2021	0.01	
2022	0.01	
Total	0.06	

20 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.3 IPPU

(b) Nitrous Oxide Reduction Projects

South Africa's N_2O Reduction Projects typically involve the implementation of advanced technologies and process modifications to capture and convert N_2O into less harmful substances. A summary of the program is provided in Table 2.44. Techniques such as catalytic decomposition, where specialized catalysts break down N_2O into nitrogen and oxygen, and the integration of emission control systems are common. By reducing N_2O emissions, these initiatives aim to lower the environmental impact of nitric acid production, contribute to improved air quality, and support South Africa's climate goals by reducing greenhouse gas emissions. Emission reductions are not reported (see footnote 21 for Table 2.45).

Table 2.44: Nitrous Oxide Reduction Projects

No.	Name	Description	Objectives	Type of instrument
11	Nitrous Oxide Reduction Projects	The Projects in nitric acid production focus on minimizing N_2O emissions through advanced technologies and process improvements. These initiatives typically involve implementing catalytic decomposition systems to convert N_2O into less harmful substances, thereby reducing the environmental impact and supporting the country's climate goals.	To significantly lower N2O emissions by employing advanced control technologies and process enhancements. These efforts aim to reduce the environmental impact of nitric acid production and contribute to the country's climate change mitigation goals.	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Energy and IPPU	N_2O	2006	Private sector

Table 2.45: Estimates of GHG emission reductions of Nitrous Oxide Reduction Projects

Estimates of GHG emission reductions	
Achieved	**Expected**
Not reported[21]	Not reported[22]

21 To avoid double accounting as there are projects registered under carbon credit mechanisms

22 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.4 AFOLU

(a) Conservation Agriculture

Conservation agriculture practices are promoted as part of Comprehensive Agricultural Support Programme (CASP); Ilima/Letsema Projects; Land Care Programme and the Working for Land Programme. These practices focus on sustainable farming techniques such as minimal soil disturbance, cover cropping, and crop rotation to improve soil health, enhance water retention, and increase agricultural productivity. A summary of the conservation agriculture measure is provided in Table 2.46. The aim of the grant funded programs are to promote sustainable land management and job creation through community-based initiatives that support social, economic, and environmental sustainability. This involves assisting vulnerable South African farming communities to boost agricultural production and invest in critical infrastructure. By providing coordinated agricultural support and collaborating with industry initiatives, these programs enhance food productivity and supports land reform beneficiaries. By adopting conservation agriculture, South Africa aims to reduce GHG emissions through enhanced carbon sequestration in soils, decreased reliance on chemical inputs, and improved overall farm resilience, contributing to the country's climate change mitigation efforts. The grant programs also aim to revitalize agricultural colleges into centers of excellence and incentivizes provincial departments to create jobs through labor-intensive methods in areas like road maintenance, building upkeep, tourism, and waste management. From 2010 to 2022; conservation agriculture practices have contributed to reducing South Africa's GHG emissions cumulatively by 13,34 Mt CO_2-eq (shown in Table 2.47).

Table 2.46: Conservation Agriculture

No.	Name	Description	Objectives	Type of instrument
12	Conservation Agriculture	Grant funded projects which focus on sustainable farming practices that improve soil health, water conservation, and crop productivity.	To advance sustainable farming practices, improve soil and water management, and support rural development and environmental stewardship	Economic
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Agriculture	CO_2; CH_4; N_2O	2001	Department of Agriculture

Table 2.47: Estimates of GHG emission reductions of Conservation Agriculture

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[23]
2010	0,64	
2011	0,69	
2012	0,74	
2013	0,8	
2014	0,86	
2015	0,92	
2016	0,99	
2017	1,06	
2018	1,14	
2019	1,23	
2020	1,32	
2021	1,42	
2022	1,53	
Total	13,34	

23 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.4.1 Grassland Restoration

The implementation of grassland restoration is guided by several key commitments and programs. It aligns with the United Nations Convention to Combat Desertification (UNCCD) medium-term goal to rehabilitate and sustainably manage 2,436,170 hectares of grassland by 2030. Additionally, it supports the natural land cover restoration objectives outlined in the National Biodiversity Strategy and Action Plan (NBSAP). This effort is further bolstered by the DFFE "Working for" programs, which focus on restoring ecological infrastructure, and the Department of Agriculture LandCare Programs, which emphasize sustainable land management in agricultural areas. A summary of the grassland restoration measure is provided in Table 2.48. Grassland restoration reduces GHG emissions by enhancing carbon sequestration in soils and vegetation, improving soil health, and preventing soil erosion and land degradation. From 2010 to 2022; grassland restoration activities have contributed to reducing South Africa's GHG emissions cumulatively by 13.95 Mt CO_2-eq (shown in Table 2.49).

Table 2.48: Grassland Restoration

No.	Name	Description	Objectives	Type of instrument
13	Grassland Restoration	Grassland restoration aims to enhance the productivity of grasslands by encouraging sustainable grazing practices that minimize topsoil loss and disruption, boost forage production and coverage, and preserve the diversity of essential forage species.	To restore and rehabilitate grasslands and grazing lands while reducing soil erosion	Regulatory measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Agriculture and LULUCF	CO_2; CH_4; N_2O	2001	Department of Agriculture; DFFE

Table 2.49: Estimates of GHG emission reductions of Grassland Restoration

Estimates of GHG emission reductions[24]		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[25]
2010	1,18	
2011	1,21	
2012	1,21	
2013	1,22	
2014	1,22	
2015	0,41	
2016	0,41	
2017	0,4	
2018	0,45	
2019	1,55	
2020	1,55	
2021	1,56	
2022	1,58	
Total	13,95	

24 There are registered carbon credit mechanism projects for grassland restoration. The total annual emission reductions of these projects are very small, and therefore negligible. The emission reductions from these projects are excluded from accounting.

25 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.4.2 Afforestation

Forestland management, including natural forests and plantations and the afforestation and restoration activities thereof, is regulated by the National Forests Act, 1998 (Act No. 84 of 1998). This Act emphasizes sustainable forest management and outlines how forests can be used by people and communities without causing destruction. Additionally, the National Veld and Forest Fire Act, 1998 (Act No. 101 of 1998) is crucial for managing forest fires and ensuring fire safety.

These laws are supported by various amendments and policies, such as the Forestry Laws Amendment Act, 2005 (Act No. 35 of 2005) and the National Forest and Fire Laws Amendment Act, 2001 (Act No. 12 of 2001). Together, they provide a comprehensive framework for the sustainable management and protection of South Africa's forest resources.

The National Forests Amendment Act, 2022 aims to enhance forest management and protection by clarifying definitions, establishing public trusteeship, promoting sustainability, controlling deforestation, reinforcing penalties, and providing an appeals process. The proposed 2023 amendment reinforces the appeals mechanism for provisions for appeals against delegated decisions, the formation of an appeals committee, specific timeframes for lodging and deciding appeals, and measures to ensure transparency and fairness, all aimed at enhancing accountability and fairness in forest management. The afforestation programs managed by DFFE, including the Working for Land and Working for Ecosystems initiatives, focus on expanding and restoring forested areas to enhance environmental sustainability and ecosystem health. A summary of the measure is provided in Table 2.50. The main objectives of these programs are to increase forest cover, improve biodiversity, and rehabilitate degraded landscapes. By doing so, these initiatives help reduce South Africa's GHG emissions by sequestering carbon dioxide in vegetation and soil, improving overall carbon storage, and mitigating the effects of climate change. From 2010 to 2022; afforestation activities have contributed to reducing South Africa's GHG emissions cumulatively by 352,24 Mt CO_2-eq (shown in Table 2.51).

Table 2.50: Afforestation

No.	Name	Description	Objectives	Type of instrument
14	Afforestation	The afforestation programs managed by the Department of Forestry, Fisheries, and the Environment, including the Working for Land and Working for Ecosystems initiatives, focus on expanding and restoring forested areas to enhance environmental sustainability and ecosystem health.	To increase and rehabilitate forested regions in order to boost environmental sustainability, enrich biodiversity, and strengthen ecosystem health.	Regulatory measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	LULUCF	CO_2	2006	DFFE

Table 2.51: Estimates of GHG emission reductions of Afforestation

Estimates of GHG emission reductions[26]		
Achieved		Expected
Year	**Emission Reduction (Mt CO_2-eq)**	Not reported[27]
2010	17,24	
2011	18,07	
2012	20,21	
2013	21,64	
2014	18,72	
2015	21,6	
2016	26,62	
2017	24,48	
2018	24,67	
2019	31,45	
2020	38,56	
2021	40,15	
2022	48,83	
Total	352,24	

26 There are registered carbon credit mechanism projects for afforestation. The total annual emission reductions of these projects are very small, and therefore negligible. The emission reductions from these projects are excluded from accounting.

27 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.4.3 Forest and Woodland Restoration and Rehabilitation

The forest and woodland restoration and rehabilitation activities managed DFFE, including as part of the Working for Land and Working for Ecosystems initiatives, focus on revitalizing degraded forest and woodland areas to restore ecological balance and enhance environmental quality. A summary of the measure is provided in Table 2.52. The primary objectives are to rehabilitate damaged landscapes, increase biodiversity, and improve carbon sequestration. By expanding forest cover and improving the health of these ecosystems, these activities contribute to reducing South Africa's GHG emissions through enhanced carbon capture and storage, while also supporting overall climate resilience and ecological sustainability. From 2010 to 2022; forest and woodland restoration and rehabilitation activities have contributed to reducing South Africa's GHG emissions cumulatively by 50.96 Mt CO_2-eq (shown in Table 2.53).

Table 2.52: Forest and Woodland Restoration and Rehabilitation

No.	Name	Description	Objectives	Type of instrument
15	Forest and Woodland Restoration and Rehabilitation	As part of the Department of Forestry, Fisheries, and the Environment's Working for Land and Working for Ecosystems initiatives, the actions aim to restore degraded landscapes, enhance biodiversity, and improve carbon sequestration to support ecological balance and mitigate climate change.	To rehabilitate degraded landscapes, boost biodiversity, and improve carbon capture to strengthen ecological health and climate resilience.	Regulatory measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	LULUCF	CO_2	2006	DFFE

Table 2.53: Estimates of GHG emission reductions of Forest and Woodland Restoration and Rehabilitation

Estimates of GHG emission reductions[28]		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[29]
2010	1.92	
2011	2.23	
2012	2.55	
2013	2.98	
2014	2.28	
2015	2.88	
2016	4.03	
2017	3.25	
2018	2.96	
2019	5.13	
2020	6.48	
2021	6.23	
2022	8.04	
Total	50.96	

28 There are registered carbon credit mechanism projects for forest and woodland restoration and rehabilitation. The total annual emission reductions of these projects are very small, and therefore negligible. The emission reductions from these projects are excluded from accounting.

29 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.4.4 Thicket Restoration

The Biodiversity Act of 2004 in South Africa supports the restoration and afforestation of natural landscapes through conservation and sustainable use, ecosystem protection, biodiversity management plans, incentives for landowners, and monitoring and enforcement mechanisms. The National Biodiversity Framework serves as an implementation tool for the National Environmental Management: Biodiversity Act and outlines specific outcomes to achieve biodiversity conservation. The NBSAP provides a strategic framework for biodiversity management, which is operationalized through the National Biodiversity Framework (NBF) as mandated by Chapter 3 of the Biodiversity Act.

Thick restoration is driven by several key commitments and programs. A summary of the measure is provided in Table 2.54. It aligns with the medium-term (2030) UNCCD commitment to combat desertification by rehabilitating and sustainably managing 87,621 hectares of thicket. Additionally, it supports natural land cover restoration goals outlined in the National Biodiversity Strategy and Action Plan (NBSAP). The Department of Forestry, Fisheries, and the Environment's "Working for" programs focus on restoring ecological infrastructure, while the Department of Agriculture, Land Reform, and Rural Development's LandCare programs emphasize sustainable land management in agricultural areas. quality. A summary of the measure is provided in Table 2.49.

Thicket restoration helps reduce GHG emissions by enhancing carbon sequestration, as restored thickets absorb and store carbon dioxide in their biomass and soil. Additionally, healthy thickets improve soil quality and stability, reducing the release of carbon stored in the soil and minimizing soil erosion. Overall, thicket restoration contributes to a more resilient and sustainable ecosystem that plays a crucial role in reducing the country's GHG emissions. From 2010 to 2022; thicket restoration activities have contributed to reducing South Africa's GHG emissions cumulatively by 16.08 Mt CO_2-eq (shown in Table 2.55).

Table 2.54: Thicket Restoration

No.	Name	Description	Objectives	Type of instrument
16	Thicket Restoration	Thicket restoration activities in South Africa focus on rehabilitating degraded thicket ecosystems to enhance biodiversity, improve soil quality, and increase carbon sequestration, thereby supporting environmental sustainability and climate change mitigation.	The main objective of thicket restoration in South Africa is to rehabilitate degraded thicket ecosystems involving the replanting of thicket vegetation to enhance biodiversity and improve ecological health, with the purpose of increasing carbon sequestration and thereby reducing GHG emissions.	Regulatory measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	LULUCF	CO_2	2006	DFFE; Department of Agriculture

Table 2.55: Estimates of GHG emission reductions of Thicket Restoration

Estimates of GHG emission reductions		
Achieved		**Expected**
Year	Emission Reduction (Mt CO_2-eq)	Not reported[30]
2010	1.1	
2011	1.2	
2012	1.11	
2013	1.19	
2014	1.11	
2015	1.29	
2016	1.41	
2017	1.32	
2018	1.3	
2019	1.37	
2020	1.38	
2021	1.12	
2022	1.18	
Total	16.08	

30 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.4.5 Shrubland restoration and afforestation

Shrubland exists in South Africa distributed in the Northern Cape, Western Cape and Eastern Cape. Smaller areas of karroid type shrubland exists in other interior provinces such as North West and Free State. A summary of the measure is provided in Table 2.56. Shrubland restoration and afforestation aligns with the medium-term (2030) UNCCD commitment to combat desertification by rehabilitating and sustainably managing 1 349 714 ha of fynbos; 149 877 ha of Succulent Karoo and 528 632 ha of Nama Karoo. The restoration and afforestation of shrubland align with the National Biodiversity Framework (2019-2024) and the National Biodiversity Strategy and Action Plan (2015-2025) by promoting ecosystem restoration, enhancing climate resilience, protecting biodiversity, and supporting sustainable land use. The Working for Ecosystems programme, under the DFFE, focuses on restoring degraded landscapes through ecosystem rehabilitation and invasive alien species control, particularly in Karroid regions. Similarly, the Working for Water Programme targets the removal of invasive alien species that degrade water resources and ecosystems, including those affecting Karroid vegetation in arid regions, thereby helping to restore natural shrublands, enhance water availability, and improve biodiversity.

The restoration and afforestation of shrubland vegetation help reduce South Africa's GHG emissions by enhancing carbon sequestration in arid and semi-arid regions. Restored shrublands capture and store carbon in plant biomass and soils, which can mitigate emissions from other sectors. Additionally, restoration prevents further land degradation, reducing the release of carbon stored in soils. From 2010 to 2022; restoration and afforestation of shrubland has contributed to reducing South Africa's GHG emissions cumulatively by 11,77 Mt CO_2-eq (shown in Table 2.57).

Table 2.56: Shrubland Restoration and Afforestation

No.	Name	Description	Objectives	Type of instrument
17	Shrubland Restoration and Afforestation	Initiatives that are a part of the Department of Forestry, Fisheries, and the Environment's policy and programmes which focus on rehabilitating degraded shrublands, improving soil fertility, and restoring vegetation cover to prevent further degradation	For the Karoo, objectives include restoring degraded landscapes, enhancing soil and water management, and promoting sustainable land use to improve ecosystem health and carbon sequestration, while for the Fynbos, the goals are to conserve biodiversity, protect high-biodiversity areas, restore degraded lands, integrate biodiversity into land use planning, and enhance ecosystem resilience to climate change.	Regulatory measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	LULUCF	CO_2	2006	DFFE

Table 2.57: Estimates of GHG emission reductions of Shrubland Restoration and Afforestation

Estimates of GHG emission reductions		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	Not reported[31]
2010	0.85	
2011	0.87	
2012	0.82	
2013	0.93	
2014	0.95	
2015	0.65	
2016	0.67	
2017	0.67	
2018	0.74	
2019	1.24	
2020	1.18	
2021	1.09	
2022	1.11	
Total	11.77	

31 GHG emissions reductions are reported to the extent possible as the achieved emission reductions. Specific information about the GHG effect of individual PAMs are not provided for in the technical documentation of the NDC. The combined impact of existing and planned policies is modelled through scenarios that consider key drivers such as GDP growth and population. These scenarios are linked to sectoral emission and economic modules to quantify the economy-wide greenhouse gas (GHG) effect of these policies.

2.4.2.5 Waste

(a) Municipal Landfill Gas Destruction

Municipal Landfill Gas Destruction in South Africa, as mentioned in the National Waste Management Strategy of 2020 and regulated by the National Environmental Management: Waste Act of 2008: National Standards for the extraction, flaring or recovery of landfill gas 2013, focuses on capturing and destroying CH_4 emissions from landfills to mitigate GHG emissions and reduce environmental impact. A summary of the measure is provided in Table 2.58. The strategy promotes the installation of landfill gas extraction and flaring systems, encouraging municipalities to adopt these technologies to improve waste management practices. By converting landfill gas into energy, the initiative also supports renewable energy development and contributes to South Africa's broader climate change mitigation goals. Emission reductions are not reported (see footnote 32 for Table 2.59).

Table 2.58: Municipal Landfill Gas Destruction

No.	Name	Description	Objectives	Type of instrument
18	Municipal Landfill Gas Destruction	Municipal landfill gas extraction and flaring activities in South Africa involve capturing methane emissions from landfills and burning them to reduce GHG emissions and environmental impact	The capturing and safe destruction of methane from landfills, thereby mitigating climate change and minimizing the environmental impact of waste disposal.	Regulatory measures
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Waste	CO_2	2008	DFFE

Table 2.59: Estimates of GHG emission reductions of Municipal Landfill Gas Destruction

Estimates of GHG emission reductions	
Achieved	**Expected**
Not reported[32]	Not reported[32]

32 To avoid double accounting as there are projects registered under carbon credit mechanisms

2.4.2.5.1 National Waste Management Strategy

The National Waste Management Strategy (NWMS) establishes a cohesive strategy and framework for enacting the Waste Act, detailing the government's policy and strategic approach to waste management. The primary aim of the strategy (DFFE; 2020) is to create a sustainable, efficient, and inclusive waste management system that minimizes environmental impact, promotes socio-economic development, and transitions towards a circular economy. The NWMS 2020 addresses key waste management issues by providing a service delivery model based on the waste management hierarchy, with specific objectives, actions, and targets for different waste streams. This includes promoting alternatives to landfilling, composting, and energy recovery, encouraging sustainable product design and packaging, advancing residential separation at source programs, and supporting the development of skills in the waste sector. It also aims to strengthen the role of waste pickers, align enforcement responsibilities, support local governments in implementing integrated waste management plans, and coordinate a comprehensive public awareness program. A summary of the NWMS is provided in Table 2Table 2.60.61.

Between 2010 and 2021; the NWMS has helped cumulatively reduce GHG emissions by 8.49 Mt CO_2-eq (Shown in Table 2.61) through several initiatives: promoting waste minimization, enhancing recycling and reuse, encouraging composting and energy recovery, supporting sustainable product design, facilitating residential separation at source, integrating waste pickers into the formal system, developing waste management infrastructure, and raising public awareness. These efforts collectively reduce the amount of waste in landfills, lower methane emissions, and decrease the carbon footprint of production and disposal processes.

Table 2.60: National Waste Management Strategy

No.	Name	Description	Objectives	Type of instrument
19	Waste Management Strategy	The South African National Waste Management Strategy (NWMS) 2020 is a comprehensive framework designed to guide the country's efforts in managing waste sustainably and effectively. The strategy builds on previous versions, aiming to address current challenges and align with international best practices	Promote waste minimization, reuse, recycling, and recovery. Ensure effective and efficient delivery of waste services. Enhance the waste sector's contribution to the green economy. Raise awareness about the impact of waste on health, well-being, and the environment. Achieve integrated waste management planning. Ensure sound budgeting and financial management for waste services. Provide measures for the remediation of contaminated land. Establish effective compliance with and enforcement of the Waste Act.	Other
Status	**Sector affected**	**Gases affected**	**Start year of implementation**	**Implementing entity**
Implemented	Waste	CH_4	2011	DFFE

Table 2.61: GHG emission reductions of the National Waste Management Strategy

Estimates of GHG emission reductions[33]		
Achieved		Expected
Year	Emission Reduction (Mt CO_2-eq)	FX
2010	0.61	
2011	0.81	
2012	0.97	
2013	1.05	
2014	1.09	
2015	1.11	
2016	1.12	
2017	0.92	
2018	0.69	
2019	0.06	
2020	0.02	
2021	0.02	
2022	0.02	
Total	8.49	
Flexibility is applied as per p85 of the MPGs to not report expected emission reductions. Figures for ex-ante estimates of GHG emission reductions are not available in official South African government reports. GHG emissions reductions are reported to the extent possible as the achieved emission reductions.		

2.4.3 How actions, policies and measures are modifying longer-term trends in GHG emissions and removals

Many of the PAMs described in this BTR; impact GHG emissions and removals in the short-term. Instruments provisioned in the Climate Change Act 22 of 2024 including sectoral emission targets and carbon budgets are orientated to steer sectors to make transformative changes for achieving long-term reductions of GHG emissions. The DFFE study completed in 2020 about the long-term impacts of existing and planned PAMs (DFFE; 2020); indicated that there have been four main drivers of GHG emissions which have steered historical long term trends:

- Lower costs of renewable energy technology have helped to increase mitigation in the electricity sector.
- Decreased demand for liquid fuels is happening due to better efficiency, changes in transportation methods, and the rise of fuel cell and electric vehicles.
- Slower economic growth is also a factor, leading to lower industrial activity and energy consumption .
- Improved understanding of South Africa's land-based sequestration capabilities indicates that past estimations of removals in the land sector were underestimated.

33 There are registered carbon credit mechanism projects for waste management. The total annual emission reductions of these projects are very small, and therefore negligible The emission reductions from these projects are excluded from accounting.

2.5 SUMMARY OF GREENHOUSE GAS EMISSIONS AND REMOVALS

A summary of the 2022 National Inventory Report (NIR) for South Africa is presented in Chapter 1 of this BTR.

2.6 PROJECTIONS OF GREENHOUSE GAS EMISSIONS AND REMOVALS, AS APPLICABLE

GHG emissions are projected for a 'with measures' scenario for the period 2023 to 2030. South Africa has not identified the reported projection as its baseline. Reporting on the "with additional measures" scenario and "without measures" scenario is not mandatory; for which South Africa is not reporting this information in this BTR. In Figure 2.9 shown below, the projection of GHG emissions is shown for total GHG emissions including LULUCF.

South Africa has applied the flexibility provision in para 95 of the MPGs to report the projections for the time period from 2023 until the endpoint of the NDC which is 2030. While the modelling of projected GHG emissions has been completed (in February 2024), analysis of the modelling output is not yet completed. This is part of the process to develop sectoral mitigation plans as mentioned in the Climate and Development Knowledge Network (CDKN) Planning for NDC Implementation Guide (CDKN; 2016). Also included in this process is to consult the sectors (ministerial heads) and other affected stakeholders (public and private sector interest groups). As the timeline for completion of the sectoral mitigation plans are much later than the submission deadline for this BTR; detailed information about the GHG modelling and findings of the sector plans development will be reported in the BTR3 to be submitted in 2028.

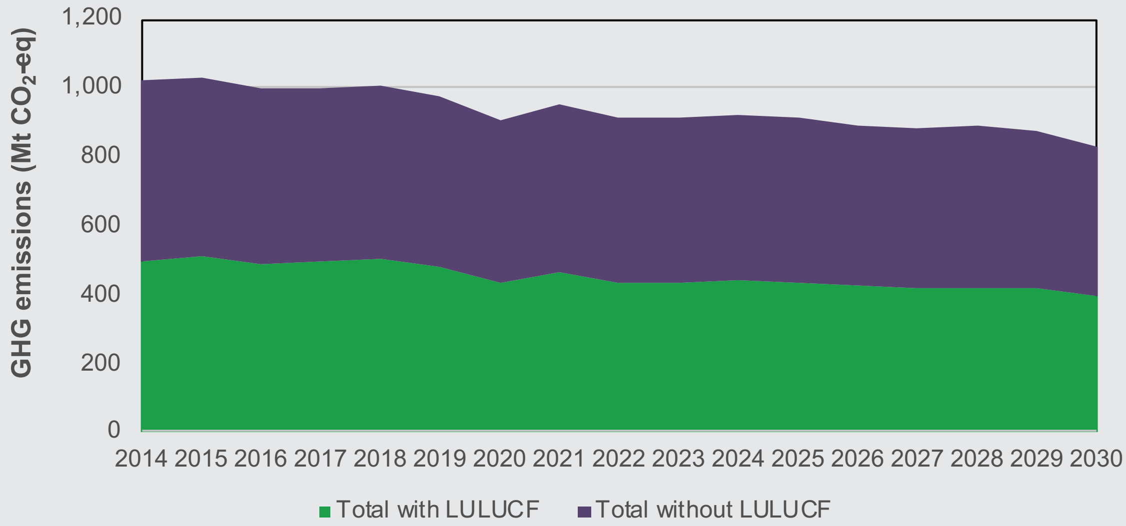


Figure 2.9: A 'with measures' Projection of Greenhouse Gas Emissions and Removals 2023- 2030 and including inventory values for preceding years 2014 -2022

2.6.1 Models and/or approaches used and key underlying assumptions and parameters used for projections

The information about the methodology used to develop the projections is reported in less detail (application of flexibility provision para 102 of the MPGs). Detailed information about the methodology used will only be included in BTR3 to be submitted in 2028, as per the explanation provided for the development of sectoral mitigation plans. Changes in methodology are not reported because this is only applicable for the BTR submissions post BTR1. Reporting all the information about methodologies is not mandatory. South Africa is not reporting on the following aspects in this BTR:

- Models and approaches used and key underlying assumptions and parameters used for projections
- Assumption about PAMS included in projections
- Sensitivity analysis for the projections, together with the methodologies and parameters used

The Analytica based integrated assessment DFFE Integrated Climate Change Mitigation Model has been used to quantify GHG emission projections for South Africa up to 2050. This model builds on historical activity data and integrates assumptions about emission drivers and mitigation strategies.

Incorporating earlier studies like the Mitigation Potential Analysis (MPA), South Africa's Greenhouse Gas (GHG) Emission Pathways, the Policies and Measures (PAMs) model, and Ex-post tools, the integrated model updates both historical data and assumptions. The historical data spans from 2000 to 2022, and the assumptions include the country's existing and potential climate and non-climate policies, economic developments, new scientific findings, and technological advances. Using a bottom-up approach, the model estimates GHG emissions by considering activity data and mitigation potential in key economic sectors. It employs two linked economic models. The first is a social accounting matrix (SAM) within the Analytica framework, which evaluates the socio-economic implications of individual mitigation options. The second is an external socio-economic model developed by Cambridge Econometrics, linked to the integrated model, assessing the socio-economic impacts of mitigation strategies across different sectors and the entire economy. Additionally, the model incorporates multi-criteria assessments (MCA) to evaluate the socio-economic, environmental, and practical aspects of each mitigation option.

The socio-economic model complements the DFFE's integrated energy model by estimating the economic impacts of various energy pathways on South Africa's economy at national, industry, and household levels. It uses a simulation approach to project outcomes based on policy changes and integrates seamlessly with the Analytica energy model. The model focuses on minimizing costs under constraints and projecting outcomes based on variable relationships. Using the SAM, it links industries, products, households, and labour types for detailed scenario analysis. The model considers factors like uncertainty, market frictions, and economic capacity, and is demand-driven. Data exchange between the socio-economic and Analytica models enriches the analysis. Econometric estimations and error correction models help understand relationships between employment, wages, investment, and prices. Key economic indicators, such as sectoral output, employment, and household consumption, are calculated to provide insights into the socio-economic impacts of decarbonization pathways, aiding policymakers in understanding the broader implications of energy policies on the economy, employment, and income distribution.

Historic population data was updated to reflect the most recent historical population dataset from 2002 to 2022 The population projections were revised during the update of the MPA in 2021, with the medium scenario updated in 2024 to align with the IRP 2023. These population projections are assumed to follow the United Nations population projection from its Population Division.

Projections are reported in less detailed coverage (application of flexibility provision p102 of the MPGs). South Africa does not report on projections on a sectoral basis and by gas in this BTR. South Africa indicates that the more detailed sectoral and gas specific information about GHG emissions projections is part of the analysis of the modelling output that is part of the development of the sectoral mitigation plans. The information will only be reported on in 2028 in BTR3. Guidance for this process is from the CDKN Planning for NDC Implementation Guide.

2.7 USE OF FLEXIBILITY PROVISIONS

Flexibility provisions used in this chapter are listed in Chapter 5 of this report.

03 INFORMATION RELATED TO CLIMATE CHANGE IMPACTS AND ADAPTATION UNDER ARTICLE 7 OF THE PARIS AGREEMENT

3. Information related to climate change impacts and adaptation under Article 7 of the Paris Agreement

3.1 NATIONAL CIRCUMSTANCES, INSTITUTIONAL ARRANGEMENTS AND LEGAL FRAMEWORKS

3.1.1 National Circumstances

3.1.1.1 Climate and natural environment

South Africa possesses various climatic regions, ranging from the steppe hot summer rainfall region (marked 1 in Figure 3.1), the Sub-tropical climatic region (marked 2 in Figure 3.1), the temperate hot summer region (marked 3 in Figure 3.1), the arid desert and semi-desert climate in the western parts of the country (marked 4 in Figure 3.1), and the Mediterranean climate in the south-western Cape (marked 5 in Figure 3.1; Taljaard, 1994; Beck et al., 2018). These regions have also been classified according to the Köppen-Geiger historic climatic classification (Beck et al., 2018). The steppe hot summer rainfall region is characterized by semi-arid and hot conditions with rainfall seasons observed between November and March. The Mediterranean climatic region is experiencing mild, rainy winters and hot, dry summers. Mid-latitude storms bring heavy to extreme precipitation to the Mediterranean climatic region in winter (Favre, et al., 2013). Subtropical lows, such as CoLs, are known for causing severe weather and significant precipitation events (Engelbrecht et al., 2012; Favre, et al., 2013; Du Plessis and Schloms, 2017). The Temperate Climatic region is characterized by dry, cold winters due to subsiding air from strong high-pressure circulations. These high-pressure systems move southward in summer, resulting in favourable conditions for wet summers in temperate regions (Mahlalela et al., 2019). The Subtropical climatic region is regarded as an all-year-rainfall region, with hot, humid summers and mild, moist winters. Here, summer extreme precipitation events are typically caused by tropical storms in the east or by mid and upper-level troughs elsewhere. The desert and semi-desert climatic regions are characterized by warm-to-hot and dry conditions (Taljaard, 1994).

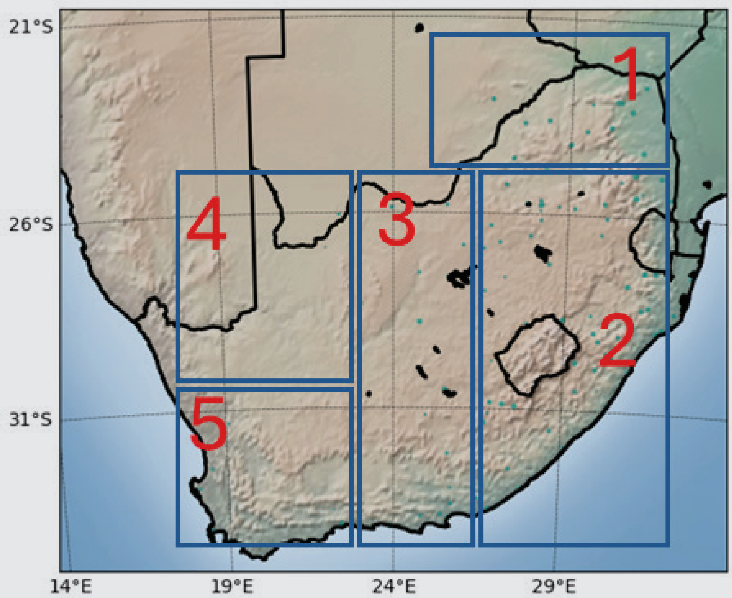


Figure 3.1: The climatic regions of South Africa, based on the Köppen-Geiger historic climatic regions of South Africa (Beck et al., 2018): (1) the summer rainfall area, (2) the all-year-rainfall area, (3) the temperate semi-arid region, (4) hot, desert region and (5) mediterranean, winter rainfall region.

Due to its geographical location, South Africa is influenced by tropical and temperate weather systems. The circulation patterns include subtropical anticyclones, easterly lows, subtropical lows/troughs, westerly waves, ridging anticyclones, west-coast troughs, thunderstorms, and tropical cyclones (Preston-Whyte and Tyson, 2000). Furthermore, the country is flanked by the Atlantic Ocean, associated with the cold Benguela current, on the west, and the Indian Ocean, which is associated with the warm Agulhas current, on the east. Most of the country's rainfall comes from moisture transported by the Agulhas current from the Indian Ocean (Taljaard, 1994; Preston-Whyte and Tyson, 2000). Additionally, the weather of South Africa is greatly influenced by the movement of a high-pressure belt circling the globe between 25^0 and 30^0 south (latitude) during winter, and the presence of low-pressure systems in summer (Taljaard, 1994; Preston-Whyte and Tyson, 2000).

This diverse climate has resulted in the country having a range of environments and vegetation types, including savannas, grasslands, shrublands, forests, and deserts. Different plant species have adapted to thrive in these specific climatic conditions, leading to a rich biodiversity including many endemic species (Rebelo et al., 2006). South Africa hosts three of the world's 36 biodiversity hotspots (Skowno, 2018).

Nevertheless, South Africa also faces significant biodiversity and environmental challenges. Human activities such as urbanization, agriculture, and resource extraction have placed significant pressure on the country's natural resources. According to the South African National Biodiversity Institute (SANBI), over 50% of South Africa's wetlands have been lost or degraded, primarily due to agriculture and urbanization. Additionally, the South African State of Environment Report highlights that between 2000 and 2018, South Africa lost approximately 1.16 million hectares of natural vegetation, with most of the loss attributed to agricultural expansion, urban development, and afforestation (DFFE, 2023). Pollution from industrial activities, mining operations, and urban centers has degraded water quality, soil health, and air quality, threatening both environmental sustainability and public health. Mining activities have left a legacy of pollution and environmental degradation in many areas of the country.

3.1.1.2 Demographics

South Africa is a country marked by diversity, with a population comprising various ethnicities, cultures, and languages. According to Statistics South Africa (Stats SA), the 2022 census revealed a population exceeding 60 million, making South Africa one of the most populous countries on the African continent. The age structure leans towards a slightly younger population, with a median age of around 28 years. This high youth ratio presents both opportunities and challenges for the nation's development trajectory, highlighting the importance of investing in education, skills development, and job creation to harness the demographic dividend and unlock the potential of the youth as drivers of economic growth and social progress. However, the country also faces an aging population, with a growing number of individuals exceeding 65 years, leading to a dependency ratio of 48.8.

South Africa faces significant disparities in access to education and healthcare. The public healthcare system is intended to serve most of the population, particularly those who cannot afford private healthcare services. The public health care sector faces numerous challenges, including resource constraints, infrastructure deficiencies and staff shortages (NDoH, 2020). Rural and underserved areas often bear the brunt of these challenges, where limited access to healthcare exacerbates the vulnerability of marginalized communities to the health impacts of climate change. For instance, extreme weather events such as heatwaves, floods, and storms can lead to injuries, waterborne diseases, and vector-borne illnesses, disproportionately affecting populations with inadequate access to healthcare services. Without timely and effective healthcare interventions, these communities may experience higher morbidity and mortality rates during climate-related disasters. Furthermore, chronic health conditions exacerbated by climate change, such as respiratory diseases and malnutrition, pose significant challenges to healthcare systems that are already strained by limited resources and capacity.

South Africa also faces challenges in access and quality of education, with significant gaps in quality and resources between schools serving affluent and disadvantaged communities. Education plays a crucial role in raising awareness, building knowledge, and fostering adaptive capacities among communities and individuals. However, unequal access to quality education limits the ability of vulnerable populations to understand climate risks, adopt sustainable practices, and participate in adaptation efforts. Addressing the social and economic disparities exacerbated by climate change is crucial for building resilience within these communities and ensuring that adaptation measures are inclusive and equitable.

Urbanization is another key demographic feature, with over 67% of the population residing in urban areas (Mthiyane et al., 2022). Gauteng province, encompassing Johannesburg and Pretoria, is the most populous, highlighting the economic pull of major metropolitan centres. South Africa's urban population accounts for most of the country's economic activity, infrastructure development, and social services provision. However, urbanization also poses challenges related to informal settlements, inadequate housing, unemployment, and socio-economic inequalities, underscoring the importance of urban planning, inclusive development strategies, and equitable access to services to ensure sustainable urban growth and improve the quality of life for all residents. Vulnerable communities, particularly those living in informal settlements, are often disproportionately affected by extreme weather events, such as floods, droughts, and heatwaves. These communities often lack the resources and capacity to cope with climate-related shocks and disasters, placing them at greater risk of displacement, food insecurity, and loss of livelihoods.

3.1.1.3 Economic profile

The economy of South Africa is one of the most developed and diversified on the African continent, encompassing a mix of industries such as mining, manufacturing, agriculture, finance and services. The economy is heavily reliant on its abundant natural resources, including minerals, metals, and a diverse range of agricultural products, which serve as significant drivers of growth and development. The country's vast reserves of coal and other minerals have historically powered its industrial sector, making substantial contributions to GDP, foreign exchange earnings, and employment. However, South Africa's dependence on fossil fuels for energy production poses a significant challenge as the country navigates the global transition to greener economies.

Despite its strengths, South Africa's economy struggles with persistent issues such as high unemployment, income inequality, and slow growth with a large portion of the population living below the national poverty line. In South Africa approximately 49.2% of the adult population live below the upper-bound poverty line (UBPL) (StatsSA, 2019). People living in poverty often lack the resources to prepare for and cope with climate shocks like floods, droughts, or extreme weather events. The country's Gini coefficient of 0.67, a measure of income inequality, remains among the highest in the world, highlighting the deep divides between rich and poor. This inequality is often compounded by persistently high levels of unemployment, particularly among the youth and historically disadvantaged communities. Official statistics from Statistics South Africa (StatsSA, 2022) show that the unemployment rate among South Africans aged 16 to 64 who are actively seeking work reached 32.8% in 2023, the highest rate among G20 countries.

As South Africa's socio-economic sectors are intricately linked to the environment, climate change threatens to disrupt these sectors, undermining livelihoods and economic growth. For example, the agricultural sector, a cornerstone of the economy, is increasingly threatened by water scarcity, soil degradation, and pest outbreaks exacerbated by climate change. Increased temperatures, changes in precipitation patterns, and extreme weather events like floods and droughts can disrupt agricultural activities, leading to food insecurity and economic losses. South Africa is already a water-scarce country, due to the combination of an inherently low and variable rainfall, high evaporative demand, and the rapidly rising demand for water for agriculture, industries and urban areas (Rasifudi et al., 2023). Similarly, the energy sector, which relies heavily on coal-fired power plants, is vulnerable to disruptions caused by extreme weather events and the transition to renewable energy sources. Investing in sustainable and climate-resilient economic development pathways is thus essential for ensuring long-term prosperity and reducing carbon emissions.

vSouth Africa's infrastructure is a vital backbone of its economy and society, encompassing a diverse network of roads, railways, ports, airports, energy facilities, water systems, and telecommunications networks. As the most industrialized country in Africa, South Africa's economic activities, trade, and connectivity rely heavily on its infrastructure, which spans vast distances.

Although infrastructure plays a critical role in supporting South Africa's economy and society, it is also highly susceptible to the impacts of climate change. Aging infrastructure, inadequate maintenance, and poor planning exacerbate vulnerabilities to extreme weather events, such as flooding, storm surges, and sea-level rise. Climate change is impacting South Africa's coastline, which is vital for the country's economic activities, through rising sea levels and more frequent storm surges. These hazards could bring increased coastal flooding and erosion that can damage infrastructure, threaten coastal ecosystems, and displace communities living in low-lying areas.

3.1.1.4 Adaptive capacity

The national circumstances above are crucial for understanding South Africa's adaptive capacity. South Africa's adaptive capacity to climate change is significantly constrained by its socio-economic vulnerabilities, which exacerbate the impacts of climate stressors. High levels of poverty, inequality, and unemployment, especially in rural areas and informal settlements, limit the ability of communities to adapt to changing environmental conditions. Many marginalized populations lack access to basic services, resilient infrastructure, and financial resources, making it challenging for them to cope with extreme weather events such as floods and droughts. Additionally, the reliance on climate-sensitive sectors like agriculture and water further heightens the vulnerability of livelihoods, particularly for smallholder farmers and communities already facing food insecurity. While South Africa has developed national policies and adaptation strategies, their effectiveness is often hampered by limited local capacity, inadequate funding, and gaps in implementation at the municipal level. Building adaptive capacity, therefore, requires targeted investments in social protection, education, and community resilience, alongside efforts to address the underlying socio-economic disparities that amplify climate risks.
South Africa's adaptive capacity is also described by its national arrangements (relevant departments for adaptation coordination) and national legal and policy framework which is crucial for planning and implementation of different adaptation actions. The sections below describe South Africa's institutional arrangements which are key to enhancing the country's adaptive capacity.

3.1.1.5 Institutional Arrangements

South Africa's climate change institutional arrangements span from the national to the local levels of government, emphasizing collaboration, research, civic society and sectoral action to combat climate change. The institutional arrangements and governance for climate change adaptation in South Africa involve a comprehensive and integrated approach, with clear roles and responsibilities for various stakeholders. These institutional arrangements are designed to ensure the effective assessment of climate change impacts, and the systematic and transparent conduct of decision-making, planning, coordination, consultation, participation, monitoring, and reporting. Collaboration between government bodies, research institutions, and civil society, is essential for developing effective institutional arrangements. Hence, collaborative efforts are crucial for building resilience and adapting to the challenges posed by climate change. Figure 3.2 shows the institutional arrangements and governance for climate change adaptation in South Africa.

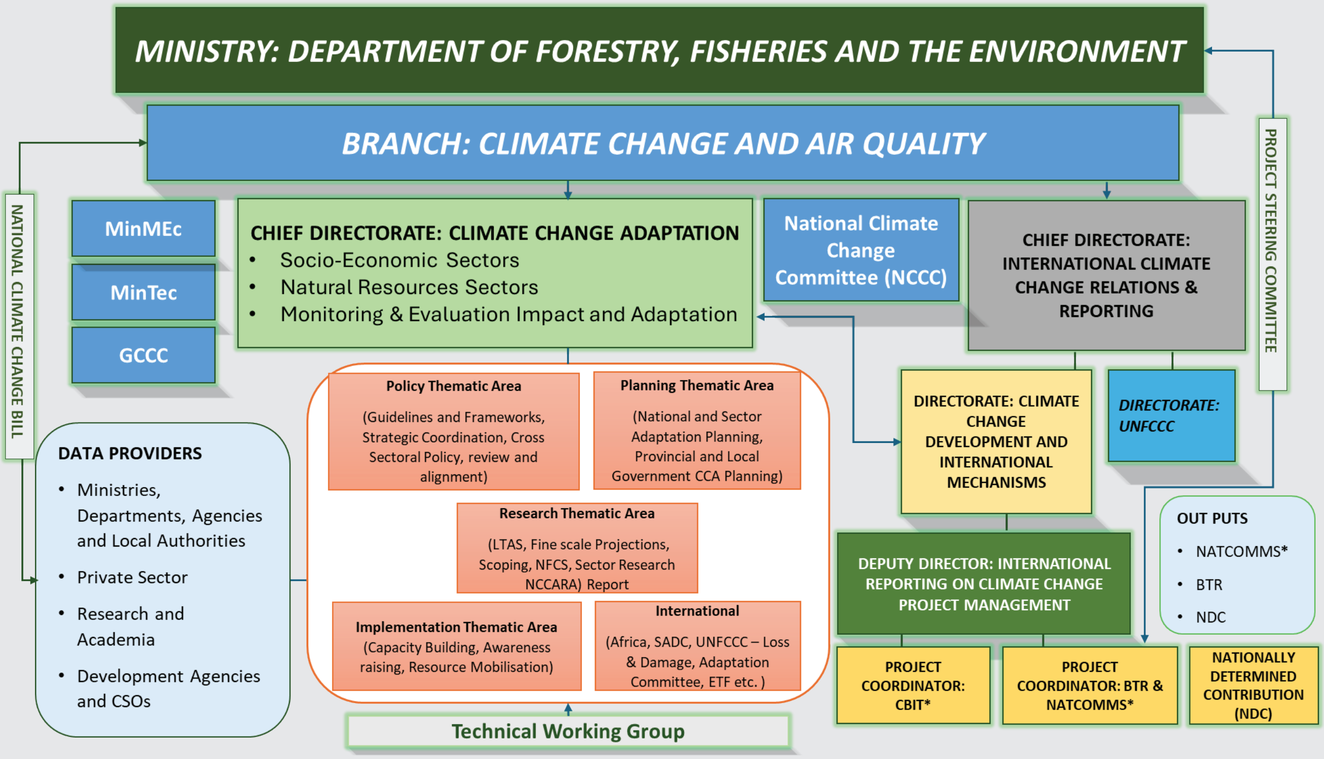


Figure 3.2: Institutional arrangements and governance for climate change adaptation in South Africa.

3.1.1.6 Intra-departmental arrangements

The Department of Forestry, Fisheries, and the Environment (DFFE) plays a pivotal role in South Africa's climate change adaptation efforts, providing leadership, policy direction, and support for various adaptation initiatives nationwide (Figure 3.3). Within the DFFE, the Branch: Climate Change and Air Quality (CCAQ) is specifically tasked with promoting, facilitating, informing, monitoring, and reviewing the integration of environmental sustainability, low carbon development, climate resilience, and air quality into South Africa's transition towards sustainable development.

The CCAQ Branch oversees several key functions through its Chief Directorates, which lead and support national, provincial, and local climate change adaptation responses. The Climate Change Adaptation Chief Directorate is responsible for the national policy on adaptation, enforcement of implementation by sectors at provincial and local levels through the three directorates listed below:

- Directorate: Climate Change Monitoring and Evaluation – Impact & Adaptation
- Directorate: Adaptation of Natural Resource Sectors
- Directorate: Socio Economic Sectors

The Chief Directorate manages the Monitoring and Evaluation (M&E) of adaptation efforts through the web-based National Climate Change Information System (NCCIS), which consolidates data from various sources for reporting purposes. Analysed data from the NCCRD within NCCIS is then forwarded to the Chief Directorate: International Climate Change Relations and Reporting. This chief directorate oversees reporting to international bodies, including the United Nations Framework Convention on Climate Change (UNFCCC), through National Communications and Biennial Transparency Reports.

3.1.1.7 Inter-departmental institutional arrangements

Other national-level departments and government agencies such as the South African National Biodiversity Institute (SANBI), the South African Environmental Observation Network (SAEON), the Department of Agriculture, Land Reform, and Rural Development (DALRRD), and the Department of Water and Sanitation (DWS) that support DFFE in its climate change agenda through collaborative efforts, integrated policies, and coordinated actions. The South African Weather Service (SAWS) plays a crucial role within DFFE by providing essential meteorological and climatological services that support the Department's mandate in addressing climate change, environmental management, and disaster risk reduction. SAWS operates as a public entity under the auspices of the DFFE, ensuring that its activities are aligned with national environmental and climate objectives.

The different national-level departments and institutions collaborate on data collection, analysis, and sharing, as well as providing comprehensive and accurate information for informed decision-making and effective climate action. They also engage in collaborative research initiatives to develop innovative solutions for climate challenges, leveraging expertise and resources from multiple sectors.

3.1.1.8 Advisory Bodies

The National Climate Change Committee (NCCC) coordinates and monitors the implementation of climate change policies across sectors. It includes representatives from government departments, civil society, and the private sector.

3.1.1.9 Assessment of Impacts

Sectoral departments conduct assessments of climate change impacts relevant to their domain. DFFE also plays a role in coordinating these assessments and ensuring a consistent approach. Various research institutions and universities contribute to climate change impact assessments through research and data collection.

3.1.1.10 Decision-Making, Planning, and Coordination

The Cabinet, informed by DFFE and other relevant departments, makes final decisions on national climate change strategies and policies. Sectoral departments develop their own climate change plans within the framework of national strategies. The NCCC plays a crucial role in coordinating climate change action across sectors and ensuring coherence in policies and plans.

3.1.1.11 Consultation and Participation

Stakeholder consultations are an essential part of the policy development process. DFFE and sectoral departments engage with civil society, the private sector, and communities to gather input and ensure that their needs are considered. Public participation platforms exist to allow citizens to voice their concerns and participate in decision making related to climate change.

3.1.1.12 Adaptation policy landscape

South Africa has made significant progress towards becoming a low carbon and climate resilient society. As a signatory of numerous global climate change responses including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement, the country continues to strengthen its efforts in achieving and stabilizing greenhouse gas (GHG) concentrations in the atmosphere and adapting to the impacts of climate change. South Africa has also developed overarching policies and frameworks to support climate change responses. Its climate change response actions are guided by Section 24 of the Constitution of the Republic of South Africa (RSA, 1996), the National Development Plan 2030 (NDP 2030) (NPC, 2012), the National Climate Change Response Strategy (NCCRS) (2004), and National Climate Change Response Policy (NCCRP) (DEA, 2011) which builds on the NCCRS. NDP 2030 defines the country's development pathway and is closely aligned with the Sustainable Development Goals (SDGs). The NCCRP provides a clear framework for the mainstreaming of climate-resilient development; all government sectors must ensure that all policies, strategies, legislation, regulations, and plans are in alignment with the NCCRP (DEA, 2011).

Key developments since the NCCRP have been the submission of the country's first Nationally Determined Contributions (NDC) in 2015 (RSA, 2015), which was updated in 2021, and the National Climate Change Adaptation Strategy (NCCAS), approved by national government in 2020 (DEA, 2019). The NDC is the cornerstone of South Africa's climate change response and addresses both adaptation and mitigation measures, and outlines the finance and investment needs required to achieve its goals, grounded in principles of equity (RSA 2015). SA's updated NDC (submitted in September 2021) included the country's first adaptation communication and a section on international support requirements (RSA, 2021). South Africa's first NDC provided a channel to communicate the country's high-level vision and objectives on adaptation to the international community, while the NCCAS communicates the country's adaptation priorities.

The National Climate Change Adaptation Strategy (NCCAS) serves as the country's National Adaptation Plan (NAP). It outlines a vision for adapting to and building climate resilience against climate change, supporting the country in fulfilling its commitment under the Paris Agreement. The NCCAS is aligned with South Africa's policy and laws, incorporating relevant principles and commitments from international agreements. It supports the NDP's vision of creating a low-carbon, climate resilient economy and a just society.

Recognising the need to strengthen the climate change mandate, South Africa developed a Climate Change Bill which is the latest instrument to ensure enhanced (scaled-up) climate action in South Africa. The Bill was tabled in Parliament in February 2022 and went through various public participation and law-making processes to become South Africa's Climate Change Act. The Climate Change Bill was signed into law by the President of South Africa on 23 July 2024. The Climate Change Act aims to mobilise South African society toward a climate-resilient, low-carbon economy. This legislation establishes the institutional arrangements required for coordinated climate action across ministries and spheres of government, clearly defining roles, responsibilities, and authorities to enable effective action. The Climate Change Act provides clear frameworks for mitigation and adaptation, as well as a mechanism to support and finance the country's climate change response. In terms of mitigation, the Climate Change Act provides for a just transition away from our current carbon-intensive energy system and towards a decarbonized economy and society, while meeting our critical development challenges. From an adaptation perspective, the Act provides for the establishment of national adaptation objectives, the development of climate scenarios to assess vulnerabilities, and a National Adaptation Strategy and Plan to manage adaptation in a clear and coordinated manner. The Act also states that national adaptation objectives will be used to guide the country's adaptation response and that a national adaptation strategy must be developed and reviewed every 5 years. In terms of climate finance, the Act provides the mechanisms to support and finance the climate change response, providing guidance and a governance framework to promote planning and implementation by national, provincial and local governments.

The climate policy landscape and how this has evolved over time in terms of national climate polices is shown in Figure 3.3.

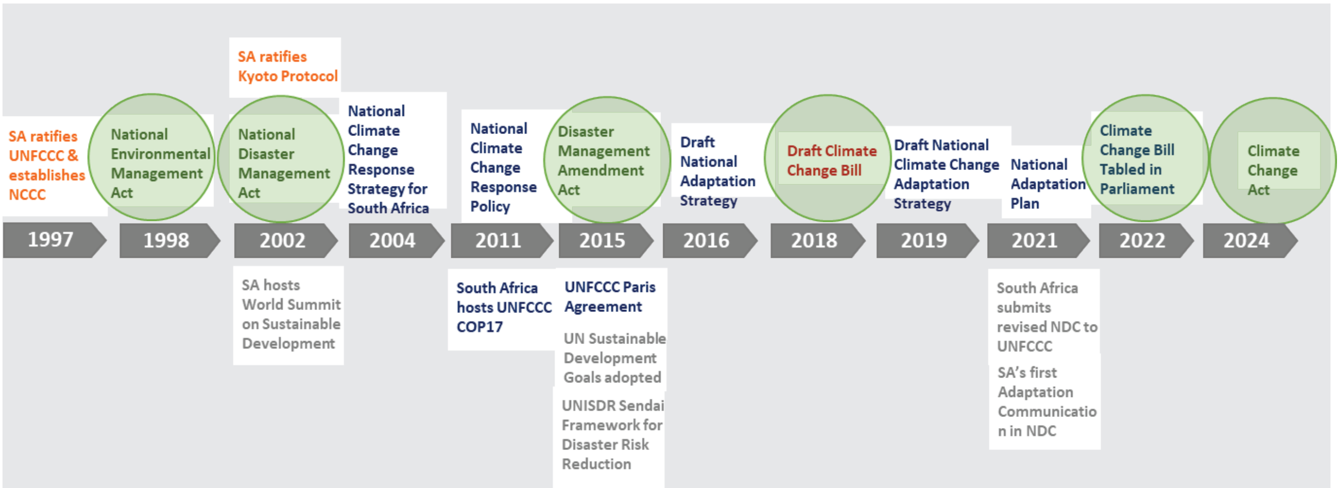


Figure 3.3. South Africa's policy environment and responses to international processes of relevance to adaptation in South Africa from 1997 to 2024

3.2 IMPACTS, RISKS AND VULNERABILITIES

The World bank gives a summary of natural hazards that were observed between 1980 and 2020 for South Africa, of which storms and flooding events take the lead in frequency (The World bank Group, 2021). In terms of weather-related disasters, these are followed by wildfires and droughts. Also, statistics from the South African Weather Service (SAWS) show that both drought years and wet years have become more frequent in some provinces, including the North-West, the Northern Cape, and the Free-State (SAWS, 2023). Contrarily, the Eastern Cape has been experiencing more wet years, while Mpumalanga, Gauteng, KwaZulu-Natal and Limpopo provinces have mainly experienced dry years since the beginning of the 21st century.

South Africa is at the forefront of the global climate change crisis. The evidence is seen in temperature rise, changes in precipitation patterns, increased frequency and intensity of extreme weather events, amongst others. There is a general warming trend, with significant increases in observed temperature, particularly in higher latitude regions. Further evidence shows that South Africa has been warming at 1.5-times the global warming rate (Wolski, P. 2019).

Observed climate trends over Southern Africa reflect that the regions are warming at more than twice the global warming rate with parts of South Africa being imparted the alarming warming rate 1931-2015 (DEA, 2018). The National Communication has further shown that during the period 1921 -2015 parts of the country have experienced a higher frequency of hot days than cold nights. Moreover, there has been an increase in rainfall intensity and frequency in the southern interior regions extending into parts of the Northern Cape, Northwest, Free State, and Gauteng, as well as significant decreases in annual rainfall totals over Limpopo. The associated extreme weather phenomena include recent heavy rainfall and flooding events such as (FloodList, 2024).

3.2.1 Extreme weather events impact and their climate change attribution

Despite significant scientific efforts in developing climate model-based evidence over the South Africa region, attribution of change in the characteristic extreme climate events, especially those that are already established as characteristic of South Africa climate variability, is still at its infancy stage. While the signal of climate change is largely based on long term (derived from above 20 years climate variables time series) term shifts, experienced impacts of climate change could manifest on weather time scales. Profiled in this section are extreme weather events whose characteristics could have been potentially modified by the rapid warming in global temperatures and therefore merit further attribution research attention. Examples of catastrophic recent extreme weather include:

- Severe thunderstorms from a tropical low-pressure system that resulted in flooding, damage to roads, homes, powerlines and water infrastructure were observed over Vhembe district between 21 and 22 February 2021.
- On 6 May 2021, Cape Agulhas municipality experienced a winter storm that was associated with severe flooding, in which over 120 mm of rainfall was measured at one of their stations. Severe damage to homes and infrastructure were reported as a result. Additionally, two people were reported dead after their truck got stuck in flood waters, one was reported missing, and several others were evacuated.
- At least seven people lost their lives when heavy rainfall, associated with flooding, occurred over parts of the Eastern Cape on 8 January 2022. Many lost their livelihoods and massive damage to infrastructure was reported as a result.
- Severe thunderstorms that resulted in flooding, river overflows and flood gates of Vaal and Bloemhof dams being opened were reported over parts of the country between 15 and 17 January 2021. About 25 fatalities, 2 missing persons, massive damage to homes, commercial properties, roads and bridges were reported as a result. Additionally, hundreds of people were evacuated.

- A COL that wreaked havoc, resulted in the loss of over 400 lives was reported on 9 – 12 April 2022. The amount of damage caused by the storm was estimated at R7 billion. Many jobs, ports, manufacturing plants, agriculture, the water and energy sectors, travel and tourism sector, and many small-to-medium enterprises were greatly affected.
- A flash flood that resulted in nine fatalities and eight missing people was reported over Johannesburg on 3 December 2022. The event resulted from a surface trough over the central parts of the country, which further resulted in favourable conditions for the formation of a severe thunderstorm.

3.2.2 Methodology and data sources

Climate models' simulation of historic and future climate is critical for investigating historic trends and possible future patterns of shifts in the climate and its associated extremes under both understanding climate variability and change. The climate model evidence of unprecedented shifts in the climate of the region and that of the associated key drivers are critical in informing the understanding of vulnerability and hence risk induced by climate variability and change. The outcome of climate modelling efforts is also critical for informing policy and providing guidance to sectors that may be affected by climate change. This includes drought monitoring, leading to significant precipitation deficits, evidence of changes in fire weather, flooding, heatwaves and other compounding extreme precipitation and temperature events. A substantial body of literature has been established reflecting the severity, frequency, duration, and exceedance of critical thresholds to support various national reporting obligations such as the Nationally Determined Contributions (NDC) Adaptation component technical report (CSIR, 2021) and National Communications (DEA, 2018). The NDC report highlights the different aspects of climate change and associated impacts on various sectors (agriculture, forestry and fisheries, biodiversity, health, human settlement and water sector), amongst others.

The change in climate and climatology of extreme climate events is calculated relative to the 1961-1990 reference period and during the 1.5, 2.0 and 3.0 °C warming Levels. The climatological baseline 30-year period, 1961 – 1990, is considered by the World Meteorological Organization (WMO) as a standard reference for many impact studies. The climate change signal is analysed using eight bias-adjusted Coupled Model Intercomparison Project Phase 6 (CMIP6) models that also contributed to the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP; Lange, et al., 2021). The selection of CMIP6 models has been shown to have acceptable performance in terms of capturing various atmospheric phenomena, specifically, those that had high performance in capturing El Niño–Southern Oscillation (ENSO) as it is critical for South African weather and climate (Fasullo, 2020; Steyn and Matladi, 2023). As part of the ISIMIP project, the models (CESM2, NorESM2-MM, GFDL-ESM4, EC-Earth3, MRI-ESM2-0, ACCESS-CM2, CNRM-ESM2-1 and MPI-ESM1-2-LR; Lange, et al., 2021) were both bias-corrected and downscaled to 0.5 x 0.5 ^{0} resolution. The 0.5 x 0.5 ^{0} resolution Climatic Research Unit (CRU) data, which comprises multiple variables of mean monthly climatology for global land areas, was used to validate these models (Harris et al., 2020).

Two categories of climate extremes are analysed, namely, temperature extremes and rainfall extremes. Temperature extremes focus on investigating anomalies of the maximum daytime temperature time series (txx) and consecutive dry days (CDD), which speak to temperature extremes and dry spell frequency, respectively. Rainfall extremes refer to precipitation that are quantified through the r20mm index which quantifies the frequency of occurrence of rainfall above 20mm and the count of consecutive wet days (CWD). Further, the analysis is conducted for the three future global warming levels (GWLs), i.e., 1.5, 2.0, and 3.0 °C, across four Shared Socioeconomic Pathways (SSPs), i.e., ssp1-2.6, ssp2-4.5, ssp3.70 and ssp5-8.5. Additionally, the analysis was conducted for five regions in South Africa (Figure 3.1) selected in line with the Köppen-Geiger historic climatic regions of South Africa (Beck et al., 2018).

3.2.3 Climatology of observed and projected mean annual maximum temperature and annual rainfall

This section summarizes South Africa's state of climate since 1960 and climate projections up to the end of the 21st century. Figure 34 depicts precipitation anomalies calculated relative to the 1961 – 1990 baseline as well as anomalies of observed precipitation calculated relative to the 1960 – 2022. The anomalies are spatially averaged over the five key climatic regions over South Africa. For precipitation, the bias-adjusted climate variability for ISIMIP models (the green historical line) is within the range of variability for the CRU observations (pink envelopes) for all South African climatic regions(Figure 3.4). However, there are instances when the models do not produce the magnitude of precipitation extremes that fall within the variability of the CRU observations (the green historical line that goes outside the pink envelope in all the regions). This is most pronounced over temperate region 3, the desert and semi-desert region 4 and the Mediterranean region 5 between the 80's and 90's. Nevertheless, the frequency of these extreme events is well represented by the models. As a result, there is confidence in using the models to calculate rainfall extremes for future climate.

Further, the medians of models from the various SSPs are leaning towards a general decline in precipitation for future climate. This declining trend is most prominent over the Mediterranean region 5, followed by the desert and semi-desert region 4 and the temperate region 3. Less decline is projected for the semi-arid steppe region 1. The Subtropical region 2, which is dominated by high-lying areas, shows the slightest decline in precipitation. This is also the region which manifests a high level of uncertainty with regards to rainfall projections, which may result from some models over-estimating precipitation while other under-estimate it, leading to the 50th percentiles of the models showing little departure from the historical mean. This uncertainty may also result from the fact that course-resolution models are known to have difficulty in resolving precipitation that is due to convection in such areas (Ban et al., 2014). Also, the precipitation decline over the regions generally becomes steeper beyond 2050.

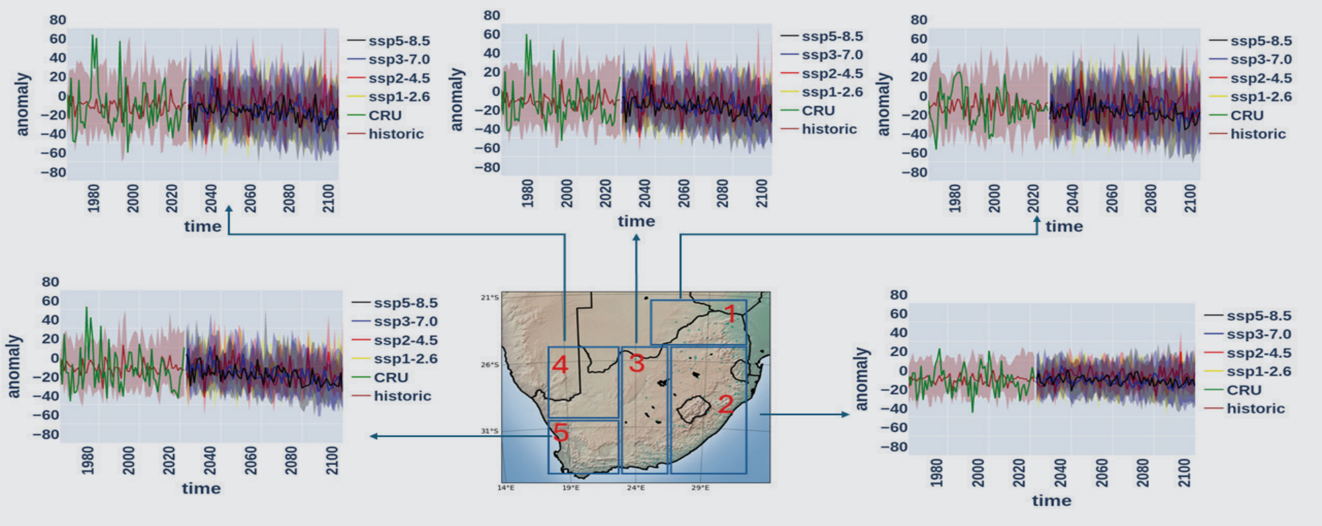


Figure 3.4: Total annual precipitation anomaly (% change) time series for the climatic zones in South Africa based on historic (brown), CRU observations (green), ssp1-2.6 (yellow), ssp2-4.5 (red), ssp3.70 (blue) and ssp5-8.5 (black). The shadings show the 10th and 90th percentiles as a measure of inter-model distribution. The anomalies are calculated relative to the 1961-1900 baseline.

A time series of historical and projected temperature anomalies relative to 1960 – 2022 baseline period is depicted in Figure 3.5. The analysis of spatially averaged anomalies is shown for five climatic regions of South Africa. The CRU observations and model outputs reflect a warming trend during the historic period relative to a climatological average. The warming signal reflects a plausible consistent increase in temperatures which gets amplified non-linearly going into the future. The warming is in line with the observed global warming trend (IPCC, 2022). The model confidence in the warming signal over South Africa is high (i.e., all models agree on the sign of change). The models reflect that the projected warming rate will likely be highest under the future low mitigation (SSP5.8-5). The model uncertainty in the projected levels of warming for the five respective regions in South Africa gets more pronounced towards the end of the 21st century. However, there is congruence in the historic and projected warming trends among the models.

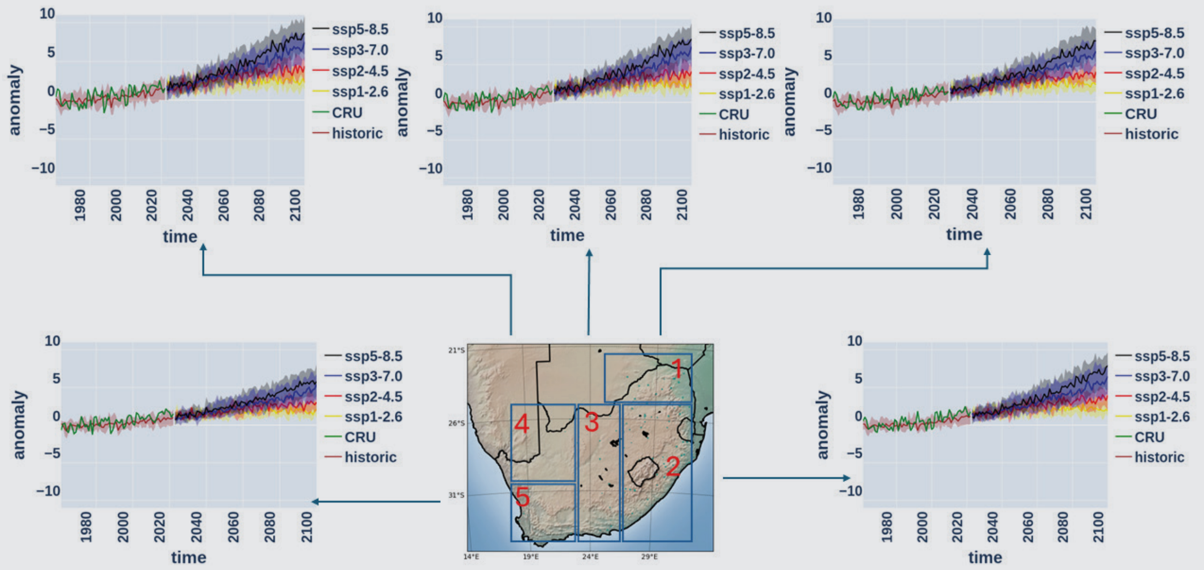


Figure 3.5: Mean annual maximum temperature (°C) anomaly time-series for the climatic zones in South Africa based on historic (brown), CRU observations (green), ssp1-2.6 (yellow), ssp2-4.5 (red), ssp3.70 (blue) and ssp5-8.5 (black). The shadings show the 10th and 90th percentiles as a measure of inter-model variability. The anomalies are from a 1961-1900 baseline.

3.2.4 Historic Climate extremes

To get a sense of the current and projected exposure of various sectors of development to physical climate hazard spatial pattern of extreme climate indices are investigated. This section summarizes the pattern of change in the climate extreme events specifically the maximum of daytime temperatures (txx) and frequency of dry days belonging to dry spells or Consecutive Dry Days (CDD), the count of days belonging to a wet spell, or Consecutive wet days CWD) and the count of extreme rainfall days which is used for events that potentially lead to floods.

3.2.5 Heat extremes

The top panel/row of Figure 3.6 Shows the spatial pattern of maximum temperature over South Africa during the baseline periods. While the average temperature over South Africa reflects a north-to-southwest gradient, the figure reflects that extreme temperature-ranging thresholds of about 36 – 42 °C have been registered for most parts of the country. The similarities in the 10th, 50th, and 90th percentile maps further confirm the narrow model ensemble distribution as reflected on the average temperature time series above which is indicative of model agreement.

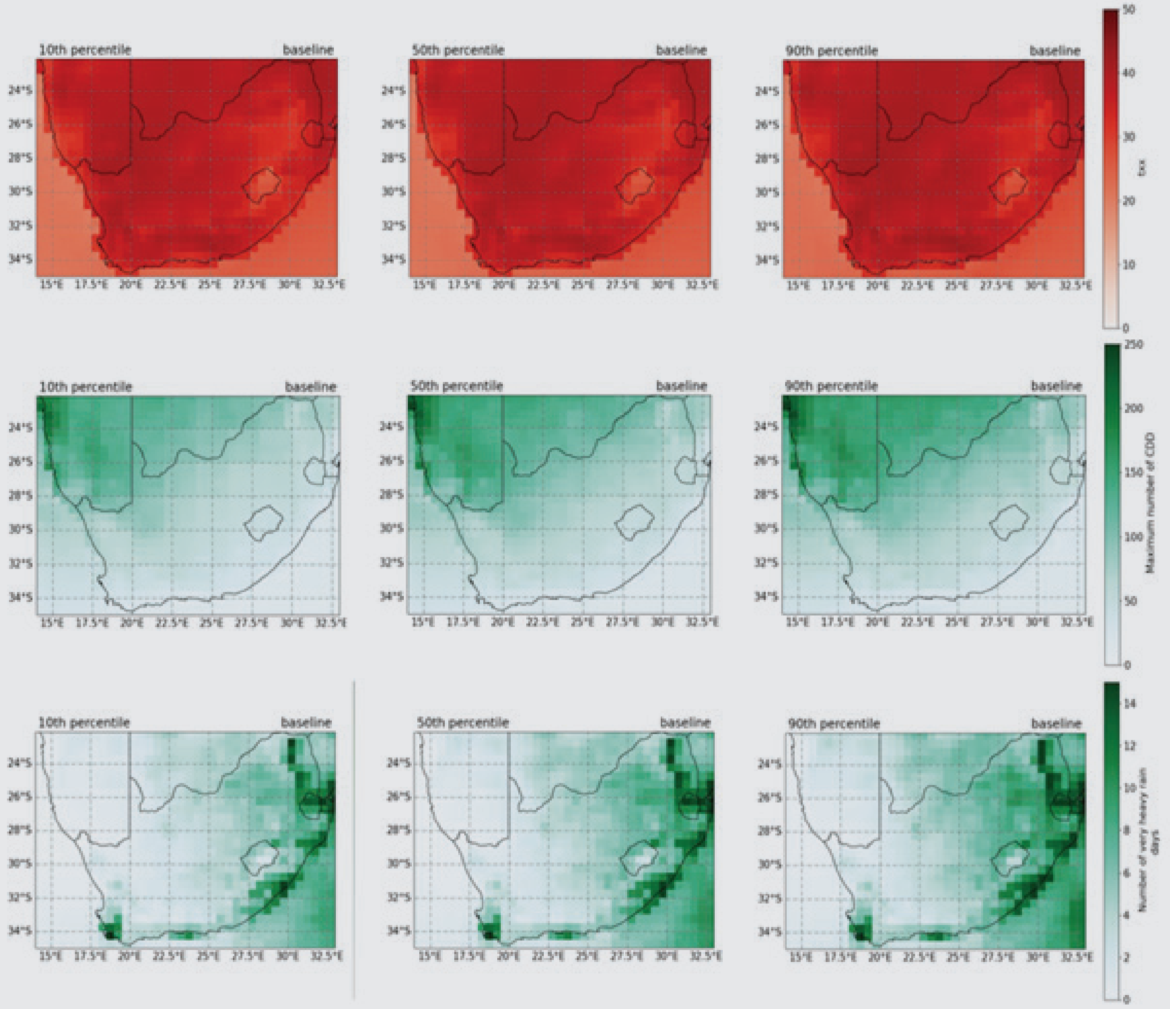


Figure 3.6: Depiction of the historic climate extreme indices, mean annual txx (°C; top row), cdd expressed in in days (middle row), and r20mm reflected in days (bottom row) averaged over the baseline period of 1961-1900. The 10th, 50th, and 90th ensemble percentiles are calculated over the eight models under the ssp3-7.0 scenario.

3.2.6 Drought

Figure 3.6 (second row) reflects the CDD index during the baseline period. The occurrence of dry spells is higher over parts of the western, central, and eastern interior. As per the 2023 annual State of the Climate report from the South African Weather Service (SAWS, 2023), drought years have become more frequent in provinces such as the North-West, the Northern Cape, and the Free State.

3.2.7 Floods

According to the WMO (WMO, 2024), changing rainfall and weather patterns are among the most severe impacts of climate change. The implications of extreme rainfall and flooding for South Africa have been evident in the disruption of the hydrological cycles, which impacted river flows, dam levels, and groundwater recharge. The bottom row of Figure 3.6 shows that the number of heavy rainfall days is highest over the southwestern tip of the country, parts of the Garden Route, the east coast, and the north-eastern interior. The frequency of heavy rainfall days further decreases from the east to the west of the country. This agrees with the study by McBride et al. (2022), which found the same outcome from a study conducted over the period of 1921 to 2020. Furthermore, the 2023 annual State of the Climate report from the South African Weather Service shows that the Eastern Cape has been experiencing more wet years (SAWS, 2023).

3.3 CLIMATE PROJECTIONS OF TEMPERATURE AND RAINFALL EXTREMES

3.3.1 Temperature extremes: heat and drought

The 2015 Paris Agreement aims to limit global warming to well-below 2 °C, preferably below 1.5 °C, above pre-industrial levels (Falkner, 2016; IPCC, 2022). Figure 3.7 reflects the likely changes in the long-term average of the maximum daytime temperatures (txx) and the consecutive dry days (cdd) relative to the 1961-1900 based line. The anomalies are calculated under the scenario SSP3-7.0, during the respective three global warming temperature scenarios or warming, namely 1.5 ^{0}C, 2 ^{0}C, and 3 ^{0}C. These are presented in the form of box plots. These box plots are a graphical representation of the distribution txx and cdd data over the regions of interest and depict key characteristics like the central tendency (median), spread, and presence of outliers (unusually high or low values compared to the majority of the data, which are often outside the expected range of values).

From Figure 3.7, the following is evident:

- For all the climatic regions, the ensemble median average daytime temperatures increase with the increasing global warming levels, indicating that the local extreme daytime temperatures in South Africa are warming with the general warming in global temperatures. Moreover, the interquartile range also increases with global warming levels, for all the climatic regions, except at 2 ^{0}C for region 4. The spread of the interquartile range is indicative of both model uncertainty and spatial heterogeneity in the magnitude of temperature with an increase in the warming levels.
- The central tendency of dry spells, represented by the typical length of consecutive dry days (median), is the highest at 2 ^{0}C global warming level for the climatic regions of South Africa. This is indicative that there will be benefit in keeping global temperatures at 2.0 °C for South Africa. This can be realized should the global action and ambition reach the levels at which shifts in global warming levels are kept below 2.0 °C relative to the pre-industrial period (1850 -1900). Moreover, the increase in interquartile range is noticeable for region 5. This suggests an increase in the number of days belonging to dry spells for the region at higher global warming levels relative to the pre-industrial reference period. Furthermore, the length of the interquartile range on box-and-whisker plots as well as the outliers are reflective of spatial heterogeneity of change as well as the model uncertainty in representing both precipitation and temperature over the respective regions.

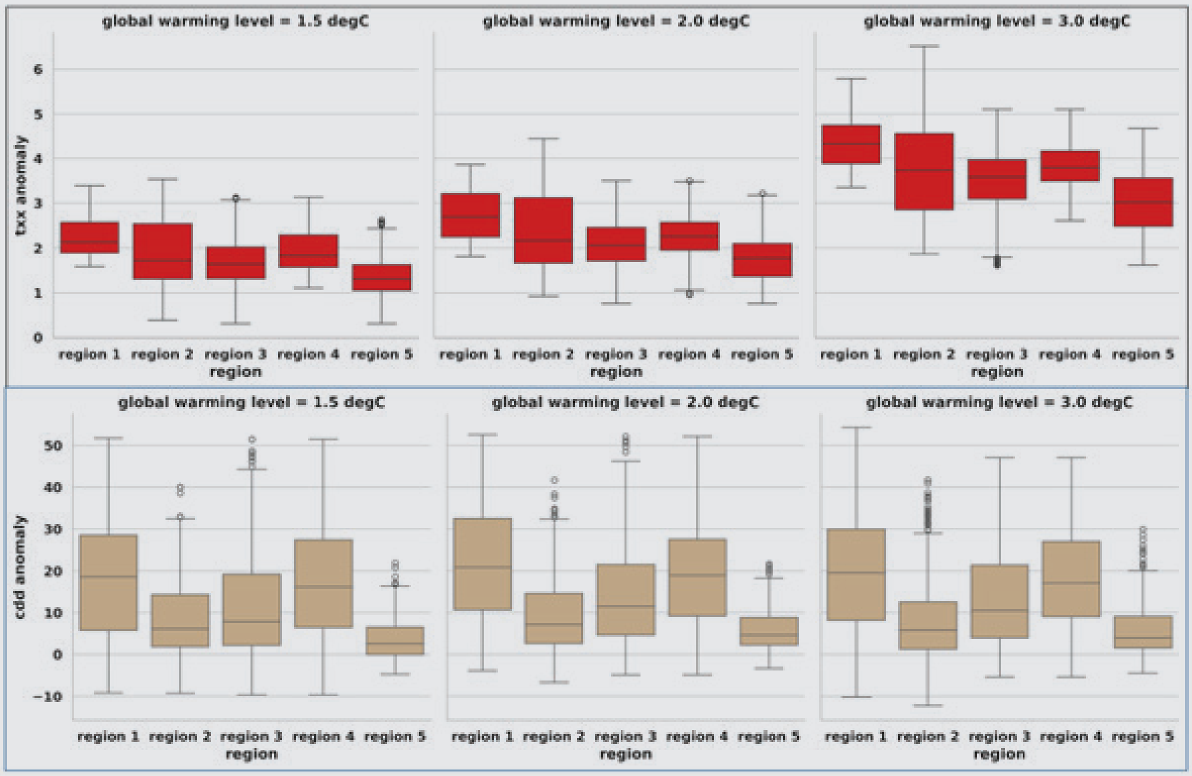


Figure 3.7: Boxplots of mean annual txx (top), expressed in °C, and cdd, expressed in days, (bottom) indices anomalies showing the spatial variability of the five climatic zones of South Africa under ssp3-7.0 for three global warming levels. The anomalies are calculated relative to the 1961-1900 baseline.

3.3.2 Rainfall extremes: Flooding and wet days anomalies

Figure 3.8 gives an overview of projections for rainfall extremes, i.e. total rainfall anomalies (top row), heavy rainfall anomalies (middle row), and wet spell (bottom row) in relation to the baseline period. Total precipitation indicates a general trend towards an increase in higher global warming levels relative to the pre-industrial period. Looking at the r20mm median change, the extreme precipitation, i.e., precipitation thresholds with a potential of leading to flooding events, are projected to remain within their historic frequency during the baseline period for regions 3-5, while declining for regions 1 and 2 for 1.5 and 2.0 °C warmer world (the models suggest a decline in median r20mm index mean annual average values). During the 1.5 and 2.0 °C warmer world the median of the mean annual cwd index (which is indicative of wet spell frequency) is projected to follow a pattern like that of r20mm for all regions. During 3.0 °C global warming level regions 2 and 5 reflect negative values. This is indicative of possible decline in wet spell frequency. In summary, looking at the interquartile range there is a clear sign of incongruence between the climate change signal reflected by precipitation and extreme climate indices which are derived from precipitation. This type of uncertainty in the climate change evidence calls for analysis of the impact of climate change on the key precipitation drivers. Adaptation efforts could therefore benefit from anticipating a general decline in annual precipitation % accumulation while not neglecting the possibility that during a 1.5 - 3.0 °C warmer climate the occurrence of destructive precipitation events also be likely.

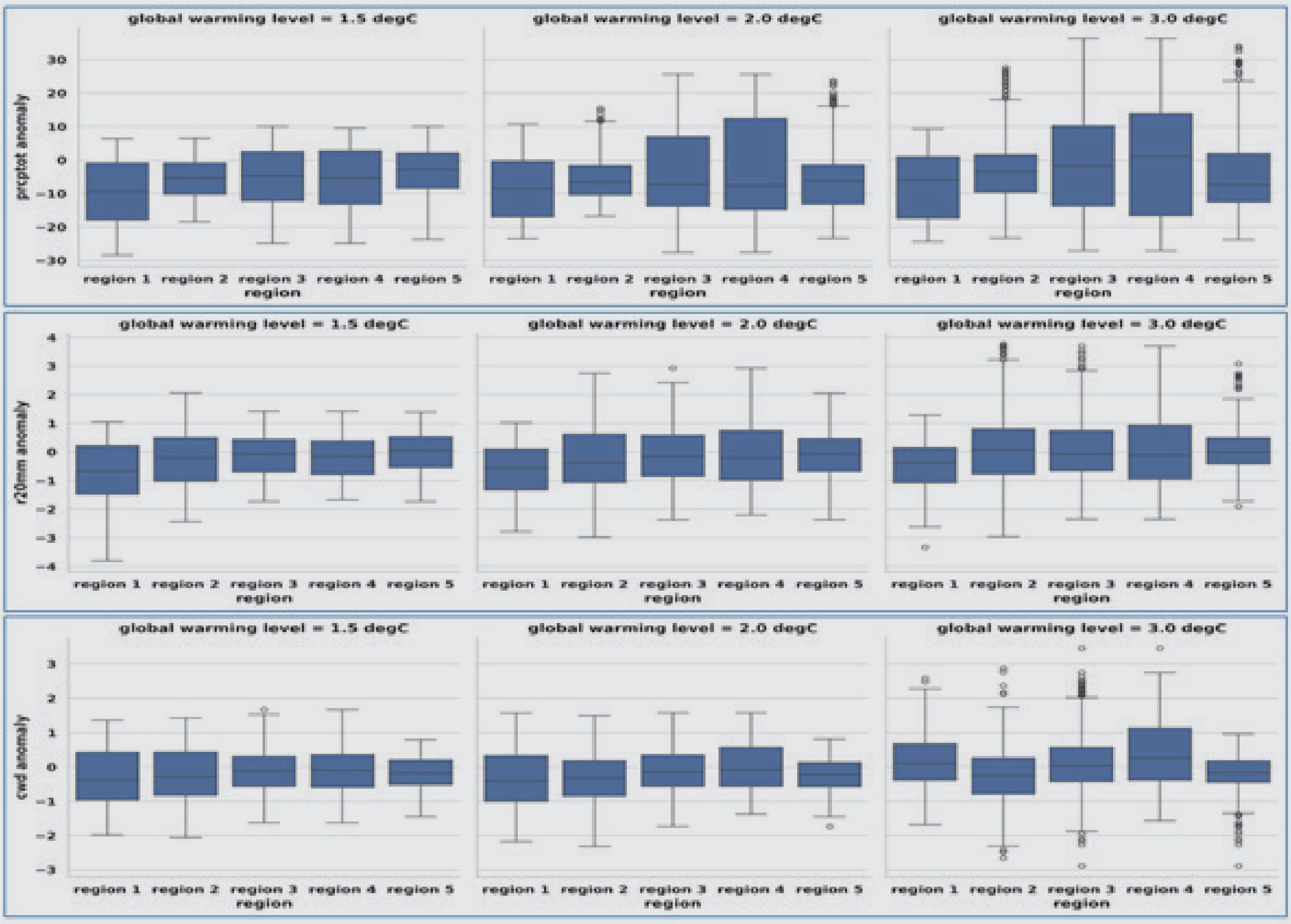


Figure 3.8: Precipitation-based extremes, mean annual prcptot, expressed in % (top), r20mm, expressed in days, (middle), and cwd, expressed in days, (bottom), anomalies boxplots showing the projected changes relative to the baseline during the 1.5, 2.0, and 3.0 °C GWLs for five climatic zones of South Africa under SSP3-7.0. The anomalies are calculated relative to the 1961-1900 baseline.

3.3.3 Discussion

Results indicate that South Africa is a climate change hotspot, aligning with findings from the IPCC AR6 report. Notable impacts include a decline in annual precipitation in some regions, although uncertainty remains in specific areas. The increased frequency of dry spells suggests a heightened risk of drought under various Global Warming Levels (GWLs), raising significant concerns for water resources, food security, and biodiversity.

Rainfall extremes generally show a declining trend across most climatic regions, except for the Mediterranean region (Region 5), where spatial and ensemble uncertainties persist. This pattern holds true for 1.5 °C and 2.0 °C GWLs. By 3.0 °C GWL, projections indicate a higher likelihood of increased precipitation towards the end of the century. However, rising maximum temperatures may exacerbate surface water losses due to elevated evaporation rates.

Overall, the clear signal of more frequent dry spells, supported by high confidence and strong spatial and ensemble agreement, underscores the urgent need for robust adaptation measures. South Africa must also remain committed to global climate action and ambition under the Paris Agreement to limit global temperature increases and mitigate these impacts.

3.4 CLIMATE RISKS AND VULNERABILITIES OF KEY SOCIAL AND ECONOMIC SECTORS

The evidence of climate change impacts in South Africa clearly emphasizes the need for the country to build resilience and adaptive capacity to understand and respond to climate change vulnerability and risk. Regular updates of climate risk and vulnerability assessments across key socioeconomic sectors inform the ongoing national risk assessment process and support research and development initiatives. The technical work for updating the NDC presents the most recent vulnerability and risk assessments for key socio-economic sectors, conducted in 2021 at the request of the DFFE. This assessment reviewed and prioritized climate change risks and vulnerabilities for the following priority sectors for adaptation: forestry and agriculture, biodiversity and ecosystems; water; health; settlements (coastal, urban, rural) and disaster risk reduction (NDC, 2021). These sectors are prioritized to enhance resilience and address vulnerabilities across environmental, social, and economic dimensions.

The assessments are focused on the national scale and, where possible, provincial-level details are presented to demonstrate the spatial variations.

3.4.1 Agriculture and forestry

The agricultural and forestry sector contribute 2-3% to South Africa's Gross Domestic Product (GDP) (DALRRD, 2021). While this contribution may seem relatively small compared to other sectors such as mining, manufacturing, and services, it remains significant due to its critical role in providing employment and supporting rural economies. The commercial agricultural sector also plays a prominent, indirect role in the economy through backward and forward linkages to other sectors.

South Africa's agricultural and forestry products are significant contributors to export earnings. The country exports a variety of agricultural products, such as citrus fruits, wine, maize, wool, and nuts, as well as forestry products like timber and paper. The sector is also an important source of employment, particularly in rural areas where alternative job opportunities may be limited. These sectors provide livelihoods for millions of people involved in farming, forestry, fishing, and related activities.

a. Agriculture

The agricultural sector in South Africa comprises a mix of large-scale commercial farms and smallholder or subsistence farmers. Commercial farming, characterized by large, mechanized farms and agribusinesses, dominates the production of export crops and high-value commodities. It accounts for most of the country's food production, with only 30,000 commercial farmers contributing over 80% of the total food supply (Loeper et al., 2018). Additionally, there are approximately 2 million subsistence farmers and around 200,000 emerging smallholder farmers (Stats SA, 2021). While the productivity of small-scale farming is often viewed as low, the importance of small-scale farming extends beyond mere productivity, as it provides a critical safety net for households, contributing to food security and serving as a crucial source of livelihood for millions of South Africans. However, the agricultural sector in South Africa faces various challenges, including water scarcity, pests and diseases, market access, and socio-economic inequalities.

One of the primary impacts of climate change on crop production in South Africa is the increasing frequency and severity of extreme weather events, such as droughts, floods, and heat waves (Mangani et al., 2023; Olabanji et al., 2021; Simanjuntak et al.; 2023a, 2022a). These events can have devastating consequences on crop yields, as they can disrupt the delicate balance of temperature, rainfall, and other environmental factors that are crucial for plant growth and development. For instance, a study by Gyamerah and Ikpe (2021) found that the overall revenue from crop production in Africa is projected to decline by up to 90% by 2100 due to climate change, which would be further exacerbated by substantial reduction in the length of cropping seasons and unpredictability of the onset of wet periods (Gyamerah & Ikpe, 2021). Additionally, climate change has also been linked to the emergence and spread of new pests and diseases that can negatively impact crop production. The livestock sector in South Africa has also been significantly impacted by climate change. Increased temperatures, droughts, and changes in precipitation patterns have affected the availability of grazing land and water resources, leading to reduced livestock productivity and increased vulnerability to pests and diseases. Key vulnerabilities and risks for the agricultural sector in South Africa are outlined in Table 3.1.

Table 3.1. Key vulnerabilities and risks for the agricultural sector in South Africa

Sector	Agriculture
Key vulnerabilities	• High dependence on rainfed agriculture. Approximately 80% of South African agriculture relies on rainfall, making it highly susceptible to fluctuations in precipitation patterns (Hartley et al., 2021). • Limited irrigation infrastructure: Uneven distribution of irrigation infrastructure leaves many areas vulnerable to water shortages during dry periods, hindering agricultural production. • Unsustainable management practices: Overuse of synthetic fertilizers and pesticides, overgrazing, use of monocultures, deforestation, and habitat destruction can reduce biodiversity, which is crucial for ecosystem function and resilience. • Soil erosion and land degradation: Over-tilling, inadequate crop rotations, and the failure to use cover crops can lead to soil erosion, nutrient depletion, loss of soil structure, and decreased fertility, which reduces the soil's ability to hold water, making crops more susceptible to drought and reducing long-term fertility. Research has shown that between 7% and 10% of carbon content in soil is lost during every cultivation cycle in South Africa's main cropping areas. According to Le Roux et al. (2008) the average soil loss in areas under grain crops in SA is 13 ton/hectare/year. This is much higher than the natural soil formation rate and it implies that almost 3 tons of soil is lost per hectare (ha) for every ton of maize produced yearly. • Socio-economic factors: A sizeable portion of South African agriculture consists of smallholder farmers with limited resources. These farmers are often less equipped to adapt to climate change and absorb financial losses due to crop failures. • Limited access to technology and information: Many farmers, particularly in rural areas, lack access to the latest technologies and information on climate-resilient agricultural practices. This can hinder their ability to adapt effectively.
Prioritized risks and impacts	Decline in crop yield, suitability, and quality: • *Heat stress and heat waves* will have detrimental impacts on crop yield and quality. Studies have shown an increasing likelihood of experiencing temperatures exceeding the maximum threshold for maize production in certain areas in South Africa (Challinor et al., 2016; Mangani et al., 2023; Simanjuntak et al., 2022b). Exposure to elevated temperatures during the maize reproductive stage will affect pollen viability, fertilization, and grain development, which can significantly reduce maize yield between 80 and 90% (Simanjuntak et al., 2023b). In fruit crops it causes fruit sunburn, inadequate pollination, delayed ripening, reduced colour development, poor fruit quality and fruit set as well as low fruit yield. Research has shown that apple production in the Ceres area of South Africa will be compromised through a decline in the accumulated PCUs of 2–5% by the 2020s, 7–17% by the 2050s, and 20–34% towards the end of the 20th century. This will have serious economic consequences for farmers and employment in the region. • *Drought:* Multiple droughts in the past decade over Southern Africa have severely impacted maize and staple crop production, leading to significant declines in yield and threatening food security in the region. Recurrent dry spells have reduced water availability, impaired crop growth, and increased vulnerability to pests and diseases. Parts of Southern Africa have been experiencing a severe drought since late 2023, enhanced in part by the ongoing El Niño Southern Oscillation.

Sector	Agriculture
Prioritized risks and impacts	• Animal health and performance. Heat stress negatively impacts livestock by reducing feed consumption, reproductive and growth rates, and milk production, while also compromising meat quality. Neser (2016) modelled the effect of heat stress on milk production in Holstein cattle on pasture in South Africa. The results indicate progressive shrinking of currently suitable areas and a geographical shift towards the southern parts of the east coast of South Africa for optimal milk production from Holstein dairy cattle (Neser, 2016). A study investigating effects of climate change on the distribution of the bont-legged tick (*A. hebraeum*), the carrier of Heartwater disease in animals, suggests climate change as a reason for the wider spread of Heartwater in South Africa (Leask & Bath, 2020). Heat stress also affects growth and reproduction in animals. For example, maximum seasonal temperature explained up to 42% of variation in weaning weight in cattle in a dry arid area of South Africa (Jordaan et al., 2021). • Food waste, health, and safety: The secondary impacts of increases in temperature extremes are the increased risk for food spoilage during post-harvest processes as well as reduced marketability and shelf life of food products. This could lead to an increase in food waste as well as having food safety and health risks for humans and livestock. • Distribution, intensity and abundance of pests and diseases. Warmer winters and rising minimum temperatures will drive emerging, new, and more aggressive pests (insects, pathogens, and weeds) affecting crop yield levels and stability. (Mafongoya et al., 2019). Additionally, warmer temperatures will also expand the geographic range and intensity of many pests and diseases in regions that have traditionally experienced low pest risk. This leads to increased costs associated with managing pests and diseases as well as a potential overuse of pesticides, which will necessitate new products. An increase in temperatures could also lead to increased growth of toxigenic fungi in crops (Perrone et al., 2020). The fall armyworm (FAW) is a significant agricultural pest in South Africa and was first detected in early 2017. The extent of its impact in South Africa has been considerable, affecting various crops such as maize, sorghum, wheat, and sugarcane (Mafongoya et al., 2019). Additionally, *Herlicoverpa amigera* (African bollworm) is a problematic insect pest on crops in South Africa, recorded as being dependent on increased temperatures and able to overwinter during the warmer winter season (Phophi et al., 2020). The dramatic increase in South Africa's average winter temperature over the past 40 years has altered the susceptibility of apples to fungal disease, with fungi showing a much faster adaptation rate to changing temperatures than apples (Meitz-Hopkins, 2020) • Loss of market opportunities: Shifts in rainfall and temperature patterns are altering traditional planting and harvesting seasons. Farmers are often not able to respond swiftly because of a lack of resources. • Livelihood loss: Decreased agricultural output can lead to job losses and economic hardship for farmers and communities dependent on agriculture. • Increased food prices: A decrease in domestic food production can lead to a reliance on imported food, making the country vulnerable to fluctuations in global food prices.

b. Forestry

The commercial forestry sector encompasses approximately 1.2 million hectares of land, mostly found in the provinces of Mpumalanga and KwaZulu-Natal, while the Eastern Cape, Western Cape and Limpopo also include some forestry areas. These plantations produce timber for various manufacturing industries, including pulp and paper production, furniture manufacturing, and construction. Plantations are dominated by three main types of trees, namely Pinus, Eucalyptus, and Acacia. Pinus or pine trees are the most common species, making up around 49 % of all plantation trees. Wood and paper products are also major export earners for South Africa, generating over R38.4 billion annually. The Forestry and Forest Products sector also employs more than 149,000 people, with most of the forestry workforce living in rural communities (Forestry SA, 2022).

South Africa's forestry industry faces several risks from climate change due to impacts on the supply chain as well as direct bio-physical impacts on forests. These are exacerbated by rising costs of transportation, labour, raw material inputs and energy (Mudombi, 2020). Direct impacts on plantation forests include increased vulnerability to droughts, more intense fires, and heightened susceptibility to both established and emerging pests and pathogens. Climate change has exacerbated the potential for forest fires. The abnormally long and destructive fire season of 2017 attributed to drought conditions across South Africa, causing 29,443 ha of plantation area to be damaged or lost (DFFE, 2018) (Table 3.2). Increased pest outbreaks due to milder winters and warmer temperatures also threaten the health of South Africa's plantation forests. Extreme weather events such as heavy rainfall, drought, and windstorms also increase vulnerability to pests and diseases. Projected increases in temperature and changes in rainfall could result in some areas not being climatically suitable for a specific genotype, with other areas potentially becoming climatically unsuitable for forestry (DEA, 2013a). Table 3.3 shows the key vulnerabilities and risks for the forestry sector in South Africa.

Table 3.2. Plantation area damaged by fires and other causes (DFFE, 2018)

Causes of fires	2015/16		2015/16		2015/16		Total area (ha)
	Area (ha)	% affected	Area (ha)	% affected	Area (ha)	% affected	
Natural	747	5	5 232	32	4 681	27	10 660
Accidental	4 652	33	3 356	21	4 049	23	12 057
Arson	3 254	23	2 188	14	4 563	26	10 005
Unknown	5 570	39	5 368	33	3 972	23	14 910
Total	**14 223**	**100**	**16 144**	**100**	**17 265**	**100**	**47 632**

Table 3.3. Key vulnerabilities and risks for the forestry sector in South Africa

Sector	Forestry
Key vulnerabilities	• Climate change • Natural disasters • Soil erosion • Invasive species • Land-use conflicts • Competition • Economic recessions • A shortage of skilled workers • Community dependence • Equipment breakdown • Unclear/inappropriate policies/regulations • Corruption

Sector	Forestry
Prioritized risks and impacts	• Increased frequency and intensity of wildfires due to hotter and drier conditions pose a significant risk to commercial plantations in South Africa. Wildfires can cause extensive damage to tree stands, reduce forest cover, and lead to significant economic losses. • Warmer temperatures and changes in precipitation patterns alter the distribution and lifecycle of pests and diseases, potentially leading to more frequent and severe outbreaks. • Changes in temperature and precipitation patterns also affect the growth and distribution of tree species. Some species may become less viable in their current locations due to altered climatic conditions, leading to changes in forest composition and structure. • Increased rainfall intensity and changes in land use patterns can lead to soil degradation and erosion, reducing soil fertility and stability. • The vulnerabilities faced by the forestry sector due to climate change can result in significant economic impacts. Reduced productivity of commercial plantations affects timber supply and associated industries. The costs of managing increased risks, such as wildfires and pest outbreaks, add to the economic burden on the sector. • Many communities in South Africa depend on forests for their livelihoods, including employment in the forestry sector, collection of non-timber forest products, and ecosystem services such as water regulation and soil fertility. Climate-induced changes to forests can threaten these livelihoods, leading to social and economic challenges for rural communities. • Extreme weather events such as storms and heavy rainfall can damage infrastructure related to the forestry sector, including roads, bridges, and processing facilities. This can disrupt operations and supply chains, leading to economic losses and increased costs for maintenance and repairs.

3.4.2 Biodiversity and ecosystems

South Africa is a global biodiversity hotspot, boasting exceptional richness and variety in plant and animal life. The country has nine distinct biomes, including savannas, grasslands, deserts, and Mediterranean type shrublands (fynbos). Each biome hosts endemic species unique to its environment. The Fynbos biome, which consists of evergreen, hard-leaved mediterranean type shrubland, comprises over 7,000 plant species not found anywhere else on Earth, displaying incredible floral and associated animal diversity. The country is also home to iconic mammals including the Big Five (lion, leopard, rhinoceros, elephants, and Cape buffalo). It is also a global hotspot for birds, reptiles, and amphibian species. Birdlife flourishes with over 870 species, of which about 60 species are endemic to South Africa. The country's coastal zone supports a variety of ecosystems, including coral reefs, kelp forests, and estuaries. These marine areas are home to diverse fish species, marine mammals, and invertebrates, many of which are important to the country's marine and coastal economy.

This rich biodiversity contributes to vital ecosystem services such as water purification, climate regulation, and soil fertility, and increases resilience against environmental changes and natural disasters. Biodiversity underpins various sectors including agriculture, tourism, and fisheries, all of which are crucial to South Africa's economy.

Table 3.4 shows the key vulnerabilities and risks for the biodiversity sector in South Africa.

Table 3.4. Key vulnerabilities and risks for the biodiversity sector in South Africa

Sector	Biodiversity and Ecosystems
Key vulnerabilities	• Habitat loss, degradation and fragmentation: One of the most significant threats to biodiversity in South Africa is habitat loss, degradation and fragmentation due to unsustainable land and ocean use, urbanisation, agriculture, mining, and infrastructure development. Fragmented and isolated vegetation populations have a reduced ability to adapt to climate change in terms of climate migration (biome shifts). South Africa lost 0.12% of its natural vegetation per year between 1990 and 2018, and 0.24% per year between 2014 and 2018 (Skowno et al., 2021). Additionally, due to these changes, 14% of plants, 17% of mammals and 15% of birds are currently classified as threatened with extinction. Over 70% of the Cape Floral Region has been lost due to land use changes. • Rivers and wetlands: Rivers and wetlands are the most threatened ecosystems in South Africa, with 64% and 79% threatened, respectively. Most are critically endangered. This is due to water pollution, invasive species, and changes to their hydrological regimes (SANBI, 2018). Increasing temperatures will affect the hydrological cycle, exacerbating existing pressures. • Estuaries: According to the South African National Biodiversity Institute (SANBI, 2018), estuaries have the highest proportion of threatened ecosystem types, making them vulnerable to further anthropogenic changes and climate change. Extreme weather events, increased temperature and sea-level rise may lead to further harmful changes in estuaries such as salinity regime shifts, loss of biodiversity due to temperature changes and an increase in pollutants leading to eutrophication, harmful algal blooms and the accumulation of toxic substances. • Invasive alien species: Invasive alien species, particularly trees and freshwater fishes, threaten people, biodiversity and ecosystems in South Africa (Zengeya & Wilson, 2023). Invasive trees such as *Acacia mearnsii* (Black Wattle) threaten indigenous flora, leading to habitat degradation, water loss and biodiversity loss. Alien invasive plants have covered approximately 7% of the country (Van Wilgen, 2018). • Pollution and contamination: Pollution from industrial, agricultural, and urban sources degrades water and soil quality, posing threats to biodiversity and ecosystem health. It is also a threat to coastal ecosystems. • Water scarcity and drought: Water scarcity and drought exacerbate the vulnerability of ecosystems in South Africa, particularly in arid and semi-arid regions. Competition for water resources between human activities and ecosystems intensifies, leading to habitat degradation and loss of aquatic biodiversity. Reduced rainfall, increased evaporation, and changes in precipitation threaten freshwater availability, affecting wetlands, rivers, and dams. Water is a nexus issue, which means that water scarcity will exacerbate the vulnerability of ecosystems and food and energy production systems.

Sector	Biodiversity and Ecosystems
Prioritized risks and impacts	• Species and biome shift and extinction: Habitat fragmentation prevents organisms from quickly migrating to areas with more favourable climates. The rate of species extinction is alarming, and the severity will depend on the extent of future warming. The fynbos biome, a biodiversity hotspot area of South Africa, could experience extinction rates up to 25%, as the winter rainfall region is expected to shrink in extent. • Increased frequency of extreme weather events: Extreme weather events, such as fires, floods, droughts, and heatwaves can cause immediate and severe damage to ecosystems and species. For example, in fire-prone and fire-dependent ecosystems, such as fynbos, renosterveld, savanna, and grassland vegetation types, fire regimes are likely to change to higher fire frequency and intensity. These ecosystems might not have the capacity to recover post-fire, especially if it coincides with droughts in the first year after fire. • Bush encroachment: Increasing levels of atmospheric carbon dioxide may be associated with bush encroachment and increased woody vegetation cover, particularly in South Africa's savanna and grassland ecosystems (O'Connor et al., 2014). Rangeland ecosystems are home to South Africa's iconic game species, and most agricultural activities occur in these ecosystems. Bush encroachment, therefore, threatens the tourism and agricultural sectors. Invasive alien species may also spread more easily in degraded rangelands, increasing the risk. • Economy and livelihoods: Climate change affects agricultural productivity in South Africa, impacting ecosystems and biodiversity. Changes in temperature and precipitation patterns can contribute to crop failures, affecting food availability for humans and wildlife and disrupting ecosystem services provided by agricultural systems.

3.4.3 Health Sector

South Africa's health sector comprises a two-tiered system represented by the public sector that caters to most of the population (around 80%) and is funded by government allocations. The private sector serves a smaller portion (around 20%) and relies on private health insurance or out-of-pocket payments. This system leads to significant disparities in access to quality healthcare. Public facilities often face resource constraints, leading to long waiting times and limited access to specialized care. There is also a shortage of healthcare professionals, and the system faces ongoing budget limitations, making it difficult to provide adequate services and keep pace with rising healthcare costs. HIV/AIDS remains a significant public health challenge, although advances in treatment have been made. Tuberculosis and other infectious diseases also pose a significant burden. South Africa is also experiencing a growing prevalence of non-communicable diseases like diabetes, heart disease, and cancer, straining healthcare resources. Climate change poses a significant threat to human health in South Africa, with the potential to exacerbate existing health challenges and introduce new ones. Table 3.5 shows the key vulnerabilities, risks and adaptation strategies for the health sector in South Africa.

Table 3.5. Key vulnerabilities and risks for the health sector in South Africa

Sector	Health Sector
Key vulnerabilities	Health sector vulnerabilities may come from diverse sources, such as: • Resource limitations which may result in shortages of medical supplies, insufficient staff and equipment. These limitations restrict timeous and appropriate response to outbreaks or disasters. • Social health determinants such as poverty, social inequality and mental health can increase the risk of health problems; and may also be a barrier to accessing adequate health services. • Air pollution from increased wildfires, among other sources contributes to respiratory diseases, heart diseases and lung cancer • Limited access to safe, clean drinking water, affecting especially rural communities which increase the risk of water-borne diseases • Inadequate sanitation, contaminating water sources and contributing to the spread of infectious diseases • Exposure to toxins and pollutants such as industrial waste and pesticides, used in agriculture. • Informal settlement increasing the vulnerability and exposure of millions of South African population to heat related stress and deaths. • These events and practices can cause new, emerging diseases, or increase the severity of existing diseases, thus putting additional strain on already overburdened health services. • The elderly and children under 5 years are most vulnerable to heat exposure (Sewe et al., 2015; Scovronick et al., 2018)
Prioritized risks and impacts	Climate change poses a significant threat to health in South Africa, particularly for vulnerable populations. Priority risks and impacts include: • Climate-related aspects such as rising temperatures and variable precipitation patterns can expand the range and spread of mosquito-borne diseases such as malaria and dengue fever resulting in increased burden of infectious diseases. These diseases may spread into areas where they were not previously a concern. Higher temperatures have already been linked to cases in Limpopo (Nel and Richards, 2022). The South African National Institute for Communicable Diseases (NICD) monitors weather patterns and malaria transmission rates to predict outbreaks and issue early warnings. (NICD, 2023). The NDoH also released the National Heat-Health Action Guidelines in 2022 (NDoH, 2020a). • More frequent extreme weather events such as floods, droughts and heat waves can disrupt sanitation systems, water supplies and food production. resulting in disease outbreak, injuries and malnutrition, heatstroke, increased cardiovascular diseases. Areas with limited access to clean water are especially at risk of outbreaks of waterborne diseases like cholera and diarrhoea. • Mental health is affected by the stresses of climate change, such as extreme weather events, displacement due to flooding or drought, and food insecurity, increasing conditions such as anxiety, depression, and post-traumatic stress disorder. The South African Department of Health has begun incorporating mental health considerations into climate change adaptation plans and strategies (NDoH, 2020b).

Sector	Health Sector
Prioritized risks and impacts	• Impacts on food security: Climate change can disrupt agricultural production, leading to food shortages and malnutrition. This can weaken immune systems and make people more susceptible to infectious diseases. • Impacts on healthcare infrastructure: Extreme weather events like floods and storms can damage or destroy healthcare facilities and disrupt essential services such as telecommunications and supply chains, and access routes. • Increased heat-related deaths: Additional heat exposure from recent human-caused global warming suggest that approximately 43.8% of heat-related mortality in South Africa was attributable to human-caused climate change from 1991–2018 (Vicedo-Cabrera et al., 2021). In many of South Africa's 52 districts, this equates to dozens of deaths per year. The impacts of climate change are already felt disproportionately by those who are already most vulnerable, such as low-income communities, women, the elderly and children.

3.4.4 Human Settlements and Infrastructure

Human settlements in South Africa vary from densely populated Metropoles to rural villages, informal and coastal settlements. These settlements face various vulnerabilities to climate change impacts due to their geographical location, socioeconomic conditions, and infrastructure development. The various types of settlements will be discussed according to type of settlement as well as the climate hazards that it faces, its exposure to the hazards as well as the social and economic factors that amplify vulnerability. Settlements can be grouped as follows:

- **Urban settlements:** These are discussed in terms of urban settlements, peri-urban settlements and mixed (urban/rural) settlements.
- **Rural settlements:** These include sparsely populated rural areas containing small settlement nodes and denser, spatially distributed rural settlements.
- **Coastal settlements:** Here climate change vulnerabilities that are specific to the coastal context of affected cities and towns are discussed, such as those driven by sea level rise and storm surges.

a) Urban Areas

- **Infrastructure vulnerability:** Urban areas, especially metropolitans such as Johannesburg, Cape Town, and Durban, are vulnerable to climate change due to their dense infrastructure. Floods, heatwaves, and storms can damage critical infrastructure like roads, bridges, and buildings, leading to economic losses and disrupting daily life.
- **Heat stress:** urban heat islands exacerbate heat stress, particularly during heatwaves, which can pose health risks to vulnerable populations, such as the elderly and the homeless.
- **Water stress:** Urban water systems may face increased stress due to changing precipitation patterns and increased demand. Droughts and stormwater pollution can lead to water shortages, affecting sanitation and public health.

b) Rural Areas

- **Agricultural impacts:** Rural areas are heavily reliant on agriculture and are susceptible to changes in precipitation patterns and temperature. Droughts and floods can damage crops, leading to food insecurity and loss of livelihoods.
- **Water scarcity:** Rural communities often rely on local water sources for drinking and irrigation. Changes in precipitation patterns can lead to water scarcity, affecting both human consumption and agriculture.
- **Vulnerability of informal settlements:** Informal settlements, common in both urban and rural areas, lack proper infrastructure and services. Informal settlements are particularly vulnerable to flooding, landslides, and other climate-related disasters due to their precarious location and inadequate housing conditions.

c) Coastal Areas

- **Sea-level rise:** Coastal settlements face the risk of permanent inundation and erosion due to sea-level rise. This poses a threat to infrastructure, property, and livelihoods, especially in low-lying areas such as Cape Town and Durban.
- **Storm surges:** Intense storms and storm surges can cause flooding and coastal erosion, damaging homes and infrastructure along the coastline.

Table 3.6 shows the key vulnerabilities and risks for the human settlements sector.

Table 3.6. Key vulnerabilities and risks for the human settlements sector in South Africa

Sector	Human Settlements
Key vulnerabilities	**Urbanisation and urban growth:** • Urbanisation is progressing in South African towns and cities. According to the GreenBook, between 19 and 24 million more people will reside in South African urban areas by 2050 compared to 2011 (CSIR, 2019). The Institute for Security Studies predicts that South Africa's urbanisation rate will reach 77% by 2043 (ISS, 2023). • The rapid pace of urbanisation often exceeds the capacity of local governments to manage and plan effectively, leading to significant social, economic, and environmental challenges. These challenges can result in high levels of social discontent and political instability. • Key urban challenges include inadequate policy and legislative implementation, poor urban planning, climate change, disaster risks, high inflation, conflict, and food and energy crises (Clos, 2015; Van Niekerk & Le Roux, 2017). • Some of these challenges stem from the colonial and apartheid legacies of cities, while others are perpetuated by current market forces, planning practices, and decades of ineffective urban development planning (Obi, 2016; Van Niekerk & Le Roux, 2017). **Spatial and physical vulnerability:** • Much of urban growth and transformation is the result of poor development decisions and inadequate planning. Settlements often expand into undesirable areas such as floodplains, coastal flooding zones, and steep hills, exposing communities to climate hazards (IFRC, 2018). • Informal settlements in South Africa are highly vulnerable and exposed to heat-related stress and urban flooding under climate change due to inadequate infrastructure, poor housing conditions, and limited access to essential services. • South African settlements face a significant infrastructure deficit, characterised by inadequate water supply and sanitation systems, insufficient energy supply, expensive and unreliable broadband networks, and inadequate transportation networks. Where infrastructure exists, there is often underinvestment in maintenance, asset replacement, and infrastructure expansion (SADC, SARDC, 2019). • Local governments struggle to meet the demand for water infrastructure and services, leading to severe backlogs, unhealthy living conditions, the spread of diseases, and a lack of dignity for many residents (Van Niekerk et al., 2018). • Climate change is expected to have long-term negative effects on infrastructure. Severe weather events are damaging infrastructure, buildings, roads, and utility systems, reducing their lifespan and creating ripple effects throughout urban systems and the economy (Van Niekerk & Le Roux, 2017; DEA, 2018; IPCC, 2022).

Sector	Human Settlements
Key vulnerabilities	**Socio-economic vulnerability:** • Net rural-to-urban migration is driven by land shortages, poverty, changing rural landscapes, declining agricultural returns, and perceived economic opportunities in urban areas (SADC, 2008; Van Niekerk & Le Roux, 2017; UNECA, 2017; SADC, 2020). • Climate-related impacts such as increasing temperatures, droughts, floods, can lead to displacement from rural areas to urban centres, further increasing urban populations and exacerbating competition for resources and pressure on service delivery (IPCC, 2022). • South Africa attracts a considerable number of international migrants and migrant workers, with many moving to towns and cities in search of job opportunities. Approximately 8 million people (3% of the SADC population) are migrants, with South Africa hosting 58.4% of all regional migrants (SADC, 2020). • Urbanisation often occurs without accompanying economic growth and insufficient investment in the built environment, leading to the urbanisation of poverty, where only a few benefit from wealth accumulation (Van Niekerk & Le Roux, 2017). • Inadequate urban planning and infrastructure contribute to increased competition for resources, economic disparities, prejudice, severe inequalities, social fragmentation, and tensions (UN-Habitat, 2019; UN-Habitat, 2022a). • Informal settlements generally offer limited economic opportunities and are unsafe, with dwellings often made from flammable materials and lacking building regulations or land use management and frequently being established in areas unsuitable for settlements, such as flood-prone areas (Van Niekerk & Le Roux, 2017). • Women constitute a sizable portion of the unemployed or informally employed in urban areas and are disproportionately affected by limited access to safe work environments, resources, technology, and education. • Discrimination against children, the elderly, people with disabilities, and women is increasing, a phenomenon referred to as the "feminization of poverty" (UN-Habitat, 2019). • Youth unemployment and informal sector employment are pervasive, causing significant household distress. • A lack of social safety nets leaves people with few options, inadequate education and skills for formal market access, and insufficient housing, infrastructure, and services (UNECA, 2017; UN-Habitat, 2022a). **Environmental vulnerability:** • South African cities are characterised by exploitative extraction and unsustainable consumption of natural resources and productive land, pollution, and a heavy dependence on fossil-fuel energy (UN-Habitat, 2019; SADC, 2020). • Urban expansion is encroaching on natural habitats, and the growing urban population is putting increasing pressure on natural resources (Van Niekerk et al., 2018). • Water, a critical natural resource, is scarce and threatened by urban growth. As urban populations and economies grow, so does the demand for water and the quantity of wastewater. Changing lifestyles often lead to unsustainable consumption patterns, particularly among the affluent. • Studies indicate that 80-90% of wastewater generated in developing country cities is not properly treated before being discharged into surface water bodies (UN Water, 2017).

Sector	Human Settlements
Prioritized risks and impacts	Urban areas bear substantial climate risks, making resilience and adaptation to climate change one of the most pressing challenges for human settlements. Local governments are at the forefront of addressing climate change impacts, both immediate and long-term (IPCC 2012; Pieterse et al., 2020; IPCC 2022; CSIR 2022): • Increased exposure to extreme weather events: South African settlements face growing exposure to climate hazards, leading to property damage, infrastructure disruption, and threats to human lives and livelihoods. • Water scarcity and increased demand: Changing rainfall patterns and prolonged droughts have caused water scarcity in many parts of South Africa. Urban areas are under pressure to meet the water demands of growing populations, resulting in water stress and necessitating stricter water management practices. • Infrastructure vulnerability: Climate change poses significant risks to urban infrastructure, including buildings, roads, and utility systems. Rising temperatures stress infrastructure, while extreme weather events can cause damage and disrupt essential services. • Coastal vulnerability: Coastal cities and settlements in South Africa are at risk from rising sea levels and coastal erosion, leading to land loss, infrastructure damage, and displacement of coastal communities. • Health risks and disease outbreaks: Climate change can worsen health risks in urban areas. Higher temperatures can cause heat-related illnesses, and changes in rainfall patterns can spread waterborne diseases like cholera. Poor sanitation and inadequate infrastructure amplify these risks. • Food security and agriculture: Climate change impacts agriculture, crucial for many urban areas in southern Africa. Altered rainfall patterns and increased temperatures can reduce agricultural productivity, causing food shortages, price fluctuations, and increased vulnerability for urban populations reliant on agricultural products. • Increased energy demand: Higher temperatures due to climate change increase energy consumption for cooling in urban areas. This puts additional pressure on energy infrastructure and exacerbates greenhouse gas emissions, further contributing to climate change (Van Niekerk & Le Roux, 2017; DEA, 2018; IPCC, 2022).

3.4.5 Water sector

South Africa's water resources are unevenly distributed across the country, with most surface water resources located in the eastern and western regions. Much of South Africa experiences a naturally arid climate with limited rainfall, making water a scarce resource. The Department of Water and Sanitation (DWS) is responsible for managing the country's water resources, developing policies, and regulating water use through permits and licensing. The National Water Act (1998) provides the legal framework for water resources management, emphasizing principles such as equity, sustainability, and efficient water use.

South Africa's surface water resources account for just under 70% of usable water. These surface waters provide water for agriculture (55%), industry (18%), municipal (17%), afforestation (5%), mining (5%) and power generation (2%) activities, with all these sectors being the backbone of the South African economy and development (Rasifudi et al., 2023). Almost 100% of available water resources have been allocated, including provisions for the Ecological Reserve, which should be determined for significant water bodies to inform water use licenses. However, the implementation of the Reserve has generally been poor, thus compromising future water sustainability during mega developmental projects.

Large dams and inter-basin transfer schemes play a crucial role in moving water from surplus areas to water-scarce regions. Major rivers include the Orange River in the west, the Limpopo River in the northeast, the Vaal River in the central region, and the Tugela River in the east. Groundwater supplies around 10% of total supply, and is a vital source, especially in rural areas and during droughts (Rasifudi et al., 2023). However, over-extraction can deplete groundwater reserves.

One of the most significant hazards posed by climate change over South Africa and affecting the water sector is the alteration of precipitation patterns, leading to changes in the timing, intensity, and distribution of rainfall across different regions. An increase in the frequency and intensity of extreme rainfall events is predicted over eastern parts of South Africa including the provinces of KwaZulu-Natal, Mpumalanga, and Limpopo. A decline in rainfall is however projected over the western part of South Africa. This phenomenon contributes to increased hydrological variability, including more frequent and severe droughts in some areas and intense rainfall events and floods in others. Such extremes strain water resources management, affecting water availability for various sectors, including agriculture, industry, and domestic use. Additionally, rising temperatures associated with climate change exacerbate water stress by increasing evaporation rates and altering the hydrological cycle. Higher temperatures contribute to increased water demand for irrigation, exacerbating competition for limited water resources. This thermal stress also affects ecosystems dependent on specific temperature ranges, leading to shifts in biodiversity and ecosystem services linked to water. Furthermore, elevated temperatures can degrade water quality by promoting algal blooms and microbial contamination, posing risks to human health and ecosystem integrity.

Sea-level rise and coastal erosion, driven by climate change, pose additional risks to South Africa's water sector, particularly in coastal regions. Coastal infrastructure, including water treatment plants, pipelines, and storage facilities, faces the threat of inundation and damage from storm surges and saltwater intrusion. This not only jeopardizes water supply systems but also compromises freshwater resources in coastal aquifers and estuaries. Such impacts disproportionately affect vulnerable communities living in low-lying coastal areas, exacerbating social inequalities and displacement risks.
Water demand will play a critical role in the availability of water resources as well as the management thereof. South Africa is experiencing rapid urbanization, with more people migrating to cities. This population growth translates to a significant increase in water demand for domestic purposes. While urban areas are expected to see the most significant absolute increase in water demand due to population growth, regions already facing water scarcity like the Western Cape will be particularly vulnerable.

Table 3.7 shows the key vulnerabilities and risks for the water sector.

Table 3.7. Key vulnerabilities and risks for the water sector in South Africa

Sector	Water
Key vulnerabilities	• The water sector is sensitive to, and strongly influenced by extreme weather events characterized by frequent and intense droughts and floods as well as extreme rainfall events. • Climate change impacts on water availability are likely to have negative effects on people, ecosystems and the economy. As a result, climate change poses significant additional risks for water security, which in turn has causal effects on the sectors highly reliant on water such as agriculture, electricity generation as well as some industrial and mining activities. • Overpopulation and urbanization: Growing populations and urbanization increase the imbalance between water supply and demand and lead to a higher likelihood of water shortage conditions and contribute to water scarcity. Growing populations also lead to the discharge and runoff of greater quantities of waste and pollutants into the state's streams, rivers, lakes and groundwater.

Sector	Water
Prioritized risks and impacts	• **Water quality:** Warming temperatures will also contribute to exacerbating water pollution and declining water quality, as the risk of algal blooms will increase. The increase in intense rainfall may further contribute to declining water quality due to increased nutrients, sediments and other pollutants which will runoff into rivers, dams, wetlands and soil/plant systems. Increased drought means less water is available to dilute wastewater discharges and irrigation return flows to rivers. Increased frequency of droughts causes water shortages resulting in threatening of household water supplies. • **Water availability/supply:** Drought conditions and changing rainfall patterns increase stress on internal water resources, aquifers and rivers. • **The impact of warming temperatures on surface water** includes heightened evapotranspiration and evaporation, which result in reduced catchment runoff and increased evaporation from dams. Rainfall is also projected to become more intense, resulting in increased flooding events. Increased periods of drought mean less water is available, which will affect other sectors that rely on water resources for their viability. • **Water treatment and storage:** The projected increase in localized flooding suggests that increases in the frequency and magnitude of flooding will likely affect most of the country (with the exception of the West Coast and possibly western Limpopo). This suggests that storage, conveyance and treatment structures close to rivers are at greater risk of damages. An increase in flood events may result in deteriorating water quality due to wash off-of sediments, nutrients and other pollutants. This has the potential to impact water treatment costs and efficiency and the usability of water for certain applications. Small municipalities and groups responsible for water infrastructure are likely to be most vulnerable. • **Human health and wellbeing:** More frequent droughts are causing water sources like rivers and springs to dry up or diminish, leading to water scarcity and endangering community health. Increased rainfall intensities, flash floods, and regional flooding are causing water and sanitation systems to become blocked by litter and washed-off debris, resulting in contaminated water and poor sanitation. • **Aquatic biodiversity:** Water temperature is an important variable in freshwater systems. Warming temperatures will result in habitat degradation and decline in aquatic biodiversity (mortality of temperature-sensitive fish species) due to reduced oxygen concentrations in aquatic environments • **Stormwater infrastructure:** Risk of damage and failure of infrastructure due to high flow events and treatment of contaminated water

3.4.6 Disaster risk reduction

South Africa faces significant disaster risk largely due to its unique combination of climate variability, socio-economic challenges, and environmental degradation. Climate-related disasters such as droughts, floods, and wildfires are becoming more frequent and severe, impacting communities, ecosystems, and key economic sectors like agriculture, water resources, and infrastructure. For instance, droughts have repeatedly threatened South Africa's water security, affecting rural livelihoods and urban water supplies. The devastating floods in KwaZulu-Natal (KZN) are a stark reminder of the increasing intensity of extreme weather events, causing widespread damage to homes, infrastructure, and local economies. Coastal areas face growing threats from storm surges and rising sea levels, which endanger biodiversity and densely populated coastal settlements. The country's reliance on natural resources for economic activities, particularly agriculture, further heightens its exposure to climate-related impacts, as these sectors are directly sensitive to climate fluctuations.

South Africa's vulnerability to climate change-related disasters is compounded by socio-economic factors such as poverty, inequality, and limited adaptive capacity in certain regions. Many communities lack adequate infrastructure and resources to effectively respond to and recover from disasters, creating a cycle of vulnerability and exacerbating existing inequalities. Informal settlements in urban areas are especially at risk, with limited access to resilient infrastructure and services, which makes them more susceptible to flooding and heat stress. Additionally, South Africa's scarce and unevenly distributed water resources, which are often overexploited, add further strain to already stressed systems, exacerbating the country's challenges in adapting to climate-related disasters.

3.4.7 Other relevant sectors for South Africa

3.4.7.1 Coastal and marine sector

South Africa's coastline, spanning over 3,000 kilometers, supports diverse ecosystems and vital economic activities like tourism, fisheries, and trade. With about 40% of the population living within 60 km of the ocean, the coastal zone is highly susceptible to both land-based and ocean-driven climate hazards, including sea-level rise, coastal storms, and erosion. Rising sea levels and coastal squeeze could result in the loss of land, increased flooding, and ecosystem degradation, threatening coastal livelihoods, infrastructure, and essential services.

Climate change is significantly affecting South Africa's marine sector, disrupting fish stocks, altering species distribution, and challenging the sustainability of fisheries. Key species such as sardines, hake, and West Coast Rock Lobster have already been impacted by rising ocean temperatures and changing prey availability. The southeast coastline, a biodiversity hotspot situated between the Atlantic and Indian Ocean currents, is particularly vulnerable to these shifts. Additional threats to the marine ecosystem include unsustainable fishing practices, habitat loss, pollution, and risks from offshore activities like oil and gas exploration and potential deep-sea mining.

3.4.7.2 Mining sector

South Africa's mining sector, a major economic driver and employer, faces growing climate-related challenges. Extreme weather events, like floods and droughts, impact water availability and infrastructure, while stricter environmental regulations pressure the sector to adopt sustainable practices. Climate change influences operational costs, market demands, and carbon regulations, affecting both direct and indirect mining activities. Water scarcity, heat stress, and regulatory shifts are key concerns, especially for coal mining and energy production, requiring adaptation to ensure sectoral resilience.

3.4.7.3 Transportation and infrastructure sector

South Africa's extensive transport infrastructure, including roads, rail, ports, and airports, is crucial for economic connectivity but is highly vulnerable to climate impacts (DEDT, 2023). Extreme weather events, such as floods and wildfires, damage infrastructure, disrupt services, and increase maintenance costs. Rising sea levels and storm surges further threaten coastal infrastructure, especially in major ports. The sector requires significant investment in climate-resilient upgrades, as aging infrastructure and funding constraints exacerbate its vulnerability to climate-related disruptions.

3.4.7.4 Energy sector

South Africa's energy sector, heavily reliant on coal, faces dual pressures from climate impacts and the need for a just energy transition. Water scarcity, essential for cooling in coal-fired plants, threatens reliability, while extreme weather events risk infrastructure damage and power outages. Transitioning to renewables is critical to reduce greenhouse gas emissions, but aging infrastructure, regulatory shifts, and socio-economic considerations pose challenges. Renewable energy investment, grid modernization, and community support are essential for sustainable adaptation in the sector.

3.4.7.5 Tourism sector

The South African tourism sector faces significant climate change risks and vulnerabilities due to its reliance on natural and cultural assets sensitive to changing climatic conditions. Key risks include increased temperatures, water scarcity, and extreme weather events, which can degrade biodiversity, impact iconic landscapes, and disrupt infrastructure essential for tourism. Coastal tourism, a major attraction, is particularly vulnerable to sea level rise, coastal erosion, and storm surges. Moreover, as tourists may avoid destinations affected by adverse climate impacts, there is a potential for reduced tourist arrivals, impacting local economies and livelihoods reliant on this sector. Table 3.8 shows the key vulnerabilities and risks for other adaptation sectors in South Africa.

Table 3.8. Key vulnerabilities and risks for other adaptation sectors in South Africa

Sector	Key vulnerabilities	Prioritized risks and impacts
Coastal	Exposure to climate hazards (sea-level rise, coastal storms), rapid coastal population growth, coastal squeeze	Rising sea levels and coastal squeeze causing land loss, increased flooding in low-lying areas, ecosystem degradation; threats to coastal livelihoods, infrastructure (e.g., ports, roads), and essential services, particularly in high-density areas
Marine	Unsustainable fishing practices, habitat loss, inadequate regulation enforcement, and impacts of offshore activities	Decline in fish stocks, altered species distribution, habitat degradation, and economic losses in fisheries; heightened risk from oil, gas, and potential deep-sea mining activities on marine ecosystems
Mining	Dependence on water, vulnerability to extreme weather, high carbon emissions, regulatory pressures	Operational disruptions due to water scarcity, infrastructure damage, rising operational costs, job losses
Transportation	Poor infrastructure conditions, congestion, outdated rail systems, coastal risks	Flooding and storm surges damaging infrastructure, coastal erosion, rising maintenance costs
Energy	Heavy reliance on coal, water-intensive processes, aging infrastructure, regulatory challenges	Water scarcity disrupting operations, temperature-induced efficiency loss, extreme weather damaging infrastructure

3.5 ADAPTATION PRIORITIES AND BARRIERS

3.5.1 Adaptation Priorities

South Africa has taken significant strides in recent years to coordinate its climate change research efforts in support of formulating its climate change adaptation strategies (DEA, 2018). South Africa's adaptation goals communicated in its updated NDC comprise the country's contribution to the global goal for adaptation, considering the country's projected risk and vulnerability for the period 2021-2030. These goals are (RSA, 2021):

- **Goal 1:** Enhance climate change adaptation governance and legal frameworks;
- **Goal 2:** Develop an understanding of the impacts on South Africa of 1.5 and 2`C global warming and the underlying global emission pathways through geo-spatial mapping of the physical climate hazards, and adaptation needs in the context of strengthening the key sectors of the economy;
- **Goal 3:** Implementation of NCCAS adaptation interventions for the period 2021 to 2030 (Note: Goals and actions covered in each element contained in the NDC are as per the National Climate Change Adaptation Strategy);
- **Goal 4:** Access to funding for adaptation implementation through multilateral funding mechanisms;
- **Goal 5:** Quantification and acknowledgement of the national adaptation and resilience efforts.

The national adaptation goals of the updated NDC are largely informed by the strategic objectives of the NCCAS, which represent priority adaptation actions for the country since the NCCAS/NAP is a key domestic policy instrument to guide implementation of adaptation and outline priority areas for adaptation, both to guide adaptation efforts and to inform resource allocation (DEA, 2019).

The strategic objectives of the NCCAS are as follows:

- **Objective 1:** Build climate resilience and adaptive capacity to respond to climate change risk and vulnerability.
- **Objective 2:** Promote the integration of climate change adaptation response into development objectives, policy, planning and implementation.
- **Objective 3:** Improve understanding of climate change impacts and capacity to respond to these impacts.
- **Objective 4:** Ensure resources and systems are in place to enable implementation of climate change responses.

The NCCAS also outlines nine strategic interventions which are required to achieve South Africa's vision to transition to a climate-resilient economy and society, and to which sectoral responses need to be aligned. One of the strategic interventions in South Africa's NCCAS (DEA, 2019) (Strategic Intervention 4) is to "Facilitate mainstreaming of adaptation responses into sectoral planning and implementation". In support of this intervention, Outcome 4.2 in the NAS is to achieve 100% coverage of climate change considerations in sectoral operational plans. The provision of support to private sector businesses to incorporate climate change adaptation into their strategic implementation is one of the proposed actions to achieve this intervention (Action 4.2.5). Developing a National Climate Risk and Vulnerability (CRV) Assessment Framework (DFFE, 2020), Strategic Intervention 3 in the NCCAS, is intended to guide sectors and provinces when reviewing and revising existing assessments and response plans. This will allow for comparison of the results of the assessments or to support aggregation of the results to provide an overall picture of vulnerability and response across sectors and spheres of government in South Africa.

Priority sectors in the NCCAS include biodiversity and ecosystems, water, health, energy, settlements (coastal, urban, rural), disaster risk reduction, transport infrastructure, mining, fisheries, forestry, and agriculture. The NCCAS identifies interventions to meet adaptation goals, and the interventions address both highly vulnerable sectors as well as geographic areas. However, since the NCCAS is a national strategy, it does not detail how adaptation will take place in the many sectors impacted by climate change. Prioritised adaptation actions in priority sectors are outlined in Section 3.4.1. of this report.
Intervention 5 of the NCCAS aims to "promote research application, technology development, transfer and adoption to support planning and implementation" to deliver "increased research output and technology uptake to support planning and implementation". To achieve the above-mentioned intervention, the National Climate Change Adaptation Research Agenda (NCCARA) was developed (DFFE, 2021). The NCCARA is South Africa's adaptation research roadmap, which serves to guide the research on impacts and vulnerability and adaptation options to deliver "knowledge for action", and to support the uptake of this knowledge in adaptation policy and practice. The NCCARA provides prioritization criteria for the research areas for the various sectors, while also outlining the governance and investments implementation framework, and monitoring and evaluation aspects. The NCCARA aims to define the most effective way to build (and in some cases initiate) national investments to address the priority research areas.

The NCCAS includes a set of "enabling" priority actions that would support research. The NCCARA scoping work confirmed that many of these actions were necessary and provided additional insights that can help steer how these should be implemented. Priority enabling conditions for Adaptation Research in South Africa outlined in the NCCARA include:

- Establishing a Climate Change Research Advisory Body
- Setting up a National Climate Centre and National Climate Change Adaptation Research Network
- Establishing an Interactive Online Climate Service Platform
- Continuing and enhancing climate observation and monitoring networks, modelling and projections

The scoping work, and subsequent stakeholder engagement processes, resulted in a large list of both broad and more specific research needs and topics. Given the relatively limited funds that are available for new research, those research needs had to be prioritised so that resources are allocated to the most important knowledge gaps. The prioritisation followed a two-step process which was 1) assessing and merging individual research topics into broad thematic research areas, and 2) assessing consolidated research topics against prioritization criteria (DFFE, 2021):

i. the adaptation interventions that the research evidence would support;
ii. whether the information is needed for action in the short or longer term;
iii. whether the research would be relevant to a broad set of stakeholders and/or multiple areas in South Africa;
iv. how the realised research, and any adaptation intervention, would contribute to broader national development objectives.

The broad thematic areas within which individual research topics (as informed by national departments and key stakeholders) were clustered is shown in Table 3.9. Short- and medium-term adaptation research needs were prioritised, following which 17 priority research topics for short term commissioning, covering priority sectors, were identified. A cross-cutting research topic, "Interactions, synergies and trade-offs across systems and sectors", is applicable across sectoral thematic areas. The remaining 16 priority adaptation research topics were also grouped according to thematic area in Table 3.9.

Table 3.9. Thematic areas within which individual research topics and priorities were clustered and priority adaptation research topics (DFFE, 2021)

Thematic Area	Description	Priority research topics
Long-term environmental observation and monitoring, projections and other data, and associated platforms	The maintenance and improvement of climate and other relevant environmental monitoring networks to support research, and the development of climate data products to support risk assessment and adaptation planning across other thematic areas, especially for drought, extreme heat, coastal and river flooding. Development of climate information and other platforms to support research and data utilisation.	• Climate information and climate service platform development (NCCIS, NFCS Platform, SARVA, NCCRD) • Projected changes in likelihood, magnitude and duration of climatic extremes, especially flood, drought, heat waves, veld fires etc.
Water Security	Improved assessments and data on surface and groundwater availability under changing climatic and other indirect drivers, water systems modelling to support catchment management, infrastructure development and allocation decision making.	• Water supply sustainability in drought affected municipalities • Cross-border energy generation and water nexus in a changing climate • Water budget impacts of invaded and bush encroached landscapes • Climate change impacts on groundwater • Climate impacts on surface water resources, catchment yields, CMA resources and water supply system reliability.

Thematic Area	Description	Priority research topics
Food Security	Improved understanding of vulnerability of crops and livestock across different regions of the country, especially for small scale and emerging farmers; identification of adaptation options over different time scales and levels of climate change, including conservation agriculture and climate resilient crops; mechanisms to support the adaptive capacity of small-scale and emerging farmers.	• Biochar in climate smart agriculture and soil rehabilitation • Climate impacts on livestock animal health, and appropriate adaptation options • Incorporation of climate change into agricultural curricula • Agriculture response preparedness for extreme events
Biodiversity and Ecosystem Services	Improved understanding of the value of terrestrial, aquatic and marine biodiversity and ecosystem services, their vulnerability to climate change, and adaptation options to maintain and enhance these services and how biodiversity enables our human and society to adapt to the impacts of climate change. These includes the effectiveness and impacts of nature-based solutions (NBS) to climate change (EbA, EbM, Eco-DRR, EI etc.) to inform policy, planning and implementation processes.	• Vulnerability of socio-economic value of ocean and coastal resources to climate change • Impacts of climate change on biodiversity and associated benefits for people (socio-economic)
Health	Improved understanding of how existing health indicators can be used to monitor climate-health interactions and assess the outcomes of adaptation interventions. Identification of key health vulnerabilities to climate change, for both communicable and non-communicable diseases. Development of policies and strategies to make the health system climate resilient.	• Climate change and health indicators
Human Settlements	Improved vulnerability assessments across human settlements; development of standards for climate resilient spatial planning, building regulations and other urban infrastructure.	• Infrastructure - Road Infrastructure • Infrastructure - Water / Dam Infrastructure

3.5.2 Adaptation Barriers

Understanding how adaptation barriers arise has become critical to South Africa's climate change policy (Khavhagali, et al., 2023). Moving forward requires an unpacking of barriers as well as the identification of factors that may enable adaptation or assist in overcoming these barriers. Recent studies by Sibiya et al., (2023) and Khavhagali et al. (2024) focused on an analysis of the barriers to climate change adaptation in South Africa and highlighted various barriers that impede adaptation in SA through interviewing government officials working on climate change adaptation. These officials were specifically asked to outline key challenges that exist in developing and implementing climate change adaptation policies, strategies, and programmes at all three spheres of government (i.e., the national, provincial, and local government levels). The two predominant barriers to climate change adaptation in South Africa are inadequate financial resources, which are cross-cutting across all three government levels, and insufficient human capacity at the provincial and local levels (Sibiya et al., 2023).

At a provincial level, barriers that impact the level of implementation of plans and strategies on the ground were outlined in the 2024 Draft SANAs report. Several common provincial barriers related to service provision, availability of resources, data availability, monitoring and evaluation, available capacity, etc. are outlined in Figure 3.9.

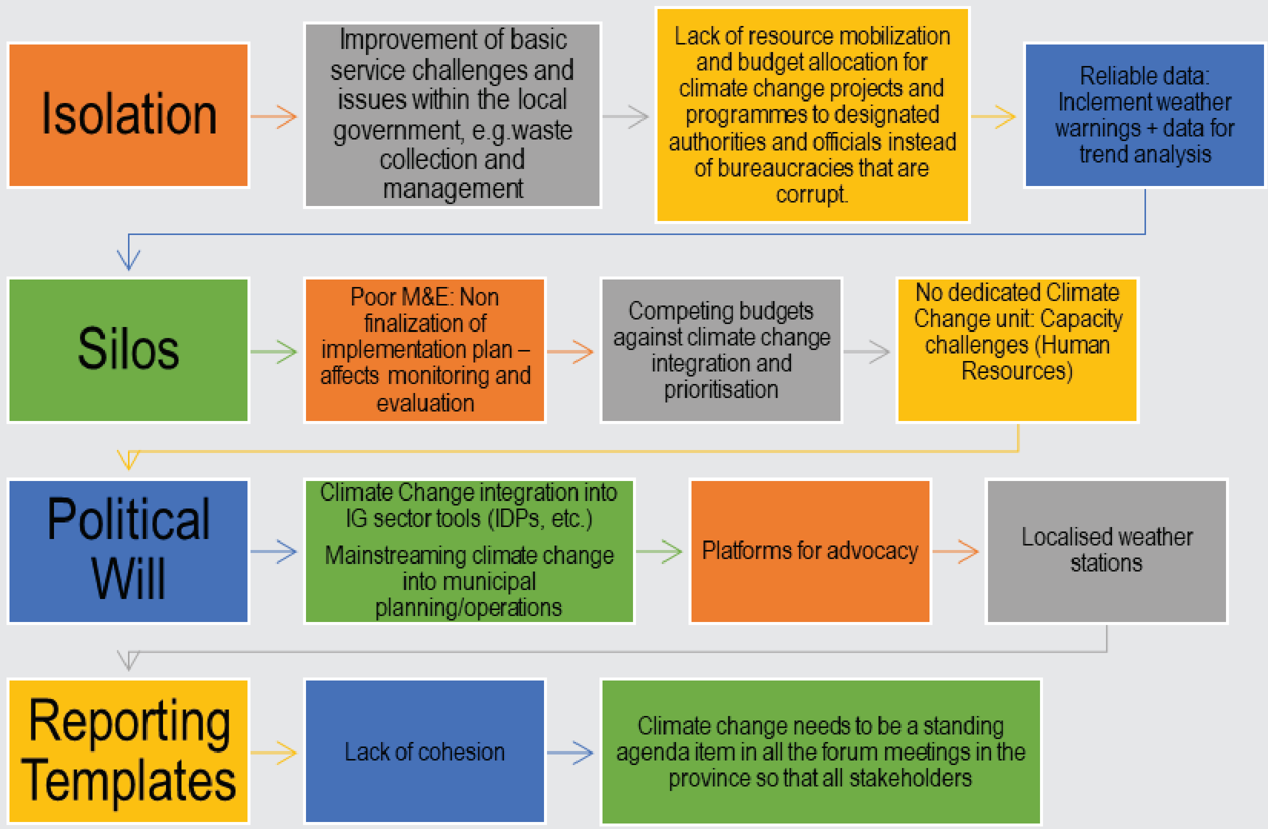


Figure 3.9. Common provincial barriers to implementation of climate action (DFFE, 2024)

3.6 ADAPTATION STRATEGIES, POLICIES, PLANS, GOALS AND ACTIONS TO INTEGRATE ADAPTATION INTO NATIONAL POLICIES AND STRATEGIES

3.6.1 Adaptation strategies, plans and goals

Climate change poses a significant threat to South Africa's water resources, food security, health, infrastructure, as well as its ecosystem services and biodiversity. Considering South Africa's high levels of poverty and inequality, these impacts pose critical challenges for national development. As part of the global community, South Africa has a responsibility to respond to both the causes of climate change and its impacts. South Africa's first adaptation communication, contained within the country's updated NDC, includes the country's adaptation goals (described in Section 3.1.1) which represent South Africa's planned contribution to the global adaptation goal during the NDC period as well as actions to be taken, or measures to be implemented in achieving the goals. This section outlines adaptation actions and progress on policies, plans, strategies and frameworks that support climate change adaptation per sector in Table 3.10 to Table 3.17.

Table 3.10: Adaptation actions and progress on key policy, strategy and legislation per sector: Agriculture

Sector	Agriculture
Adaptation actions	• **Actionable Guidelines for the Implementation of Climate Smart Agriculture in South Africa:** This practical document provides detailed guidance on climate-resilient practices for farmers. The Agricultural Research Council (ARC) of South Africa has developed a Climate Smart Agriculture guide to assist farmers, agricultural practitioners, and policymakers in adopting climate-smart agricultural practices. It provides evidence-based research and case studies that have been conducted in South Africa to help stakeholders understand and implement strategies that enhance agricultural productivity, resilience, and sustainability in the face of climate change. • **Research and innovation:** The ARC together with academia and other research institutions in South Africa is investing in research and development to create climate-resilient crop varieties, livestock breeds, and innovative farming practices. They are developing drought-tolerant and heat-resistant crop varieties and livestock breeds. • **Sustainable natural resource management:** Conservation agriculture in South Africa is promoted by the Conservation Agriculture Policy (2022), aimed at promoting sustainable farming practices that improve soil health, enhance agricultural productivity, and increase resilience to climate change. • **Capacity Building and Education:** The agricultural sector is strengthening agricultural extension services to disseminate knowledge and technologies to farmers. The sector is also implementing training programs to build farmers' capacities in climate adaptation techniques and sustainable practices. • **Institutional Frameworks:** The agricultural sector has developed several climate change adaptation plans and strategies which has been integrated into national and regional agricultural policies and development plans.

Sector	Agriculture
Progress on key policy, strategy and legislation	• **Draft Conservation Agriculture Policy (2022):** To promote and establish ecologically and economically sustainable agricultural systems to increase food security. The draft Conservation Agriculture Policy has been developed and is currently undergoing approval processes for Cabinet ratification. • **Climate Smart Agriculture Strategic Framework (2018)** which outlines the CSA measures in combating problems facing the South African agricultural sector that relate to climate change, the Department of Agriculture, Land Reform and Rural Development has developed sector response measures that includes climate change adaptation and mitigation programmes focusing mainly on enhancing the resilience of farmers, food and agricultural production systems, reducing agricultural greenhouse gas emissions while ensuring national food security. • **Carbon Tax Act 15 of 2019**: The Carbon Tax Bill was implemented on 1 June 2019. Agriculture and other land use and waste sectors are exempted from direct greenhouse gas emission taxes during the first phase of implementation; however, indirect taxes will apply for fuel and energy usage. • **The Draft Climate Change Act** (the Climate Change Act was signed into law by the President of South Africa on 23 July 2024) sought to establish a legislative framework for addressing climate change in South Africa, with specific implications for agriculture in terms of: • **Emission Reduction Targets:** Sets targets for reducing greenhouse gas emissions in the agricultural sector. • **Adaptation Strategies:** Mandates the development and implementation of climate adaptation strategies at the national, provincial, and local levels. • **Monitoring and Reporting**: Requires agricultural stakeholders to monitor and report emissions and climate adaptation activities.

Table 3.11: Adaptation actions and progress on key policy, strategy and legislation per sector: Forestry

Sector	Forestry
Adaptation actions	• Fire Management: Implementing firebreaks, controlled burns, and early detection systems to manage wildfire risks. • Water Conservation: Enhancing water use efficiency and developing drought-resistant tree species. • Pest and Disease Management: Monitoring and controlling pest populations and investing in research for disease-resistant tree varieties. • Sustainable Practices: Promoting sustainable forest management practices to maintain soil health and biodiversity. • Policy and Planning: Integrating climate change considerations into forestry policies and land use planning to enhance resilience.
Progress on key policy, strategy and legislation	• Act No. 13 of 2023: National Veld and Forest Fire Amendment, Act 2023. • The National Forests Amendment Act, No. 1 of 2022.

Table 3.12: Adaptation actions and progress on key policy, strategy and legislation per sector: Biodiversity and Ecosystems

Sector	Biodiversity and Ecosystems
Adaptation actions	• **Protected Area Expansion and Connectivity:** Enhances biodiversity resilience by expanding the network of protected areas (including marine protected areas) and establishing ecological corridors to facilitate species movement. Over the 2014- 2022 period, 163 411 ha of terrestrial biodiversity were added to National Parks and 229 519 ha of marine areas through three newly declared Marine Protected Areas (SANParks, 2023). • **Habitat Restoration and Rehabilitation:** Implement habitat restoration projects to enhance the resilience of degraded ecosystems and promote biodiversity recovery. Restore key habitats such as fynbos, grasslands, and wetlands through invasive alien plant removal, reforestation, and soil conservation measures. Ecological restoration programs from DFFE, such as Working for Water (WfW) and Working for Wetlands, have contributed significantly to alien plant removal and rehabilitation. To date, Working for Water has cleared over 3 million hectares of invasive plants and Working for Wetlands rehabilitated 634 wetlands across the country, constituting approximately 22 500 hectares. • **Integrated Water Resource Management (IWRM):** Implementing IWRM in South Africa is complex but essential to ensure sustainable and equitable water resource management. IWRM is implemented through catchment management agencies, water user associations, water stewardship programs, and ecosystem protection and rehabilitation to improve water efficiency and enhance water security in the face of climate change. Implementation challenges include capacity constraints at all levels of government, coordination and integration inefficiencies among sectors, data and information gaps impeding effective decision-making, and climate change. While there are significant challenges, ongoing efforts to improve policy, strengthen institutions, enhance stakeholder participation, ensure financial sustainability and invest in data and monitoring systems are crucial. By promoting integrated approaches and adaptive management, South Africa can better manage its water resources in the face of growing demands and environmental and climate changes. • **Climate-Smart Land-Use Planning:** Integrate climate change considerations into land-use planning and decision-making processes to minimise habitat loss, fragmentation, and degradation. This includes mainstreaming climate adaptation across sectors and incorporating ecosystem-based approaches into adaptation planning. • **Biodiversity Stewardship and OECMs:** South Africa's National Protected Area Expansion Strategy aims to achieve cost-effective, protected area expansion for improved ecosystem representation, ecological sustainability, and resilience to climate change. Biodiversity stewardship is currently the primary tool for expanding the country's conservation estate. Biodiversity stewardship involves securing land in priority areas through voluntary agreements with private landowners, Communal Property Associations, and community members. To increase biodiversity stewardship, South Africa is in the process of institutionalizing. Other Effective Area-Based Conservation Measures (OECM) into its existing policy frameworks and aligning OECMs with the biodiversity stewardship community of practice. This would facilitate fully integrating all OECM initiatives across South Africa into biodiversity stewardship agreements. This is essential in involving communities in conservation and building climate change resilience across South Africa.

Sector	Biodiversity and Ecosystems
Adaptation actions	• **Ecosystem-based Adaptation (EbA):** Implement ecosystem-based adaptation strategies that harness ecosystems' natural resilience to climate change. Examples of EbA projects in South Africa are the Natural Resource Management Programmes (e.g) Working for Water, Working on Fire, and Working for Ecosystems, etc.) as they couple ecosystem restoration and sustainable community development while considering anticipated climate change impact trends to reduce vulnerability and improve the resilience of ecosystems and communities. Between 2020-2022, the South African government invested over 1.5 billion Rand to address biological invasions, mainly in rural areas, for job creation (SANBI and CIB, 2024). SANBI is spearheading EbA work in South Africa, from creating guidelines to producing EbA priority maps and building communities of practice regarding EbA and restoration work. • **Community-Based Conservation:** Engage local communities in biodiversity conservation and climate adaptation efforts through participatory approaches, capacity building, and sustainable livelihood initiatives. Examples of this include EbA projects, biodiversity stewardship agreements and training programs for farmers on climate-smart agriculture practices. Climate-smart agricultural practices enhance agricultural resilience while minimising negative impacts on biodiversity and ecosystems. These practices include agroforestry, conservation agriculture, and sustainable land management practices. • **Research and Monitoring:** Monitor changes in species distributions, habitat conditions, and ecosystem dynamics to identify emerging threats and prioritize conservation interventions. South Africa, through the NRF, DSI, and multiple other research organizations and funding partners, conducts monitoring programs and research initiatives to assess the impacts of climate change on biodiversity and ecosystems. This data helps inform conservation strategies, prioritize actions, and track the effectiveness of adaptation measures. • **Mainstreaming Biodiversity into Business and Nature-related Financial Disclosures:** Nature is essential for the economy, financial stability, and society's resilience, yet many companies do not consider their impacts and dependencies on nature and the risks and opportunities related to their organisations. The WEF reported that environmental-related risks will be among the most severe risks on a global scale over the next ten years, exposing businesses to increasing risks (WEF, 2022). Initiatives and frameworks such as the biodiversity sector investment portal, TCFD, TNFD, WWF Risk Filter Suite, and NBBN are a great start at getting businesses involved in nature conservation and enabling private investment in climate adaptation.
Progress on policy, strategy and legislation	South Africa has strengthened its policy frameworks, legislation, and institutional capacity for climate adaptation and biodiversity conservation at the national, provincial, and local levels. These include: • **National Biodiversity Framework 2019 - 2024:** The NBF introduces new strategic priorities that align with contemporary conservation challenges and international commitments, such as the Sustainable Development Goals (SDGs) and the Paris Climate Agreement. The new framework emphasises addressing climate change's impacts on biodiversity and incorporating climate resilience into biodiversity planning and actions. • **National Climate Change Adaptation Strategy (NCCAS) 2019:** The NCCAS, which serves as South Africa's National Adaptation Plan, provides a comprehensive framework for climate adaptation across various sectors, including the biodiversity sector. It outlines priority adaptation interventions and serves as a guideline for integrating climate resilience into planning and decision-making processes at all levels of government. One of the guiding principles of these strategies is to promote the protection of ecosystems and biological diversity because of their role in supporting South Africa's adaptation to climate change.

Sector	Biodiversity and Ecosystems
	• **Nationally Determined Contribution (NDC) Update 2021:** South Africa updated its NDC under the Paris Agreement, committing to more ambitious greenhouse gas (GHG) emission reduction targets. The updated NDC includes ecosystem-based mitigation and adaptation components, reflecting the country's enhanced commitment to addressing climate change. • **Climate Change Act:** The act aims to provide a legislative framework for effectively managing climate change impacts in South Africa. It will ensure that climate action is coordinated across all levels of government, fostering a comprehensive and integrated approach to climate resilience. The bill anchors South Africa's climate change response in law and mandates the development of climate change response strategies and action plans focusing on climate mitigation and adaptation. It also gains the authority to implement more ambitious measures outlined in the NDC. • **National Biodiversity Strategy and Action Plan (NBSAP) 2015-2025:** This plan identifies the priorities for biodiversity management in South Africa and aligns them with global priorities and targets. The new NBSAP includes more comprehensive strategies for addressing the impacts of climate change on biodiversity, promoting adaptation and mitigation measures. It also emphasises the importance of building social and ecological resilience to cope with climate change impacts. • **National Environmental Management:** Biodiversity Bill: Currently out for comments, this bill aims to enable the implementation of international agreements and provide appropriate measures in response to climate change. The bill emphasises the conservation and restoration of ecosystems that are crucial for buffering the impacts of climate change, integrates climate change considerations into biodiversity planning and management, and fosters collaboration between different sectors and government agencies to ensure that biodiversity and climate change policies are aligned and mutually reinforcing. • Further, SANBI and DFFE recently drafted Biome-Level Implementation Plans For The Biodiversity And Ecosystems Sector Climate Change Adaptation Strategy • DFFE is currently developing the Climate Change Adaptation Response Plan for South Africa's Coastal Sector which will include adaptation response for the natural coastal environment. Biodiversity Management Agreements (BMA): NEMBA provides for the development of Biodiversity Management Plans (BMP) for species. A Biodiversity Management Agreement aims to allow a person or organisation to manage a species or ecosystem through an approved Biodiversity Management Plan (BMP), valid for five years. In 2024, South Africa developed and implemented its first BMA, which was enabled by tax incentive section 37C (1) of South Africa's Income Tax Act, which is dedicated to the environment. These BMAs could become OECMs, further contributing to expanding conservation areas and meeting the country's NDC and GBF targets.

Table 3.13: Adaptation actions and progress on key policy, strategy and legislation per sector: Health sector

Sector	Health Sector
Adaptation actions	South Africa's health sector is taking steps to adapt to the challenges posed by climate change. Here are some key strategies with examples and progress updates: **1. Early Warning Systems and Surveillance:** • Strategy: Develop and implement early warning systems for extreme weather events, vector-borne diseases, and heatwaves. • Example: Implementing weather forecasting systems combined with disease modeling to predict and prepare for outbreaks of climate-sensitive diseases like malaria and dengue fever. The South African National Institute for Communicable Diseases (NICD) monitors weather patterns and disease outbreaks, issuing early warnings for malaria and other climate-sensitive diseases. • Progress: South Africa already has established systems for forecasting extreme weather events. However, integrating these with disease forecasting requires further development.
	2. Climate-Resilient Infrastructure: • Strategy: Invest in climate-resilient health infrastructure, including water and sanitation systems that can withstand extreme weather events and ensure access to clean water. invest in renewable energy sources for backup power. • Example: Upgrading sanitation facilities to better withstand floods and droughts, ensuring access to clean water during extreme weather events. Upgrading healthcare facilities with heat-resistant roofing and backup power can improve their resilience to heatwaves and power outages. Western Cape Department of Health has been piloting the Municipal Risk Pooling (MURP) that will improve the capacity of municipalities to better plan, prepare, and respond to extreme weather events and natural disasters. • Progress: Limited progress has been made. Investment is needed to improve infrastructure in vulnerable communities Limited progress has been made in mainstreaming climate resilience into infrastructure development
	3. Strengthening Healthcare/health workforce Capacity: • Strategy: Train healthcare workers to identify, diagnose, and treat climate-related health problems, incorporate climate change considerations into medical curriculums, and build capacity for community health education • Example: Training healthcare workers to diagnose and treat climate-related illnesses, like heatstroke and waterborne diseases. Including climate change modules in medical training programs can equip future healthcare professionals with the necessary knowledge and skills. • Progress: The Department of Health offers some training programs, but more resources are needed to equip healthcare workers across the country and integrating climate change into health worker training. the South African Medical Association (SAMA) offers training programs on climate change and health for medical professionals.
	4. Community Engagement and Education/community-based adaptation: • Strategy: Empower communities to prepare for and respond to climate change impacts on health through education, awareness campaigns, and capacity building. This can involve promoting rainwater harvesting, improving sanitation practices, and supporting local food production systems. • Example: Educating communities about the health risks of climate change and how to protect themselves, such as promoting safe water storage and vector control practices. Community health workers can play a crucial role in educating people about heatstroke prevention, water safety, and the importance of using mosquito nets. The South African Red Cross Society works with communities in vulnerable areas to develop climate resilience plans. These initiatives show promise but require scaling up and long-term support. • Progress: Some community health initiatives exist, but broader public education campaigns are necessary; more resources and support for long-term sustainability.

Sector	Health Sector
Adaptation actions	**5. Climate-Smart Health Research:** • Strategy: Invest in research on the health impacts of climate change in South Africa, including developing evidence-based interventions and adaptation strategies. • Example: Researching the potential expansion of vector-borne diseases and developing local solutions for prevention and control. • Progress: Research is ongoing, but more funding and collaboration are needed to address knowledge gaps and develop effective adaptation strategies specific to the South African context.
	6. Social Protection Programs: • Example: Providing social safety nets, such as food assistance and temporary housing, for communities affected by extreme weather events to reduce health risks associated with malnutrition and displacement. • Progress: South Africa has existing social welfare programs, but strengthening them to address climate shocks is crucial.
	7. Research and Innovation: • Strategy: Invest in research on climate-sensitive diseases, develop heat-resistant crops for food security, and explore new technologies for telemedicine and remote healthcare delivery. • Example: The South African Medical Research Council (SAMRC) is conducting research on the impact of climate change on malaria transmission. Research efforts are ongoing, but more funding and collaboration are crucial for impactful innovation.
	Overall Progress: • South Africa has developed a national climate change adaptation strategy (NCCAS) that outlines steps for the health sector. However, implementation requires significant investment and collaboration across different government departments and stakeholders. The National Climate Change and Health Adaptation Plan (NCCHAP) is currently being updated. • The South African Medical Research Council (SAMRC) Climate Change and Health Research Programme funds research on the health impacts of climate change in South Africa, addressing issues such as malaria transmission, health risks associated with heatwaves and mental health impacts. • Climate-Based Health Services Project (CHBS), piloted in the KwaZulu-Natal province, uses climate forecasts to predict malaria outbreaks and guide public health interventions. • Training Initiatives on climate change and health for healthcare workers are offered by several organizations such as South African Medical Association (SAMA), Red Cross Society and Department of Health: • Community-Based Adaptation Projects by several NGOs and government agencies working with communities in vulnerable areas to develop climate resilience plans

Sector	Health Sector
Progress on policy, strategy and legislation	Progress on existing frameworks and some developments include: 1. **National Climate Change Adaptation and Health Adaptation Plan (NCCHAP) for Health (update in progress):** This plan aims to be a comprehensive framework outlining how the health sector will adapt to climate change (https://www.unisdr.org/preventionweb/files/57216` nationalclimatechangeandhealthadapt.pdf). 2. **National heat-health guidelines** The purpose of the guidelines is to ensure that the health sector is prepared to effectively respond to rising temperatures across South Africa. https://www.health.gov.za/wp-content/uploads/2022/06/National-Heat-Health-Action-Guidelines.pdf 3. **Revised National Health Research priorities (2021-24)** indicates the need to assess the individual, synergistic and cumulative health effects of major global and local events and processes, including extreme weather events (drought, floods, heat waves, wildfires) associated with climate change. Climate change is also mentioned as a global, planetary and national catalysts and contextual process https://www.health.gov.za/wp-content/uploads/2023/06/Revised-National-Health-Research-Priorities-2021-2024.pdf 4. **National Climate Change Response White Paper (2023)** emphasizes the importance of building climate resilience across various sectors, including health. It highlights the need for investing in early warning systems for health risks, improving water and sanitation infrastructure, and integrating climate considerations into health workforce training https://www.dffe.gov.za/sites/default/files/legislation/2023-09/national` climatechange` response` whitepaper` 0.pdf. 5. **Integration of Climate Change Considerations into Existing Health Policies and plans** indicates that there is a gradual integration of climate change considerations into existing health policies. Provincial health departments, for instance, are starting to address climate risks within their strategic plans. This highlights a growing recognition of the importance of adaptation within the health sector. 6. **Provincial and Local Initiatives:** Several provincial health departments and local municipalities are taking initiative. Examples include Heat Health Action Plans for Cities to protect vulnerable populations during extreme heat events. 7. **Advocacy and Capacity Building:** Organizations like the Climate and Health Alliance of South Africa (CHASA) are playing a crucial role. They advocate for policy change, conduct research, and provide training for healthcare workers, building capacity within the sector to address climate challenges (https://phasa.org.za/index.php/special-interest-groups/13-climate-energy-and-health). 8. **Focus on Early Warning Systems and Climate Information Services:** The South African National Institute for Communicable Diseases (NICD) are constantly improving early warning systems for climate-sensitive diseases like malaria and using climate data to predict outbreaks and take preventive measures. (National Institute for Communicable Diseases (NICD) website) 9. **Capacity Building for the Health Workforce:** Organizations like the South African Medical Association (SAMA) offer Training programs and workshops on climate change and health, aiming to equip healthcare professionals with the knowledge and skills to identify and manage climate-related health issues. (South African Medical Association (SAMA) website)

Table 3.14: Adaptation actions and progress on key policy, strategy and legislation per sector: Human Settlements

Sector	Human Settlements
Adaptation actions	• A spectrum of adaptation actions is at the disposal of local municipalities to enhance resilience and mitigate risks posed by changing climatic patterns and extreme weather events. Some of the categories of actions include: • Infrastructure development, encompassing the construction of, for example, seawalls, levees, and storm surge barriers to protect against rising sea levels and extreme weather events. These engineered solutions provide immediate protection and buy time for longer-term adaptation efforts but are mostly very expensive to build. • Green infrastructure initiatives offer sustainable and nature-based solutions. Municipalities can implement urban green spaces, green roofs, and permeable pavements to absorb excess water, reduce flooding, and mitigate the urban heat island effect. Such approaches not only enhance climate resilience but also contribute to improved air quality and overall urban liveability. • Environmental protection such as restoring ecosystems like mangroves, dunes, and wetlands, not only provides natural buffers but also supports biodiversity. • Integrated urban planning is essential to create climate-resilient municipalities. Land-use regulations should be adapted to consider climate risks, prioritising construction practices that enhance resilience. Elevating structures above projected flood- and sea levels and using climate-resilient materials in building design can minimise the impacts of flooding and storm damage. • Early warning systems and emergency preparedness plans are critical tools to ensure swift responses to extreme weather events, minimising the impact on vulnerable communities. • Innovative water management strategies are essential for municipalities facing changing precipitation patterns and increasing water scarcity. Diversifying water sources, implementing water efficiency measures, and investing in advanced stormwater management systems contribute to water security and sustainable resource use. • Engagement and education are pivotal components of successful adaptation strategies. Empowering officials, and residents, to understand and respond to climate risks through awareness campaigns, education programmes, and participatory planning initiatives can enhance local adaptive capacity (Van Niekerk, 2024). • Local governments must embrace a combination of structural, natural, and community-based approaches to build resilience and adaptive capacity, protect vulnerable communities, while ensuring long-term sustainability in the face of evolving climate challenges.
Progress on policy, strategy and legislation	• Climate Change Act • Disaster Management Act, Act 57 of 2002. • Integrated Urban Development Framework, 2016. • National Development Plan • National Spatial Development Framework • Spatial Land Use Management Act (SPLUMA), Act 16 of 2013. • Priority Settlement and Housing Development Areas Climate Risk Profiles and Climate Response Plans • Climate Adaptation response Plan for South Africa's Coastal Sector (draft June 2024)

Table 3.15: Adaptation actions and progress on key policy, strategy and legislation per sector: Water

Sector	Water
Adaptation actions	• Promoting sustainable water management by integrating use, conservation, and ecosystem health. • Upgrading and climate-proofing dams, reservoirs, and pipelines to withstand extreme weather. • Implementing water-saving technologies, efficient irrigation, and awareness campaigns to reduce consumption. • Expanding desalination, water reuse, and rainwater harvesting to diversify supply. • Protecting and restoring wetlands and catchments to enhance natural water storage and filtration. • Promoting efficient irrigation, drought-resistant crops, and soil conservation in agriculture. • Strengthening enforcement of water regulations to prevent illegal use and over-extraction. • Developing early warning systems for extreme weather to protect water resources. • Conducting training for water managers, farmers, and communities on sustainable practices. • Investing in monitoring systems for rainfall, river flows, and groundwater data collection. • Strengthening cooperation with neighbouring countries on shared water resources. • Implementing tiered water pricing and incentives to promote conservation.
Progress on policy, strategy and legislation	• The National Water Resources Strategy 3rd Edition (2023) • Water and Sanitation Sector Policy on Climate Change (2017)

Table 3.16: Adaptation actions and progress on key policy, strategy and legislation per sector: Disaster Risk Reduction

Sector	Disaster Risk Reduction
Adaptation actions	• Integration of disaster risk management into climate change adaptation strategies, and ensuring these policies are enforced across all levels of government to address the increasing frequency of extreme weather events. • Conducting climate risk assessments to identify vulnerable areas and prioritize risk reduction measures. • Collaborating with research institutions to better understand disaster risks and climate change impacts. • Establishing advanced weather forecasting and early warning systems to prepare for extreme weather events. • Educating communities on disaster preparedness, climate adaptation, and sustainable practices. • Strengthening disaster response capabilities and ensuring quick recovery and rehabilitation post-disaster.
Progress on policy, strategy and legislation	• The National Disaster Management Framework (NDMF) of 2005 is currently under review in South Africa. The Department of Cooperative Governance and Traditional Affairs (COGTA) initiated this process to update and enhance the framework in line with evolving disaster risk management needs.

Table 3.17: Summary of adaptation actions and progress on key policy, strategy and legislation per sector: coastal, marine, mining, transportation and energy.

Sector	Adaptation actions	Progress on policy, strategy, and legislation
Coastal	Risk assessments, coastal management lines, green infrastructure restoration, climate-resilient buildings, stormwater system upgrades, early warning systems, community education, and relocation of vulnerable infrastructure.	Climate Change Act (2024), Integrated Coastal Management Act (2008), NCCAS (2019), Coastal Adaptation Response Plan (draft 2024)
Marine	Monitoring fish populations, sustainable fishing, habitat protection, alternative livelihoods, and policy strengthening for fisheries.	Marine Spatial Planning Framework (2021), Operation Phakisa - Oceans Economy Initiative, Climate Change Bill
Mining	Water management, energy efficiency, infrastructure resilience, ecosystem management, research and innovation, and regulatory compliance.	Carbon Tax Act (2019), Climate Change Act, Integrated Resource Plan (IRP) updated in 2023
Transportation	Infrastructure improvements, climate-resilient road designs, stormwater system upgrades, green infrastructure, risk assessments, integrated planning, and public transport investments.	Green Transport Strategy (2018-2050), NATMAP 2050, National Land Transport Strategic Framework (2023-2028)
Energy	Diversifying energy sources, infrastructure resilience, decentralized energy systems, water recycling in power generation, research and development, and capacity building for climate-smart planning.	Integrated Resource Plan (IRP) 2010-2030, Just Energy Transition Implementation Plan (2023-2027), REIPPPP, South African Renewable Energy Master Plan (SAREM)

2.6.2 Provincial climate change responses

The NCCRP required each of South Africa's nine provinces to develop a climate change response strategy. These strategies reflect a province's climate risks and impacts and integrate NCCRP principles. The implementation of the Provincial Climate Change Support Programme resulted in the Development and Review of Climate Change Response Strategies for all nine (9) Provinces, establishment of Climate Change Fora, establishment and secondment of Climate Change units and officials for climate related functions as well as catalysing and funding project implementation (DFFE, 2024). Provincial climate-change-response policies and strategies are aligned with national policies and framed within the NCCRP and guided by the NDP. Because the NCCRP makes integrated planning a national priority, climate change considerations and responses are a part of all relevant provincial and local planning regimes. The NCCAS recognises that provincial and local governments would have different resources available to implement national priorities and recommends that the adaptation priorities should be interpreted within the spatial area of the relevant authority, with the minimum information as stipulated for sectors, being applied as appropriate. Strategic intervention 4 in the NCCAS is to 'Facilitate mainstreaming of adaptation responses into sectoral planning and implementation' with key outcomes for the intervention including:

- Provincial strategies and associated implementation plans should be reviewed and updated every five years.
- Integrate climate change adaptation into Provincial Growth and Development Strategies. This will involve each province ensuring that climate change projects and programmes are reflected in their strategic Provincial Growth and Development Strategies.

The Climate Change Act, 2024 mandates Provinces to undertake climate change needs and response assessments for the province and develop the associated implementation plan which its effective implementation should be coordinated through the Provincial Climate Change Forum in the form of annual reporting. In 2015, a Situational Analysis and Needs Assessment (SANAs) was undertaken to determine preparedness to implement the National Climate Change Response

Policy (NCCRP) Section 10.2.6. The identified needs and gaps, and recommendations of the 2015 SANAs informed the development of Provincial Climate Support Programme, and the implementation of which resulted in the development and review of Climate Change Response Strategies for all nine (9) Provinces, establishment of Climate Change Fora, establishment and secondment of Climate Change units and officials for climate change related functions as well as catalysing and funding project implementation. The SANA's has since garnered support from MinTech and MinMEc with a standing agenda item on continuous progress update (DFFE, 2024).

Through the Provincial Climate Support Programme, provinces and municipalities were supported to undertake climate change risk and vulnerability assessments and develop adaptation strategies. To date, all 9 South African Provinces (Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, the Northern Cape, Northwest, Northern, Eastern Cape and the Western Cape) have reviewed or are in the process of reviewing the provincial climate change strategies, and there have been efforts from the provinces to implement the adaptation options as prioritised in the strategies. Further to that, all provinces have established a reflective learning forums and committees which facilitates peer-to-peer learning and sharing of information on climate change adaptation amongst different stakeholders.

A prioritisation criterion was developed that sought to rank the sectors as per the priority needs. This informed further support through the development of Technical and Financial Project Proposals for all Provinces. The DFFE supported the review of five (5) Provincial Climate Change Adaptation Strategies to update the Risk and Vulnerability Assessment and compile a Green House Gas Inventory in the 2021/22 Financial year. Two more Provinces followed on with the review process bringing all nine (9) Provinces into alignment (Gauteng and Westen Cape Province included). The review process includes the sectoral polices and plans in place vulnerable to the impacts of climate change such as IDPs, Disasters Management Plans etc. to achieve a 100% coverage of climate change considerations in sectoral operational plans (DFFE, 2024).

Climate change interventions that are being implemented by provinces in all identified key sectors include (DFFE, 2024):

- Climate Change Response Strategies (Draft climate change education and awareness plan 2023/2024 developed / Developed and implemented Wildfire Management Framework (WFMF).
- Climate Change strategy exist for all provinces with Free State still in a process of reviewing and KwaZulu-Natal Climate Change Strategy and Implementation Plan adopted by the Executive on 04 October 2023.
- Partnerships with other institutions.
- Climate Change Champions at Provincial and District level.
- Climate change projects under implementation.
- Collaborations with Sector Departments on Implementation (Economic Cluster).
- Emissions Pathway Analysis, Adaptation Pathway for example in Western Cape
- Improvement of basic service challenges and issues within the local government, for instance waste collection and management.

3.6.3 Integration of gender perspectives and indigenous, traditional and local knowledge into adaptation

In South Africa, climate change has a differentiated impact across genders, with women often bearing a disproportionate burden due to societal roles, economic inequalities, and limited access to resources. While the country has a progressive legal and policy framework for gender equality, its climate change adaptation policies lack comprehensive gender mainstreaming. For example, higher unemployment rates, restricted economic participation, and high poverty rates among women exacerbate their vulnerability to climate change impacts. Additional factors, such as lower school attendance, limited access to land, and increased caregiving responsibilities, further hinder women's ability to adapt.

Women also face heightened risks of gender-based violence, reduced access to resources, and health impacts linked to their domestic roles during climate-related events. Addressing these challenges is crucial for South Africa to meet its commitments under the Paris Agreement and strengthen gender-responsive climate adaptation.

Acknowledging these inequities, gender-responsive approaches to climate change have become indispensable. Such approaches involve the systematic integration of gender perspectives into all stages of climate policy and program development. The goal is to ensure that climate actions do not perpetuate or intensify gender inequalities but rather promote gender equality and empower women. This requires the cultivation of conditions where both women and men can equally participate in and benefit from climate resilience initiatives.

3.6.3.1 Gender-climate change mainstreaming in South Africa

In South Africa, climate change has a differentiated impact across genders, with women often bearing a disproportionate burden due to societal roles, economic inequalities, and limited access to resources. While South Africa has a progressive legal and policy framework for gender equality, climate change adaptation policies still lack comprehensive gender mainstreaming. For instance, higher unemployment rates, limited economic participation, and high poverty rates among women increase their vulnerability to climate change impacts. Factors such as lower school attendance, limited access to land, and increased caregiving responsibilities further hinder women's adaptive capacity. Women also face heightened risks of gender-based violence, reduced resource access, and health impacts related to their domestic roles during climate-related events. Addressing these gendered challenges is essential for South Africa to align with the Paris Agreement and strengthen gender-responsive climate adaptation.

South Africa has taken significant steps to integrate gender considerations into climate adaptation through key strategies and policies. Gender Mainstreaming is a central approach, ensuring that both men and women benefit equally from adaptation efforts. This approach includes the National Strategy towards Gender Mainstreaming in the Environment Sector (2016-2021), which promotes gender-sensitive management in environmental policies (DFFE, 2016). The strategy aims to foster gender analysis and incorporate gender perspectives throughout project cycles, reinforcing equality in climate actions.

However, despite these efforts, gaps remain in the inclusivity of South Africa's gender mainstreaming approach. Existing policies often adopt a binary understanding of gender, primarily focusing on women while excluding the unique needs and contributions of LGBTQIA+ individuals. Recognising the differentiated impacts of climate change on all gender identities is essential to creating truly inclusive strategies. This includes addressing barriers faced by gender-diverse individuals, such as limited access to resources, increased vulnerability to violence, and systemic exclusion from adaptation programmes. To address these challenges, the DFFE has initiated training workshops on gender mainstreaming to train policymakers, local authorities, and community leaders on the importance of a broad gender perspective in climate policy. This helps to build understanding and commitment to gender-inclusive approaches to policies and intervention strategies.

The draft Gender Action Plan (GAP) (DFFE, 2022b), developed by the Department of Forestry, Fisheries and the Environment (DFFE), serves as a blueprint for integrating gender into climate change policies. Built on stakeholder consultations and the outcomes of the 2022 National Dialogue for Gender-Climate Mainstreaming, the GAP proposes six strategic actions:

1. Revise institutional arrangements for gender-climate mainstreaming.
2. Strengthen sectoral collaboration through the National Gender Machinery.
3. Enhance sectoral gender-climate policies.
4. Develop participatory Monitoring and Evaluation (M&E) frameworks for gender-climate mainstreaming.
5. Align funding streams to support gender-climate initiatives.
6. Launch gender awareness and capacity-building programs.

These actions aim to ensure inclusivity in adaptation, with a five-year rollout plan aligned with the Nationally Determined Contributions (NDCs) under the Paris Agreement.

The National Climate Change Adaptation Strategy (NCCAS) also prioritizes gender-responsive adaptation, recognizing that effective climate resilience requires gender equality. By mainstreaming gender considerations across sectors - such as agriculture, water, health, and human settlements - the NCCAS promotes a comprehensive approach to adaptation that accounts for gender-specific vulnerabilities and strengths. Each sector develops dedicated gender policies to address unique challenges, ensuring adaptation strategies are equitable and effective.

Capacity building is emphasized within the NCCAS, providing targeted training to equip government officials, community members, and stakeholders with skills for integrating gender into adaptation planning. Policy integration and coordination are key, with the NCCAS and GAP calling for revised policies that explicitly address gender issues. Gender-sensitive M&E frameworks with specific indicators and targets ensure that progress on gender equality is tracked and that strategies can be refined over time.

To support these efforts financially, the NCCAS advocates for funding that prioritizes gender equality in climate adaptation. Engaging both public and private sectors to create financial mechanisms dedicated to gender-sensitive projects ensures women's participation and empowerment in climate adaptation. The Capacity Building Initiative for Transparency (CBIT) further bolsters South Africa's institutional capacity to integrate gender into climate policies, providing training and resources to government officials and stakeholders to meet Paris Agreement transparency requirements.
South Africa's commitment to gender equality in climate adaptation reflects an understanding that resilient and inclusive adaptation is only possible when gender disparities are addressed, empowering women to actively participate and benefit from climate solutions.

3.6.4 Indigenous Knowledge Systems

South Africa recognizes the critical role of Indigenous Knowledge Systems (IKS) in climate adaptation, integrating local knowledge into national planning to enhance resilience. IKS, grounded in generations of observations and practices, offers valuable insights for localized adaptation (Smout, 2020).

3.6.4.1 Actions taken to integrate indigenous knowledge in climate adaptation

1. **Environmental understanding**: Indigenous communities have developed a deep understanding of environmental systems, using traditional knowledge to predict weather patterns and adapt agricultural practices. South Africa has begun documenting and incorporating these insights into formal adaptation strategies, supporting culturally relevant, localized adaptation (Smout, 2020).
2. **Sustainable resource management**: IKS emphasizes biodiversity conservation, soil health, and water management through methods like crop rotation and organic fertilization, which enhance resilience. South Africa is incorporating these practices into national agricultural policies, promoting sustainable resource management to reduce climate vulnerability (Modise et al., 2024).
3. **Adaptive practices**: Indigenous communities employ adaptive strategies, such as drought-resistant crops, flood-resistant structures, and rainwater harvesting. The National Climate Change Adaptation Strategy (NCCAS) supports the integration of these practices to strengthen local resilience (DEA, 2019).
4. **Knowledge transmission and cultural preservation**: Indigenous knowledge is shared through cultural practices, which South Africa is working to preserve and document. This approach supports adaptation efforts while ensuring the transfer of critical environmental knowledge to future generations (Smout, 2020).

5. **Policy integration**: Despite challenges, such as marginalization, South Africa has established inclusive platforms like the DFFE's Community-Based Adaptation Initiatives to incorporate indigenous voices in adaptation policy and decision-making (Modise et al., 2024).
6. **Mechanisms for integration**: The NCCAS prioritizes creating frameworks to integrate IKS with scientific and policy efforts, enabling indigenous communities to actively participate in adaptation planning (DEA, 2019).

3.6.4.2 Challenges and future actions

While progress has been made, challenges remain in policy mechanisms and recognition of IKS. South Africa aims to address these by refining policies, training officials on IKS, and securing funding for indigenous-led projects to build a multi-knowledge framework that enhances climate resilience (Smout, 2020; Modise et al., 2024; DEA, 2019).

3.7 PROGRESS ON IMPLEMENTATION OF ADAPTATION ON SELECTED PROJECTS IN SA

3.7.1 The National Government Programme of Work

3.7.1.1 DFFE Adaptive Capacity Facility (DFFE-ACF)

The Government of Flanders and the Government of South Africa have had a long-standing relationship, which has evolved based on international developments, cooperation, and past experiences. The Country Strategy Paper (CSP) III has been developed through a joint consultation process between the two governments and is being implemented from 2017 to 2021, with a focus on climate change adaptation and the green economy. The primary objective of the CSP III is to address the triple challenge of inequality, poverty, and unemployment. Over five years, 25 million Euros have been invested as part of the CSP III, to tackle the lack of effective climate change implementation at the local level in South Africa. The DFFE has partnered with the Government of Flanders to develop the DFFE Adaptive Capacity Facility (DFFE-ACF or ACF) under the CSP III (2017-2021). The DFFE Adaptive Capacity Facility is a project funded by the Adaptation Fund to help vulnerable communities in South Africa cope with the impacts of climate change (DFFE, 2023). It aims to build climate resilience and adaptive capacity, integrate climate change adaptation into development objectives, improve understanding of climate change impacts and responses, and ensure resources and systems for implementation.

Projects funded by the Government of Flanders in South Africa include (DFFE, 2023):

- Reaping the potential of entrepreneurship for a climate-smart inclusive green economy in South Africa
- Keep it Cool Climate Change Education
- Building resilience and reducing vulnerability of smallholder farmers by focusing on mango farming enterprises, water and ecosystem-based services to reduce the negative impacts of climate change
- Communal Agricultural Transformation (CAT) – Empowering people Restoring Land
- Enabling community-based adaptation in the Mkhuze River Ecosystem, KZN
- Micro-aquaponics Lappies – Proof of concept of community embedding
- Towards an inclusive green economy: Showcasing sustainable land use management projects in the Kruger to Canyons Biosphere Region
- Building climate resilience of coastal communities, ecosystems and small-scale fishers through implementing community and ecosystem-based adaptation activities and diversifying livelihoods
- Increasing Resilience and Reducing Vulnerabilities of Local Communities to the Effects of Climate Change: Promoting Ecosystem Based Adaptation in South Africa
- DEFF Adaptive Capacity Facility: implementing 3 Climate Change Adaptation projects in District Municipalities
- Unlocking Climate Finance for Climate Change Adaptation
- Addressing Climate Risk and Building Adaptive Capacity in South Africa's Biosphere Reserves: Towards Sustainable Water and Ecosystem Management

- An Integrated Climate-driven Multi-Hazard Early Warning System (ICMHEWS)
- Adaptive response and local scale adaptation for improving water security and increasing resilience to climate change in selected municipalities of South Africa.

3.7.1.2 Cities Resilience Programme led by the National Treasury and DFFE

The overarching objective of the National Treasury Cities Support Programme (NTCSP) under which the Cities Resilient Programme is run is to improve inclusive economic growth in cities in response to pressing development challenges. It is a multi-year demand-driven umbrella programme which will contribute to the creation of productive, well-governed, inclusive, and sustainable cities. The direct beneficiaries of the CSP support are South African national departments, provincial departments, and metro stakeholders. The indirect beneficiaries are the citizens of the eight metros, namely, citizens of eThekwini, Buffalo City, City of Johannesburg, City of Tshwane, Nelson Mandela Bay, Ekurhuleni, City of Cape Town, and Mangaung. The CSP delivers support through six components, including:

(1) governance,
(2) fiscal and financial,
(3) climate & sustainability,
(4) public transport,
(5) human settlements, and)
(6) economic development.

These projects are intended to reduce the community's vulnerability to climate variability resulting from weather shocks and reduce vulnerability to climate risks in urban areas. Examples include:

- Improved disaster management - Cape Town: Flood Management Programme
- Climate resilient planning - Ekurhuleni: Kaalspruit Wetlands Rehabilitation, Tshwane: Hennops River Rehabilitation
- Climate resilient capital investments - Mangaung: Bloemspruit Airport Node Resilient Development
- Water resilience - Cape Town: Liveable Urban Waterway Programme
- Solid waste transitions - eThekwini: Shongweni Integrated Waste Management Facility
- Sustainable municipal energy - Buffalo City: Energy Storage Facilities, Johannesburg: Land Rehabilitation and Renewable Energy

In addition, priorities are also given to the coastal cities, through the following adaptation options:

- Green Infrastructure – to improve the effective capturing and filtering of rain and stormwater.
- Bioswales: to be used as an alternative to concrete gutters and storm sewers. Bioswales use vegetated low-lying areas lined with plant materials and specialised soil mixes to treat, absorb, and convey stormwater runoff. Bioswales also have the potential to create habitats for birds, butterflies, and local wildlife as well as reduce the risk of curd flooding.
- Early Warning Systems: Education and training on what should be done once a warning is issued.
- Wetlands encroachment: Strict enforcement of wetland encroachment, and comprehensive education and awareness of the risk's inhabitants face in the area.
- Rain Gardens - Shallow, densely vegetated ground depressions, with a variety of trees, shrubs, and grasses to facilitate ground infiltration and cleaning of stormwater. Areas can also be used as recreational areas for citizens.
- Stormwater Harvesting: These are shallow, densely vegetated ground depressions, with a variety of trees, shrubs and grasses used to increase the capacity of sewer and stormwater systems, reduce the damage from pluvial floods and improve water security.
- Reduce Heat Trapping: Cool roofs reflect heat energy, reducing the heat-trapping effect in urban areas. Cool or Green Pavements (Permeable pavements) allow for the infiltration of water into the ground, reducing runoff.
- Rainwater Harvesting: to reduce surface runoff.

3.7.1.3 The South African National Biodiversity Institute (SANBI) Programme of Work

a. Community-Based Adaptation Small Grants Facility

The 'Taking Adaptation to the Ground: A Small Grants Facility for Enabling Local Level Responses to Climate Change' project, funded by the Adaptation Fund, was implemented in the Namakwa and Mopani district municipalities (SANBI, 2022). The overall objective of the Small Grants Facility project was to ensure that vulnerable, rural communities in the project target areas have increased resilience to the expected impacts of climate variability and change through the integration of climate adaptation response strategies into local practices (SANBI, 2022). The project also piloted and developed an understanding of small grant mechanism development and implementation in the context of climate finance, to scale up and replicate this model.

Through the executing entity, the project contracted 12 small grant recipients to implement small grant projects that built the climate resilience of vulnerable community members against the impacts of climate change. The projects directly benefited nearly 2 000 community members who live in areas vulnerable to the effects of climate change, which greatly exceeds the targeted number of direct beneficiaries (the original target was 600 direct beneficiaries). (SANBI, 2022). Under the guidance of the facilitating agencies for each target district, Conservation South Africa in the Namakwa district and CHoiCe Trust in the Mopani District, the project supported the small grant recipients in the implementation of their approved projects. The project objectives included capacity building premised on needs identified throughout the project (SANBI, 2022). In its final year, ending December 2021, SANBI consolidated the lessons learned through the project through the development of a set of communication products that included the finalisation of a set of eight case studies, a policy brief and the development of a blueprint for scaling up locally led adaptation in South Africa and beyond (SANBI, 2022).

3.7.1.3.1 uMngeni Resilience Project (Ecosystem Based Adaptation and Early Warning)

In its capacity as South Africa's National Implementing Entity of the Adaptation Fund, SANBI has continued to oversee the implementation of the USD 7.5 million Building Resilience in the Greater uMngeni Catchment Project. The 'Building Resilience in the Greater uMngeni Catchment' project is being implemented by the uMgungundlovu District Municipality in collaboration with the University of KwaZulu-Natal (SANBI, 2022). During 2022/2023, the project entered its final stages of implementation (SANBI, 2023). The overall objective of the project is to reduce the vulnerability of communities and small-scale farmers in the District Municipality to the adverse impacts of climate change. This is to be accomplished through implementing a suite of corresponding gender-sensitive project interventions, focusing on:

- Early warning systems
- Ecological and community infrastructure strengthening
- Small-scale climate-resilient agriculture.
- Knowledge management (SANBI, 2022).

Through the Early Warning System component, which is led by UKZN in partnership with the South African Weather Service and KZN-Cooperative Governance and Traditional Affairs, several individual Early Warning Systems have been developed. These include the Flood, Fire, Agrometeorological, Rangeland and Lightning Early Warnings Systems. These will increase the resilience of the ~100,000 community members in the catchment areas covered by the systems. This far exceeds the high-level target of the project, which is that 25,000 vulnerable community members are more resilient to the impacts of climate change because of the uMngeni Resilience Project. The DFFE and SAWS have developed a project that will scale up this work with support from the Government of Flanders.

Under the Built Environment component, over 250 rural homesteads were strengthened to better withstand the impacts of climate change, five pedestrian bridges were built, and 2 km of stormwater drains were constructed to better withstand the impacts of floods that are occurring more frequently and intensely than previously. Due to various challenges, the target for houses and stormwater drains was not fully met.

Through the Ecological Infrastructure work over 200 ha of degraded grassland has been restored and is under improved rangeland management practices. The identified wetlands were rehabilitated, with successful removal of over 2,500 ha of alien invasive vegetation from the project target areas (compared to the intended target of 150 ha). Additionally, more than 100 km of firebreaks were established.

Through the Knowledge Management and Capacity Building part of the project, over 1,300 community members have been trained through various climate change-related training courses, including accredited courses. This has resulted in over 65 National Qualifications Framework (NQF) certificates being awarded to project beneficiaries. Climate change awareness raising has been done through community and school engagement programmes, and several reflection workshops were held. A set of brochures on the different components and learnings emanating from the project and a set of policy briefs and recommendations were developed and will be widely shared. A highly successful uMngeni Resilience Project Climate Change Indaba was held, attended by representatives of communities, civil society organisations, government officials and academics from various institutions across the country. The Indaba provided an opportunity to visit the project implementation sites, reflect on the achievements of this national flagship adaptation project, share perspectives from the project and related initiatives, and discuss policy recommendations to facilitate scaling solutions.

3.7.1.3.2 Green Climate Fund Readiness Support

SANBI closed out its USD 380 000 Readiness Support Grant from the GCF The grant was used to develop a set of processes and tools to facilitate improved management of SANBI's anticipated GCF portfolio of projects, to develop initial concept note proposals for submission to the GCF, and to engage the private sector towards developing a programme of work for private sector involvement adaptation projects in South Africa (SANBI, 2022).

Unlocking Climate Finance for Climate Change Adaptation

SANBI has received core support from the Government of Flanders to develop a funded portfolio of GCF projects. The EUR 2 646 832 (approximately R48 million) project, approved in 2020, runs until November 2024 (SANBI, 2022).
This project aims to deliver:

- At least four full funding proposals (with values of at least USD 10 million in GCF investments each) being submitted to and being supported by the GCF
- Residual capacity to lead this work being built within SANBI and other South African institutions.
- The mobilisation of a science-based technical support network.
- A series of knowledge products that track this investment and contribute to a narrative that makes the case for sustained institutional investments in developing countries' direct access entities.

SANBI will also show how investments in climate change adaptation are supporting the Just Transition to a climate-resilient society. The Government of Flanders's support is proving to be critical in improving South Africa's ability to reinforce the institutional and policy environment for climate change adaptation and will also contribute to reducing the vulnerability of target communities to the adverse impacts of climate change. Progress in the GCF project pipeline has resulted in one project under full proposal development, a second project's concept note which was endorsed by the GCF, and a third project concept note. This was possible with support from the Government of Flanders (SANBI, 2022).

3.8 MONITORING AND EVALUATION OF ADAPTATION ACTIONS AND PROCESSES

3.8.1 Approaches and systems for monitoring and evaluation adaptation actions

South Africa's approach to Monitoring and Evaluation (M&E) of climate change adaptation initiatives, projects, and programs emphasizes accountability, continuous learning, and evidence-based policy adjustments to enhance resilience and achieve national adaptation goals. M&E of climate change adaptation in South Africa is comprehensive, involving multiple spheres of government, research institutions, and public engagement. This strategy is supported by a robust legislative framework, including the National Climate Change Act, signed into law in July 2024, the National Climate Change Response Policy (NCCRP) of 2011, and the National Climate Change Adaptation Strategy (NCCAS) of 2019.
Key components of South Africa's M&E approach:

1. **Multi-level M&E:** Provincial governments and municipalities develop localized adaptation plans aligned with national strategies. Community-based monitoring engages local communities to ensure adaptation actions are inclusive and responsive.
2. **Results-based framework:** A results-based M&E system tracks progress toward set adaptation goals, using baseline and target metrics to evaluate resilience outcomes. Indicators are sector-specific and tailored to local contexts, enhancing relevance.
3. **Collaboration and research support:** Partnerships with research institutions and international organizations provide access to robust data and methodologies, supporting scientific rigor in M&E.
4. **Gender-responsive indicators:** Gender-sensitive metrics are included to address the unique vulnerabilities of women and marginalized groups, supported by the draft Gender Action Plan (GAP).
5. **Data collection and public involvement:** Regular data collection, along with consultations with stakeholders such as civil society, private sector, and communities, ensures adaptation strategies reflect local needs and enhance accountability.
6. **Learning and adaptive management:** Feedback loops and adaptive management allow for continuous policy refinement based on evaluation insights.

Aligned with the Paris Agreement and Sustainable Development Goals (SDGs), South Africa's M&E framework aims to build a resilient, inclusive society through an adaptive, participatory, and results-driven approach.

3.8.1.1 The National Climate Change Response Monitoring and Evaluation Framework

South Africa's National Climate Change Monitoring and Evaluation (M&E) System Framework (NCCMR&E Framework) is a critical tool for tracking the country's progress in adapting to the impacts of climate change. The framework provides a systematic approach to monitor and evaluate South Africa's adaptation efforts, helping to ensure strategies are effective, responsive, and aligned with national adaptation priorities.

By specifically tracking adaptation progress, the framework supports informed decision-making, enhances policy effectiveness, and promotes accountability and transparency in addressing climate vulnerabilities. The National Climate Change M&E System is designed to monitor the implementation of the National Climate Change Response Policy (NCCRP) and the National Climate Change Adaptation Strategy (NCCAS), as well as other key plans and programs focused on resilience-building.

Anchored in the NCCRP and aligned with the National Development Plan (NDP), the framework utilizes a range of adaptation indicators across sectors like agriculture, water, health, and infrastructure. These indicators measure the impact of adaptation measures, allowing South Africa to assess progress in building resilience across vulnerable sectors.

The primary objectives of the framework include:

- **Monitoring adaptation actions**: Tracking adaptation measures and assessing their effectiveness in reducing vulnerability and building resilience.
- **Informing policy and strategy**: Using data from adaptation tracking to support evidence-based policymaking and strategic planning.
- **Ensuring accountability and transparency**: Enabling transparency in adaptation progress to foster trust and maintain commitment to national climate goals.
- **Facilitating international reporting**: Supporting South Africa's reporting to international bodies, such as the UNFCCC, by documenting adaptation progress and impact.

3.8.1.2 National Climate Change Information System (NCCIS)

The NCCIS (also referred to as the National Monitoring and Evaluation (M&E) system), was launched in August 2019 (see the NCCIS components in Figure 3.10). It is a web-based platform that provides access to information required for monitoring and evaluating the country's progress in accomplishing global goals, commitments, and targets, such as the National Development Plan (NDP) and Nationally Determined Contributions (NDCs). In addition, the NCCIS assesses climate change drivers, events, and their relationship with national objectives, targets, and strategies for climate change adaptation and mitigation. NCCIS is part of the national effort to monitor South Africa's transition by providing decision-support tools that inform policy and decision-making (DEA, 2020). It assesses the actions taken by stakeholders in this regard (DEA, 2020). NCCIS offers a range of decision support tools for policy and national decision-makers, including parliament and cabinet. Through the M&E system, South Africa's position is presented in various negotiation forums, such as the UNFCCC Conference of Parties (DFFE, 2022).

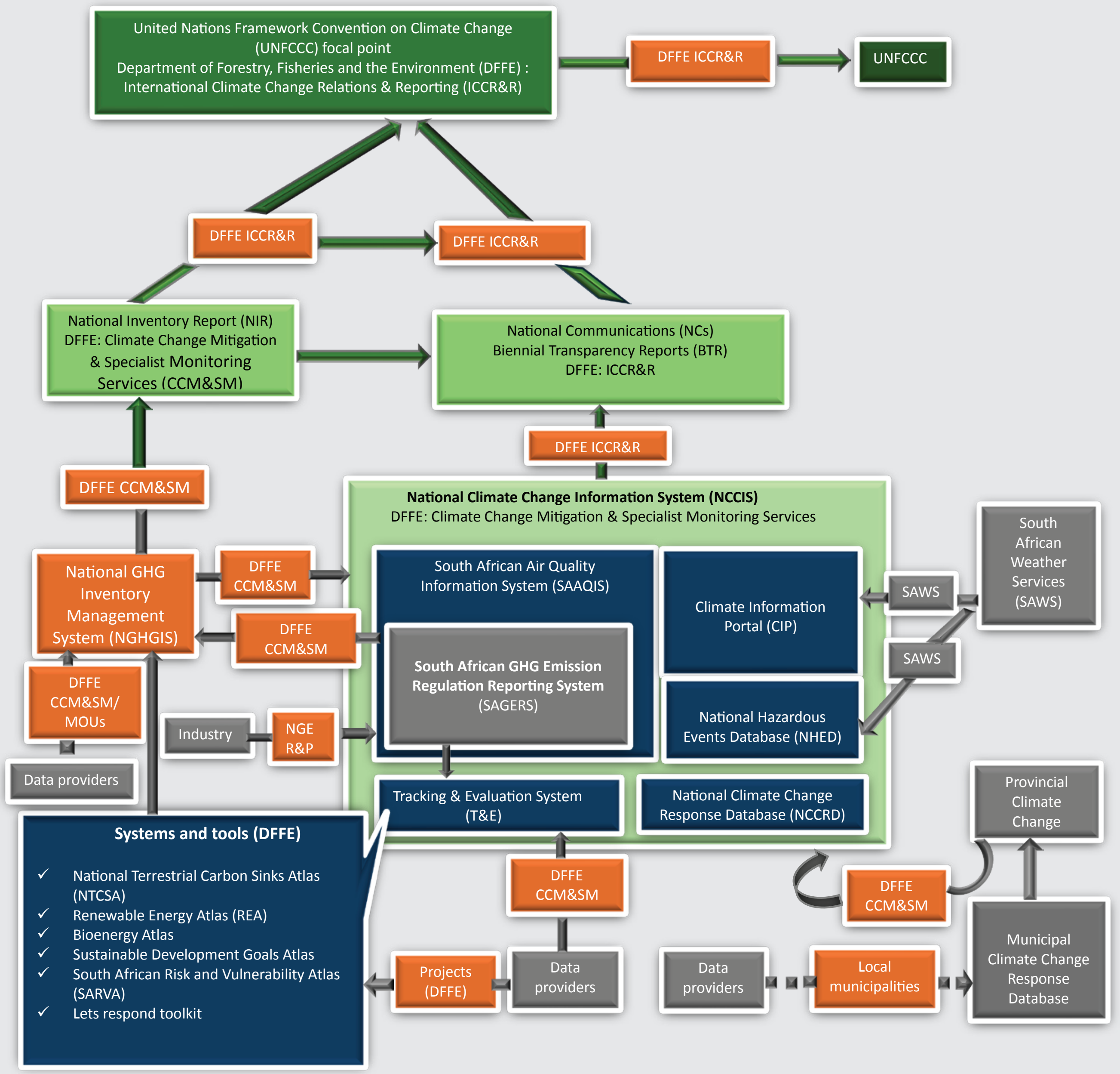


Figure 3.10 Structure of the National Climate Change Information System (NCCIS)

The NCCIS (Table 3.10) is South Africa's central platform for tracking climate adaptation and resilience efforts, providing essential data for evidence-based decision-making and strategic planning. Key components include:

- **National climate change response database (NCCRD):** The NCCRD is the core data repository within the NCCIS that consolidates information on climate change mitigation and adaptation activities across various sectors, including agriculture, biodiversity, water, health, and transportation. The database captures details about the nature, scope, and impact of different projects, ensuring that all climate actions in South Africa are documented and easily accessible. The database is designed to promote transparency by allowing stakeholders, including the public, researchers, and international partners, to access information about climate projects. This open-access model enhances accountability, making it easier for various stakeholders to monitor the government's progress in addressing climate change.

- **Climate information portal:** The portal provides climate projections, historical data, and risk assessments, aiding in adaptation planning. Accessible visual tools, including maps and graphs, simplify climate data, making it usable for various stakeholders.
- **Tracking and evaluation system:** This system uses tools like the South African Risk and Vulnerability Atlas and Let's Respond Toolkit to track and evaluate adaptation initiatives.
- **National Desired Adaptation Outcomes (NDAOs):** The NDAOs offer an M&E framework aligned with the National Climate Change Adaptation Strategy (NCCAS), with indicators that measure resilience, vulnerability, and adaptation effectiveness across sectors.
- **Advanced analytical tools:** Integrating GIS, remote sensing, and data analytics, the NCCIS enables precise climate risk mapping and impact analysis to determine the most effective adaptation strategies.

The NCCIS aggregates data from government agencies, research institutions, and international sources to provide a comprehensive national view of adaptation efforts. Adaptation indicators track progress, identifying trends and needs for continuous policy improvements. By involving diverse stakeholders, including government, NGOs, and local communities, the NCCIS fosters accountability and ensures inclusivity in adaptation efforts. The platform also offers training, best practices, and case studies to support adaptation capacity and knowledge-sharing across sectors.

In summary, the NCCIS is a cornerstone of South Africa's adaptation monitoring framework, with the NCCRD at its core, documenting all climate actions and providing stakeholders with essential information on adaptation progress. Together, these tools enable a comprehensive, transparent, and adaptive approach to building a climate-resilient South Africa.

3.8.1.3 Improvements and expansion of the NCCIS

The NCCIS institutional arrangements have been designed to facilitate national sector departments and provinces' ownership and buy-in. This involves creating subsystems that are specific to each sector and province, which are then integrated into the NCCIS. The first provincial M&E and climate information system was piloted in Mpumalanga province in 2021, while the Gauteng Province as well as the Free State Provincial Climate Information Systems are under development. These provincial sub-systems are customized to address the climate change needs of the province and include downscaled climate, risk and vulnerability information, and provincial decision-support tools for facilitating local-scale monitoring and reporting. The provincial governments of KwaZulu-Natal, Eastern Cape, and Northern Cape are also engaged in enhancing their coverage and involvement. As part of the development of the provincial sub-systems, DFFE in collaboration with SAEON is committed to improving the overall functional and technical capabilities as well as the interface aesthetics of the National Climate Change Information System.

3.8.2 Impacts and achievements of monitoring and evaluation of climate change adaptation in South Africa

South Africa has made considerable strides in the monitoring and evaluation (M&E) of climate change adaptation projects and programs over the years. Some key areas of progress include:

1. **Policy frameworks:** South Africa has developed comprehensive policies, such as the National Climate Change Adaptation Strategy (NCCAS) and the National Development Plan (NDP), emphasizing the importance of monitoring and evaluation (M&E) for assessing adaptation initiatives.
2. **Institutional arrangements:** The establishment of dedicated departments within the Department of Forestry, Fisheries and the Environment (DFFE), like the Directorate: Climate Change Monitoring and Evaluation, has strengthened governance and management of M&E processes for climate adaptation.
3. **Capacity building:** Increased capacity-building initiatives, including training programs and workshops, have enhanced the skills of stakeholders, such as local governments and NGOs, in effectively monitoring and evaluating adaptation efforts.

4. **Data collection and management:** Improvements in data collection methods, utilizing technology like remote sensing and GIS, have enhanced the ability to gather and analyze data related to climate change impacts and adaptation measures.
5. **Stakeholder engagement:** There is a growing emphasis on involving various stakeholders, including communities, in the M&E process to ensure local knowledge and experiences inform the evaluation of adaptation projects.

3.8.3 Approaches and systems used, and their outputs

The Climate Change Monitoring and Evaluation Framework, developed by the Department of Forestry, Fisheries and the Environment (DFFE), plays a crucial role in guiding the M&E processes. This framework emphasizes the importance of data collection on climate impacts, adaptation measures, and stakeholder engagement, ensuring that the adaptation efforts are both effective and aligned with national priorities.

Key systems that support these M&E efforts include the National Climate Change Information System (NCCIS) and the National Climate Change Response Database. The NCCIS serves as a centralized platform for gathering and disseminating climate-related data, facilitating informed decision-making and policy development. Meanwhile, the National Climate Change Response Database tracks the progress of adaptation initiatives and provides insights into their outcomes. Outputs from these M&E processes include detailed reports that evaluate the effectiveness of adaptation projects, highlight best practices, and inform necessary policy adjustments. Ultimately, these efforts contribute to enhancing the resilience of communities and ecosystems in South Africa against the impacts of climate change.

3.8.4 Assessment of and indicators for:

3.8.4.1 Effectiveness of adaptation and how it increased resilience and reduced impacts

In South Africa, the effectiveness of adaptation projects, programs, and initiatives in enhancing resilience and reducing impacts is evaluated using a range of indicators and frameworks. These include environmental, social, and economic assessments, as well as climate resilience indicators, adaptation tracking tools, and learning and feedback mechanisms. Some examples of climate change adaptation initiatives that have been assessed to indicate increased resilience and reduced impacts include:

1. **Integrated catchment management (ICM):** The Working for Water program, which manages invasive alien plant species, has shown improvements in water availability and ecosystem health, enhancing resilience in water-scarce regions.
2. **Sustainable agriculture initiatives:** Monitoring conservation agriculture practices indicated improved soil quality, increased productivity, and greater sustainability, contributing to farmers' resilience against climate change.
3. **Disaster risk reduction:** Through the Initiative for Climate Action Transparency (ICAT), a multi-stakeholder partnership aimed at enhancing transparency and monitoring of climate actions, the CSIR developed an M&E framework for disaster risk reduction efforts. This included developing M&E tools, identifying key indicators, and building the capacity of essential stakeholders. As a result, a Multi-hazard Early Warning System (MH-EWS) M&E Framework was developed for South Africa.
4. **Water resource management:** Monitoring water use and educational initiatives has led to more sustainable consumption, increased water availability, and improved water security.
5. **Biodiversity conservation projects:** Assessments of protected areas in the Cape Floristic Region show that these initiatives support species adaptation and maintain biodiversity, contributing to ecological resilience.

It is, however, difficult to attribute improved resilience to climate change directly to a specific adaptation action or strategy due to the complexity of climate change impacts, multiple interventions, time lags, data limitations, and context-specificity. However, it is crucial to continue monitoring and evaluating adaptation action performance and impact on resilience in South Africa to strengthen the evidence base and improve understanding of their role in enhancing climate change resilience.

3.8.4.2 When adaptation is not sufficient to avert Impacts

Adaptation alone may not always be sufficient to avert the impacts of climate change in South Africa, particularly when faced with extreme climate events or tipping points where systems reach thresholds beyond which they can no longer maintain functionality. For example, prolonged droughts in regions such as the Western Cape have pushed water resources to critical limits, affecting agriculture, drinking water supplies, and broader economic activities. In cases of sea-level rise along vulnerable coastlines, adaptive measures like coastal defenses may only offer short-term solutions, especially for informal settlements or densely populated urban areas. As these events become more frequent or intense, adaptation may only delay, not prevent, significant impacts on communities and ecosystems.

Measuring when adaptation is insufficient to prevent climate impacts is challenging for South Africa due to the complex interplay of environmental, socio-economic, and infrastructural factors that influence vulnerability. Limited data, particularly in rural and informal settlements, hinders comprehensive tracking and analysis of adaptation outcomes. Additionally, socioeconomic inequalities mean that while some areas may effectively implement adaptive actions, others lack the resources or infrastructure, making it difficult to measure national progress consistently. Furthermore, climate impacts can manifest gradually, so determining the precise point at which adaptation fails often requires localized data and long-term monitoring frameworks.

3.8.5 Implementation focus areas: Transparency, targeted support, development synergies, and best practice

South Africa has made strides in climate change adaptation across planning, transparency, support for vulnerable communities, and alignment with broader development goals, though challenges remain in each area.

3.8.5.1 Transparency of planning and implementation

South Africa's climate adaptation planning emphasizes transparency, evident in the creation of the National Climate Change Response Monitoring and Evaluation System. This system allows for systematic tracking and reporting of adaptation progress, offering publicly accessible information on sector-specific indicators and outcomes. However, while transparency at the national level is robust, there are gaps in local-level reporting and data-sharing, often due to limited resources and capacity in municipalities.

3.8.5.2 Addressing specific vulnerabilities and adaptation needs through support programs

South Africa's adaptation programs are designed to address the specific vulnerabilities of its communities and ecosystems by providing targeted financial, technical, and capacity-building support, all aligned with national development priorities. Financial support from sources like the Adaptation Fund and Green Climate Fund helps implement critical measures such as climate-resilient infrastructure and ecosystem-based adaptation. Technical support is strengthened by initiatives like the "Let's Respond Toolkit," which developed tailored climate adaptation plans for each district municipality, guiding local governments in creating locally relevant, evidence-based strategies. Capacity-building initiatives enhance the skills of communities, officials, and stakeholders through training and educational resources, fostering a culture of resilience. All adaptation efforts align with South Africa's National Development Plan and National Climate Change Adaptation Strategy to ensure these programs contribute directly to broader goals of poverty reduction, food security, and sustainable growth, ultimately bolstering resilience against climate change impacts across the nation.

3.8.6 Good practices and lessons learned from monitoring and evaluation of climate change adaptation in South Africa

Monitoring and evaluation (M&E) of climate change adaptation in South Africa is essential for enhancing adaptation effectiveness and ensuring that policies respond to climate risks. By embedding M&E within national frameworks like the National Climate Change Response Policy (NCCRP) and the National Climate Change Adaptation Strategy (NCCAS), South Africa has established continuous assessment and feedback processes that enable systematic tracking and policy refinement. Sector-specific M&E systems, focusing on areas like water, agriculture, and biodiversity, allow for tailored, data-driven evaluations of adaptation efforts. Additionally, the involvement of diverse stakeholders, from government to local communities, ensures comprehensive assessments that incorporate local insights and foster community ownership. Key tools like the National Climate Change Information System (NCCIS) and the National Climate Change Response Database (NCCRD) further support evidence-based adaptation by facilitating data collection and analysis.

Lessons learned from this approach include the benefits of sector-specific M&E, the importance of localized strategies, and the effectiveness of early warning systems, though challenges persist in addressing data gaps, enhancing capacity, and coordinating efforts across sectors and government levels. South Africa's M&E experience underscores the importance of sufficient funding, technical expertise, and institutional capacity, especially at municipal and community levels, to support adaptation efforts.

3.8.7 Effectiveness and sustainability of adaptation actions

In South Africa, adaptation actions emphasize ownership, stakeholder engagement, alignment with policies, and replicability to ensure effectiveness and sustainability. Broad involvement from research institutions, communities, government, NGOs, and private sectors in adaptation initiatives fosters local ownership, while national frameworks like the National Climate Change Adaptation Strategy (NCCAS) align actions with national and subnational policies, supporting locally tailored solutions. Successful projects, such as the "Let's Respond Toolkit" for district-level planning, demonstrate the potential for replicability across regions facing similar climate challenges.

Adaptation actions have shown positive results, especially in enhancing water security, agriculture, and disaster preparedness, with initiatives like early warning systems and ecosystem restoration programs proving effective. However, the sustainability of these outcomes depends on consistent funding, capacity building, and institutional support, particularly at the local level, where resources are often limited. Monitoring and evaluation frameworks help ensure adaptation measures remain responsive to emerging climate risks, though continued investment is essential to maintain long-term resilience across vulnerable communities.

3.9 INFORMATION RELATED TO AVERTING, MINIMIZING AND ADDRESSING LOSS AND DAMAGE ASSOCIATED WITH CLIMATE CHANGE IMPACTS

3.9.1 Observed and potential climate change impacts from extreme weather and slow onset events in South Africa

Climate change impacts and associated disasters pose significant economic, social, and environmental costs to South Africa. The country's vulnerability to climate change stems from its diverse geography, exposure to extreme weather events, and socio-economic challenges. The costs of climate change impacts and disasters in South Africa manifest across various sectors, including agriculture, water resources, infrastructure, health, and biodiversity. South climate related disasters and associated economic impacts that have occurred during 2021 and 2022 in South Africa.

Floods are the most frequent and widespread climate disaster, while droughts, veldfires, storms and heatwaves are the other significant extreme weather types contributing to loss and damage in South Africa (Figure 3.11).

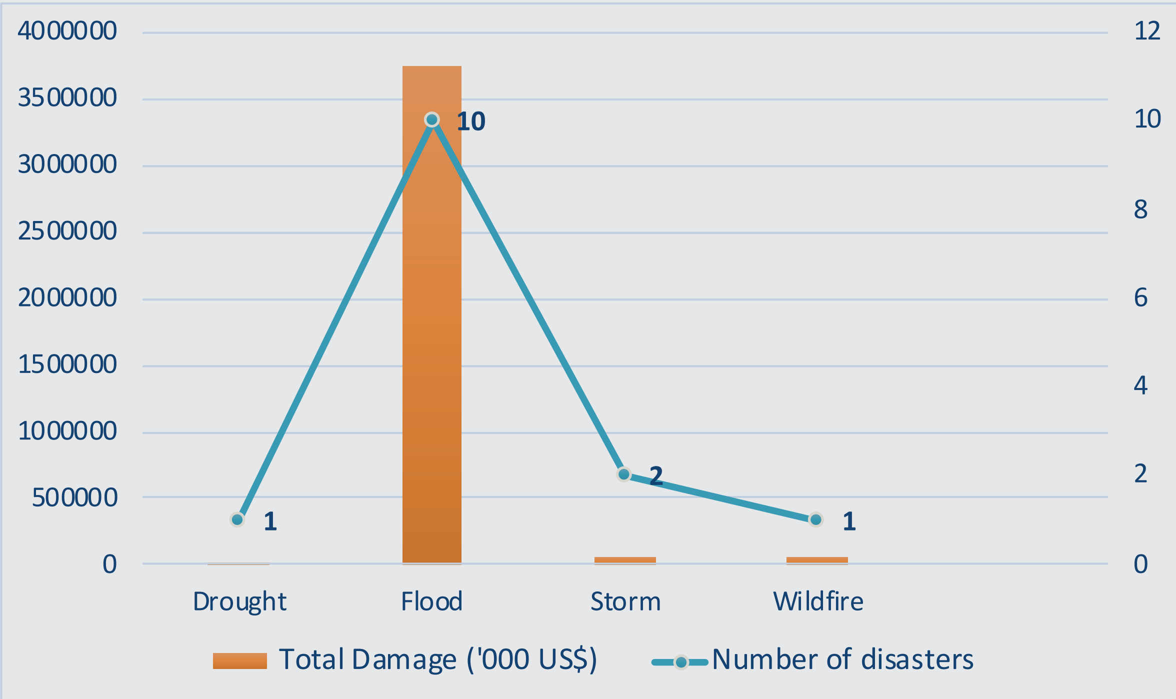


Figure 3.11. Number of declared climate related disasters and associated economic damage for the period 2021-2022 over South Africa (EM-DAT, 2024).

South Africa has experienced more frequent and intense floods, particularly along the eastern coast. In April 2022, Durban, Kwa-Zulu Natal, experienced devastating floods that caused widespread destruction and loss of life. Rainfall more than 350 mm over two days caused flash floods and mudslides, with flood water flowing through streets and settlements. At least 435 people lost their lives, and more than 40,000 people in total were affected by the floods and landslides. The cost of infrastructure and business losses amounted to an estimated US$2 billion (Grab and Nash, 2023).

During 2021/2022 the Eastern Cape province endured severe drought conditions, leading to water shortages that affected agriculture and daily life. The prolonged dry spell prompted the government to declare a state of disaster in the region. Heat waves are also becoming more frequent and intense. The South African Weather Service reported recordbreaking temperatures in some regions during over the past few years. In January 2023, a severe heatwave affected regions like Gauteng and KwaZulu-Natal, with temperatures soaring up to 39 °C. This extreme heat posed serious health risks, especially for vulnerable groups such as infants, the elderly, and outdoor workers (SAWS). During November 2023, temperatures reached unprecedented highs, with Augrabies Falls recording 46.7 °C on November 27. This marked one of the highest temperatures recorded in the Southern Hemisphere for that month (SAWS).

Using published peer-reviewed methods, scientists from various countries collaborated to assess to what extent climate change contributed to the flooding in Kwa-Zulu Natal (Pinto et al., 2022). They found that climate change approximately doubled the probability of such extreme rainfall events, and they estimated that the intensity of the rainfall event was increased by 4-8% due to climate change. The report highlights that heavy rainfall events are projected to increase in frequency and magnitude in the future with additional global warming.

A climate change attribution study done by Liu et al (2023) on the 2021 wildfire in Cape Town that caused an estimated R1-billion in damages to the University of Cape Town alone found that climate change played a role and has significantly increased the chances of such devastating fires occurring in Cape Town. According to the study, CMIP6 models suggest that the extreme fire weather associated with the April 2021 Cape Town wildfire has become 90% more likely in a warmer world.

These mentioned extreme weather events that were attributed to human induced climate change clearly illustrates the vulnerability of South African society and economy to global warming. Assessing loss and damage from severe climate events serves as a critical tool for understanding the true costs of climate change, informing effective responses, and promoting equitable solutions.

3.9.2 Activities related to averting, minimizing and addressing loss and damage associated with the adverse effects of climate change

South Africa is implementing a variety of strategies to avert, minimize, and address loss and damage from climate change, including policy frameworks, disaster risk reduction initiatives, ecosystem restoration, infrastructure development, and international collaboration.

Policy frameworks: The National Climate Change Adaptation Strategy (NCCAS) provides a national approach to building climate resilience across sectors, with specific actions to reduce vulnerabilities to climate impacts.

Disaster risk reduction: South Africa's National Disaster Management Centre (NDMC) plays a pivotal role in reducing loss and damage from climate change by coordinating disaster risk reduction (DRR) initiatives at national, provincial, and local levels. The NDMC leads efforts to strengthen preparedness, response, and resilience across the country, with a focus on early warning systems, risk assessments, and community-based disaster management. The NDMC also supports comprehensive risk assessments to identify the most climate-vulnerable areas and populations, which informs targeted DRR strategies and resource allocation.

Ecosystem restoration and conservation: Projects under the Expanded Public Works Programme (EPWP) focus on restoring degraded ecosystems, which protect communities from climate-related disasters such as floods and droughts.

Early warning systems and climate-resilient infrastructure: Investments in early warning systems improve preparedness for extreme weather events, and climate-resilient infrastructure projects are being developed to withstand long-term climate impacts.

International collaboration and funding: South Africa participates actively in global climate efforts, including support for the UNFCCC's Loss and Damage Fund, which provides financial assistance to countries vulnerable to severe climate impacts.

3.9.3 South Africa's approach to reporting loss and damage from climate events

3.9.3.1 Policy context

While there's no national policy specifically on Loss and Damage in South Africa, the National Disaster Management Act (2002) lays the foundation for disaster risk management in South Africa. It emphasizes a multi-hazard, multi-sectoral approach which includes assessing the impacts of disasters. The disaster management act also mandates the NDMC to submit a report to the Minister (who must table the report in Parliament) on the disasters that occurred, the classification, magnitude and severity of the disasters, as well as the effects they had. Organs of state must also report quarterly to the NDMC on the disasters, their impact and the expenditure incurred. The National Disaster Management framework outlines a coordinated approach to disaster risk management, including post-disaster needs assessments (PDNA). The PDNA is a crucial tool for evaluating the social, economic, environmental, and infrastructure impacts of disasters, including those related to climate change. The National Climate Change Adaptation Strategy (NCCAS) acknowledges the need for improved data collection and monitoring of climate change impacts. Implicitly, this includes assessing the impacts of climate-related disasters. Internationally, South Africa is also a signatory to the Sendai Framework for Disaster Risk Reduction (2015), which promotes a comprehensive approach to disaster risk management, including assessing disaster risks and losses.

3.9.3.2 Institutional context

In South Africa, the Department of Forestry, Fisheries and Environment acts as the leading government agency responsible for coordinating and overseeing the national climate change response, which include loss and damage from extreme climate events. Assessment of loss and damage through data collection, analysis and database development involves a collaborative effort between various government departments (national, provincial, and local levels) scientific institutions and the private sector.

Important role players at National level are the National Disaster Management Centre (NDMC) and the South African Weather Services. The NDMC serves as the national focal point for disaster response, coordinating the efforts of various government departments, provincial disaster management centres, and other stakeholders. The NDMC coordinates and supports damage assessments in the aftermath of extreme climate events. This involves evaluating the extent of damage to infrastructure, property, and livelihoods, which is crucial for allocating resources and planning recovery efforts. This ensures a comprehensive and standardized approach to gathering information.

The South African Weather Services (SAWS) plays a central role in assessing extreme climate events in South Africa by providing vital data, issuing early warnings, conducting climate analysis, disseminating information, and fostering collaboration. SAWS works closely with the National Disaster Management Centre (NDMC) and other government departments to develop a national Loss and Damage (L&D) reporting systems. They share weather information and forecasts to facilitate effective disaster preparedness, response, and recovery efforts.

Despite these extensive and dedicated efforts to collect, assess and analyse loss and damage related data in South Africa, there remains several gaps and challenges. These relate to limited human capacity and technical expertise, insufficient collaboration between different stakeholders involved in data collection and analysis, data fragmentation and inconsistency as well as limited focus on the indirect or intangible ripple effects of climate change that occur over time and can be more complex to quantify such as cultural and historical damage, mental health impacts and loss of ecosystem services.

3.9.4 Existing loss and damage monitoring systems

South Africa's National Disaster Management Framework (NDMF) seeks the development of a comprehensive information and communications management system with links to relevant role players reporting on disasters. As part of the response and recovery component of the NDMF it requires the collection of disaster data related to the area affected, the type of event (classification by type, magnitude and severity), analysis of status of critical lifeline infrastructure and analysis of reported impacts and monitoring of progress. The NDMC therefore collects data on loss and damage in line with international guidelines and tools such as the Sendai Framework for Disaster Risk Reduction and the newly developed UNDRR hazardous event and disaster losses and damages tracking system which will replace the existing DesInventar system.

South Africa as a country is therefore aligning its country level data collection initiatives to the available international loss and damage databases to allow for international reporting. Assessing the true cost of climate disasters is important to equip South Africa with data-driven arguments when negotiating for increased funding and support within the Loss and Damage framework.

The South African Weather Services is updating and improving its Severe Weather Impact Database. The Severe Weather Impact Database (SWID) is a comprehensive database maintained by the South African Weather Service (SAWS) that records and archives information on severe weather events and their impacts across South Africa (Figure 3.12). It includes data on various types of severe weather phenomena such as storms, floods, droughts, heatwaves, and wildfires, along with their associated impacts on infrastructure, agriculture, economy, and human lives. It is a standardized platform of archiving extreme weather systems, events and their impacts. It builds on the Caelum database which is a historical record of notable weather events that have impacted South Africa.

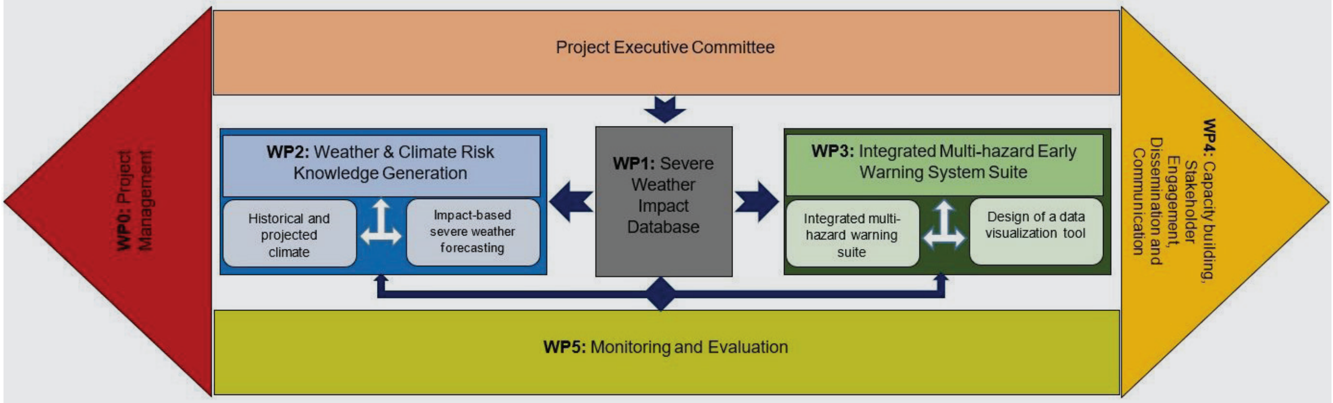


Figure 3.12: Severe Weather Impact Database (SWID)

3.9.5 National Dialogue on Loss and Damage

South Africa is an active participant in international discussions on L&D under the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts. South Africa has emerged as a leading voice for developing countries in international negotiations for the establishment of a Loss and Damage Fund to address climate change impacts. The country acts as a bridge between the developing countries and developed nations, facilitating dialogue and seeking common ground on L&D issues. This role is crucial for achieving progress in negotiations. South Africa emphasizes the specific needs of African countries facing the brunt of climate change impacts, such as sea level rise, extreme weather events, and desertification. This helps build a strong case for targeted financial assistance. Securing compensation for climate-induced loss and damage remains a complex issue. While the Loss and Damage Fund offers a promising step forward, South Africa will need to pursue a combination of approaches to ensure it receives adequate support for the losses and damages it experiences from climate change.

DFFE has therefore embarked on a process to improve the ability of South Africa to better report on loss and damage in the country. In this context, DFFE has initiated a National Dialogue on Loss and Damage. The primary objective of this initiative is to develop a comprehensive Loss and Damage Programme of Work for South Africa, ensuring a collaborative and coordinated response that aligns with global momentum on this issue. In pursuit of this objective, the DFFE, in partnership with various stakeholders, hosted three workshops aimed at establishing a coherent national approach to addressing loss and damage. These workshops facilitated discussions on the most effective strategies for South Africa, with specific goals to: enhance knowledge and understanding of approaches to address loss and damage; improve access to support, including finance, technology, and capacity-building; and strengthen dialogue, coordination, coherence, and synergies among relevant stakeholders.

The workshops resulted in several key outcomes, including: fostering stakeholder partnerships and collaboration to address loss and damage; identifying and mapping various economic and non-economic interventions at the national level; developing a comprehensive approach to implementing loss and damage interventions in South Africa; exploring innovative financial mechanisms to overcome institutional constraints in funding these initiatives; identifying research areas and strategies for managing and sourcing relevant data; and outlining processes for integrating loss and damage into monitoring and evaluation systems, as well as into national, subnational, and climate change policies and planning tools.

3.10 COOPERATION, BEST PRACTICES, AND KEY LESSONS LEARNED

South Africa's vulnerabilities to climate change in critical sectors such as water, agriculture, health, and infrastructure underscore the need for sustained and comprehensive adaptation efforts. The country has made notable progress through strategies like the National Climate Change Adaptation Strategy (NCCAS), which aim to build resilience against the adverse effects of climate change. These efforts have been instrumental in addressing climate risks and reducing loss and damage, particularly in communities that are most vulnerable to extreme weather events. However, aligning national policies with effective local implementation remains a challenge, as does ensuring adequate funding and capacity at the municipal level. Addressing these gaps is essential to achieving long-term resilience and protecting the country's socio-economic well-being.

South Africa's adaptation efforts have led to significant lessons and best practices that can inform future strategies. A key insight is the importance of integrating climate adaptation with broader development priorities, ensuring that efforts to build resilience are sustainable in the long term. The enhancement of early warning systems has proven effective in reducing the impacts of extreme weather events like floods and droughts, demonstrating the value of preparedness and rapid response mechanisms. Building adaptive capacity through education, awareness, and skills development has also been a vital component, empowering communities to better understand and respond to climate risks.

Looking ahead, South Africa's experiences highlight the need for continuous learning, flexibility, and an inclusive approach to adaptation planning. Emphasizing a bottom-up approach that engages communities, incorporates local knowledge, and fosters stakeholder collaboration is crucial for the success of adaptation initiatives. Additionally, increasing investments in data collection and monitoring systems will improve the ability to assess vulnerabilities and evaluate the effectiveness of adaptation measures. By focusing on these areas and strengthening partnerships across government, private sectors, civil society, and international organizations, South Africa can enhance its resilience to climate change and secure a sustainable future for its people and ecosystems.

04 INFORMATION ON FINANCIAL, TECHNOLOGY DEVELOPMENT AND TRANSFER AND CAPACITY-BUILDING SUPPORT NEEDED AND RECEIVED UNDER ARTICLES 9–11 OF THE PARIS AGREEMENT

4. Information on financial, technology development and transfer and capacity-building support needed and received under Articles 9–11 of the Paris Agreement

The chapter provides an update from the previous Biennial Update Reports (BURs) on financial, technology development and transfer, and capacity building support needed and received under Articles 9-11 of the Paris Agreement by South Africa between 1 Jan 2021 and 31 Dec 2022. The chapter presents an overview of international climate-related finance received and committed, as well as technology development and transfer, and capacity building support, needed and received within the BTR1 reporting period.

South Africa's national circumstances are described in the context of the climate finance landscape and institutional arrangements relevant to reporting on financial, technology and capacity building support needed and received. The international financial support received and committed is outlined in the sections that follow. Capacity building and technology support received from international donor funding sources, as well as financial, capacity building and technology support needed by South Africa to develop its response to climate change by sector is described.

4.1 NATIONAL CIRCUMSTANCES, INSTITUTIONAL ARRANGEMENTS AND COUNTRY-DRIVEN STRATEGIES

4.1.1 National Circumstances

South Africa is a signatory to numerous global climate change responses including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement. The country has developed overarching policies and frameworks to support climate change responses which are guided by Section 24 of the Constitution of the Republic of South Africa (RSA, 1996), the National Development Plan 2030 (NDP 2030) (NPC, 2011), the National Climate Change Response Strategy (NCCRS) (2004), and National Climate Change Response Policy (NCCRP) (DEA, 2011) which builds on the NCCRS.

South Africa's enabling policy, institutional, and regulatory framework for climate-related investments in mitigation, adaptation and a just energy transition demonstrates the country's resolve to fundamentally restructure the electricity sector, address energy insecurity and energy poverty, and build human capital for a new energy economy Figure 4.1). Implementation of these policy interventions needs to be matched with adequate finance, technology and capacity building support.

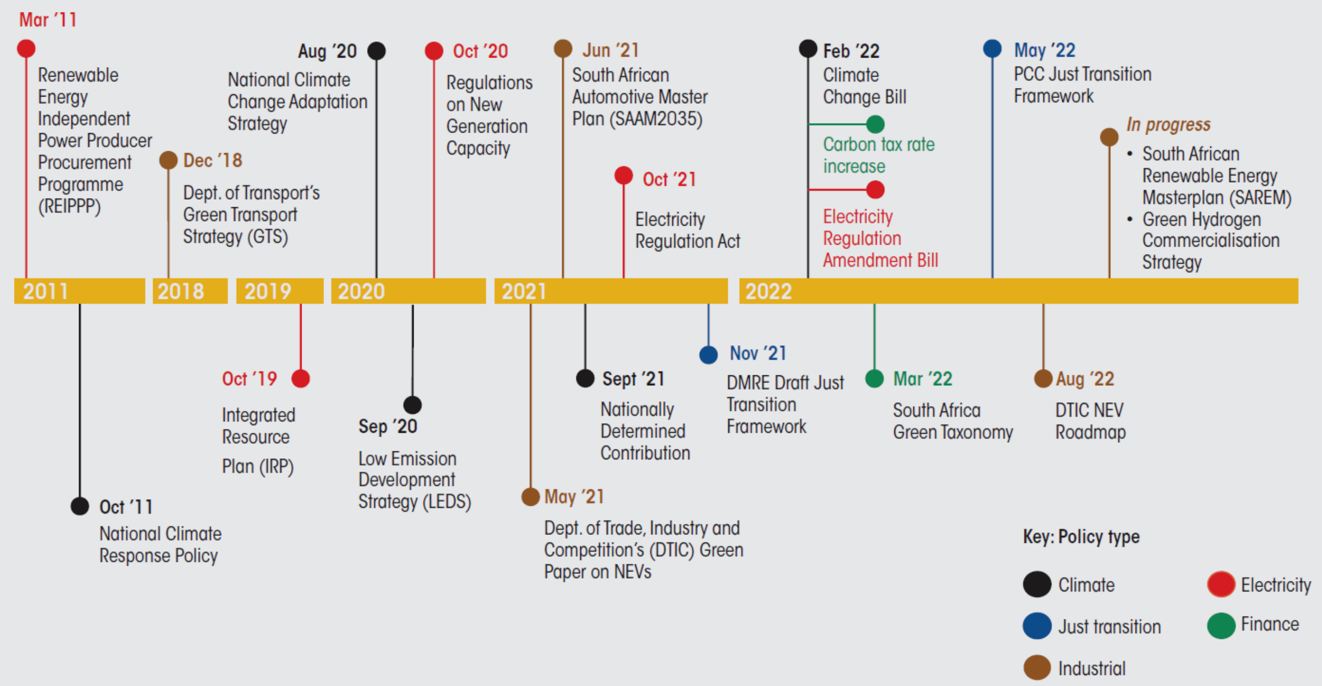


Figure 4.1: The enabling policy, institutional, and regulatory framework for climate-related investments in mitigation, adaptation and a just energy transition (Source: The Presidency of the Republic of South Africa, 2022)

South Africa's National Climate Response Policy (NCCRP) (DEA, 2011) informs both mitigation and adaptation planning. The NCCRP explicitly calls for the inclusion of the financial sector and the employment of a wide range of traditional as well as innovative finance instruments to achieve climate compatible development of the economy. Climate finance is defined in the NCCRP as "*...all resources that finance the cost of South Africa's transition to a lower-carbon and climate resilient economy and society. This covers both climate-specific and climate-relevant financial resources, public and private, domestic and international. This includes financial resources that go towards reducing emissions and enhancing sinks of greenhouse gases; reducing vulnerability, maintaining and increasing the resilience of human and ecological systems to negative climate change impacts; climate-resilient and low-emission strategies, plans and policies; climate research and climate monitoring systems; as well as climate change capacity-building and technology*" (DEA, 2011).

South Africa has defined and adopted a clear roadmap on climate change mitigation and adaption. In the case of climate change mitigation, the Low Emission Development Strategy (2050) submitted to the UNFCCC in 2020 provides an overarching framework for achieving the country's mitigation ambition under the Paris Agreement in line with the NDC commitment. The LEDS sets out a long-term decarbonisation trajectory for key economic sectors and identifies actions required to achieve this. The country's roadmap on adaptation is guided by the National Climate Adaptation Strategy which plays the role of the country's National Adaptation Plan (DFFE, 2020). The NCCAS communicates the country's adaptation priorities and gives effect to the National Development Plan's (NDP) vision of creating a low-carbon, climate resilient economy and a just society.

South Africa's updated Nationally Determined Contribution (NDC), communicated to the UNFCCC secretariat in October 2021, reaffirmed the country's commitment to making a fair contribution to global efforts to address climate change. The NDC, which is the cornerstone of the South Africa's climate response, is a means of communicating the country's high-level vision and objectives on climate action to the international community by addressing the country's climate change ambitions on mitigation, adaptation, and a just transition in a comprehensive way. The updated NDC is framed within the context of the Paris Agreement, and addresses the implementation support to be provided by developed countries in terms of Articles 9–11 (finance, technology, and capacity building) and the degree of mitigation ambition that can be achieved by a developing country Specifically, the NDC states that "It is assumed that international support will be available as specified in Articles 9, 10 and 11 of the Paris Agreement to ensure that both development and climate goals can be met within the timeframe of this NDC, for mitigation, adaptation and loss and damage". In this context, South Africa has committed to achieving an emissions target in a range between 350 - 420 $MtCO_2$-eq by 2030, dependent on the level of support received.

South Africa is gearing up domestic action to achieve its enhanced ambition under the Paris Agreement. The Climate Change Act was developed in recognition of the country's need to strengthen its climate change mandate. The Bill was tabled in Parliament in February 2022 and went through various public participation and law-making processes to become South Africa's Climate Change Act when it was signed into law by the President of South Africa on 23 July 2024. The Climate Change Act, as endorsed by the President, mobilizes South African society towards a climate-resilient and low-carbon economy. In terms of climate finance, the Act provides the mechanisms to support and finance the climate change response, providing guidance and a governance framework to promote planning and implementation by national, provincial and local government.

Tools and/or assessments to track and report support needed and received, as well as initiatives undertaken in South Africa related to climate finance include the Climate Finance Landscape Analysis and the JET Projects' Register.

4.1.1.1 Climate finance landscape analysis

South Africa undertook an update to the South African Climate Finance Landscape 2020 report (CPI, 2021). The previous report tracked climate finance for the years 2017 and 2018, while the South African Climate Finance Landscape 2023 report (de Aragão Fernandes, 2023) covered 2019, 2020 and 2021, sourcing data from both domestic and international sources. The report aimed to map climate finance investment in South Africa by way of tracking project-level investments thereby identifying sources and intermediaries of climate finance; financial instruments used; uses of climate finance; and describing which sectors benefit from climate finance flows in South Africa.

An analysis of various studies undertaken by several organisations was conducted as part of South African Climate Finance Landscape 2023 report to better understand the costs associated for South Africa to transition to a low carbon society, deliver on South Africa's net zero ambitions and reach energy security. Estimates of South Africa's annual climate finance needs vary depending on studies' timeframe, sectoral focus and methodological approach, demonstrating the need for more comprehensive and granular analysis (de Aragão Fernandes, 2023).

For the purpose of the BTR1, the information on financial support needed for mitigation in Section 4.3 will be informed by estimates from the Just Energy Transition Investment Plan (The Presidency of the Republic of South Africa, 2022). Financial support needed for adaptation is informed by the SA's Adaptation Communication, as reported in the country's revised NDC (RSA, 2021).

4.1.1.2 Green Finance Taxonomy

A draft Technical Paper on "Financing a Sustainable Economy" was published by National Treasury in May 2020 with the aim of unlocking access to sustainable finance and stimulating the allocation of capital to support a development-focused and climate-resilient economy. One of the recommendations of the paper was to "develop or adopt a taxonomy for green, social and sustainable finance initiatives, consistent with international developments, to build credibility, foster investment and enable effective monitoring and disclosure of performance". As a result, South Africa's Green Finance Taxonomy (GFT) project was developed by the Taxonomy Working Group, as part of South Africa's Sustainable Finance Initiative, chaired by National Treasury. South Africa is leading by example, with a public institution, such as the National Treasury, proactively addressing climate compatible financial system development. South Africa is the first and, so far only African country that has developed a green finance taxonomy (GIZ, 2023).

The first edition of the South African Green Finance Taxonomy (GFT 1st Edition) (NT, 2022a) outlines the results of the work to date in developing the 1st Edition of the South African Green Finance Taxonomy for environmentally sustainable economic activities. The Green Finance Taxonomy is a classification system for defining which assets, and projects substantially contribute to climate change adaptation and mitigation. The taxonomy has found widespread acceptance among stakeholders, which can largely be attributed to the extensive consultation process conducted for its development (GIZ, 2023).

The Taxonomy is intended to have a range of benefits, which, amongst others, include (NT, 2022a):

- Helping the financial sector with clarity and certainty in selecting green investments in line with international best practice and South Africa's national policies and priorities.
- Reducing financial sector risks through enhanced management of environmental and social performance.
- Reducing the costs associated with labelling and issuing green financial instrument.
- Unlocking significant investment opportunities for South Africa in a broad range of green and climate-friendly assets.
- Supporting regulatory and supervision oversight of the financial sector.
- Providing a basis for regulators to align or reference green financial products.

4.1.1.3 Climate Budget Tagging (CBT) system

Under the auspices of the National Treasury, South Africa is developing a CBT system to support climate-centric budget reform. National Treasury (NT) initiated the design and piloting of a climate budget tagging (CBT) system for South Africa in October 2020. The work was conducted with the support of the Nationally Determined Contribution Support Facility (NDC-SF), a multi-donor Trust Fund administered by the World Bank, with Mokoro/OneWorld appointed as a service provider to the NT (NT, 2022b).

CBT involves classifying and tagging public expenditure according to its expected contribution to climate change mitigation or adaptation. The intent is to implement a CBT system at all three levels of government (national, provincial and local government), given the distribution of expenditure responsibilities in key climate change sectors. The stakeholders of CBT include the Department of Forestry, Fisheries, and the Environment (DFFE), Department of Planning, Monitoring and Evaluation in the Presidency (DPME), Cooperative Governance and Traditional Affairs (CoGTA), and provincial and local government representatives.

The rationale for implementing CBT in South Africa is that it would (NT, 2022b):

- Contribute to raising awareness on and knowledge of climate change impacts on service delivery in public institutions;
- A tool for integrating or mainstreaming climate change and the just transition into policies, strategies, plans, programme design, and macro-fiscal and budget planning at all three levels of government, and in public entities;
- Provide systematic and credible evidence of existing spending, and is needed for the estimation of the funding gap for achieving South Africa's NDCs, among other policy objectives;
- Potentially strengthen climate strategies and plans by ensuring consistency in the definition of climate expenditure between strategies and the budget;
- Provide spending data that can be used to analyse trends and assess effectiveness; and improving the prioritisation of climate resources against national, provincial, and local climate strategies;
- Provide the evidence for coordinating and tracking how climate change responses are distributed across sectors, and the components (main departments and public entities) and levels of government;
- Support better accountability of departments, municipalities, and entities for the climate response responsibilities; and
- Signal commitment to climate change responsiveness and provide the base for attracting and managing green financing and support climate-aware public investment.

The CBT Project Stage I was initiated in October 2020. Between October 2020 and June 2022 the Project consulted on the needs for and objectives of a CBT system for South Africa, conducted awareness raising workshops, reviewed international experience, conducted capacity needs assessments, designed a draft CBT system for South Africa and tested the system in nine pilot sites with selected national and provincial government departments, a public entity, as well as metropolitan and local municipalities (NT, 2022b). The pilots were conducted in the water, energy, transport, and agriculture sectors.

4.1.1.4 JET Projects' Register

At COP26 in 2021, the International Partner Group (IPG) made up of Germany, France, the US, the UK and EU pledged US$ 8,5 billion in a Political Declaration to support South Africa's Just Energy Transition through a combination of grants, concessional loans, and commercial debt and equity (RSA, 2024). In 2023, Netherlands and Denmark joined the IPG. Including JET pledges from Spain, Switzerland and Canada, the international pledges to the South African JET IP have increased to US$ 11,7 billion. Of the total amount pledged, US$ 821 million has been committed to grant financing (RSA, 2024).

The JET Project Management Office (JET PMU) created a JET Projects' Register in the interest of accountability, oversight, and transparency, which is updated quarterly. Working with the IPG and other partner countries, the first phase of building the Register has been to document all the grant allocations that have been made by the international partners, per Portfolio, since November 2021 when the Political Declaration was signed between South Africa and the IPG at COP26. Note: Others, including philanthropy organisations and private sector donors, are contributing to the Just Energy Transition but are not yet included in the JET Grants Register. It is anticipated that these contributions can be recorded in the JET Grants Register in due course (RSA, 2024).

4.1.2 Institutional arrangements

The institutional arrangements relevant to reporting on financial, technology and capacity support needed and received are illustrated in Figure 4.2 in terms of data providers and the flow of information from various directorates within the DFFE who are responsible for outputs to the United Nations Framework Convention on Climate Change (UNFCCC), *viz.* National Communications, Biennial Transparency Reports and Nationally Determined Contributions.

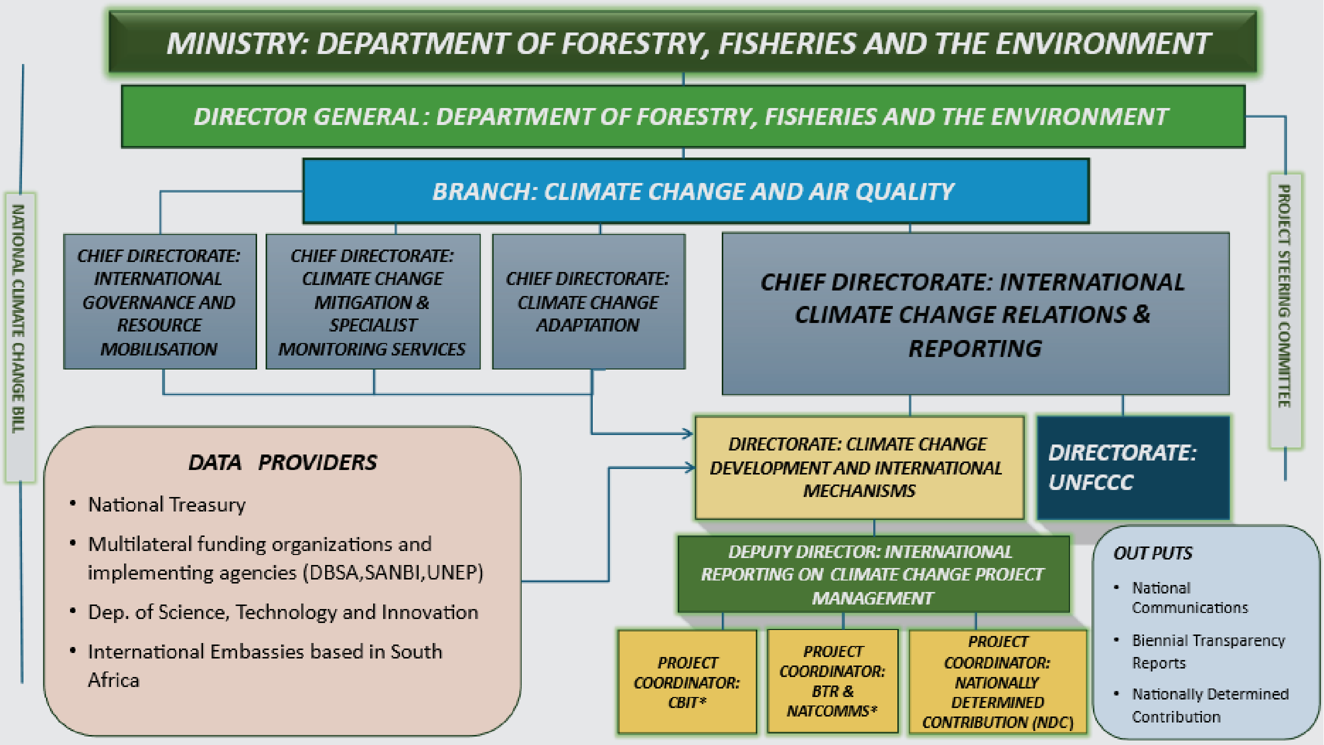


Figure 4.2: Institutional arrangements relevant to reporting on support needed and received

4.1.2.1 Tracking of Financial support received

The National Treasury manages South Africa's national government finances. The National Treasury provides data on some of the bilateral climate financial support received to the Department of Forestry, Fisheries and the Environment (DFFE) for inclusion in the Biennial Transparency Report (BTR). The data is processed and analysed through the Directorate: Climate Change Development and International Mechanisms (CCD&IM) for inclusion in the BTR.

Some of the climate data on bilateral financial support received is collected annually through a standardised template by the Climate Change Mitigation Research and Analysis from the international embassies in Pretoria. It is analysed by the Chief Directorate and shared with the CCD&IM Directorate for inclusion in the BTR.

The data on multilateral financial support received is sourced from the multilateral funding organisations, mostly from the websites such as the GEF and GCF as well as the implementing agencies such as the DBSA, SANBI, UNEP etc. Some of the multilateral financial support received is tracked from the International Governance and resource mobilisation Chief Directorate who are also responsible for this function. The data is also shared with the CCD&IM Directorate for inclusion in the BTR. The tracking of financial support in South Africa is not centralised, data is collected from different entities, thereby making it challenging to track.

4.1.2.2 Tracking and coordination of financial support needed

The DFFE, through the Chief Directorate International Climate Change Relations and Reporting often mobilises resources from enabling activities projects funded by the GEF. The Directorate: CCD&IM, part of the DFFE, oversees the tracking and coordination of financial support needed to address climate change. Working closely with other Chief Directorates and Project Steering committee and other relevant entities, CCD&IM ensures that financial resources needs are documented and reported in the BTR. This collaborative approach aims to enhance South Africa's ability to mitigate and adapt to climate change impacts, promoting sustainable development and environmental responsibility nationwide.

4.1.2.3 Technology Transfer and Development Support Needed and Received

The Department of Science, Technology, and Innovation (DSTI) is mandated to lead the technological needs assessment for South Africa. DSTI collaborates closely with the DFFE and other relevant organizations in this regard in conducting the technology needs assessment (TNA) study (CSIR, 2019), which was an updated assessment of South Africa's climate technology needs across key sectors to both adapt to and mitigate climate change effects to achieve sustainable developmental goals. The scope of the TNA included the prioritisation of sectors and technologies that support adaptation and mitigation measures based on a review of policy, a barrier analysis to assess barriers to implementation of prioritised technologies as well as barriers to technological innovation, and a synthesis of the country's actions/ planned activities towards supporting the deployment of selected prioritised technologies. The DFFE, through the Chief Directorate International Climate Change Relations and Reporting mobilised resources from enabling activities projects funded by the Global Environment Facility (GEF) and collaborated with the DSTI in hiring the service provider to assist with conducting the TNA study. The results of the TNA study are then used by the CCD&IM Directorate for inclusion in the BUR/BTR.

4.1.2.4 Capacity Building Support Received

The Directorate: CCD&IM is responsible for coordinating and tracking capacity building support received. The Directorate does this in consultation with the Chief Directorates: Climate Change Mitigation & Specialist Monitoring Services and Climate Change Adaptation, in terms of capacity building support received, and tracks all of it for reporting in the BTR. Through the Project Steering Committee (PSC) within DFFE (), the Chief Directorate: International Climate Change Relations and Reporting, also tracks on the capacity building support received on the Measurement Reporting and Verification of climate change reporting in the BTR.

4.1.2.5 Capacity Building Support needed

The CCD&IM Directorate coordinates with the Chief Directorates: Climate Change Mitigation & Specialist Monitoring Services and Climate Change Adaptation, in terms of their capacity building needs. Within the Climate Change Mitigation and Specialist Monitoring Services Chief Directorate the Climate Change Monitoring and Evaluation: Mitigation Response Analysis: GHG Inventory and Systems Directorate coordinates the GHG Inventory in terms of their priorities for the GHG improvement Plan. The coordination also done with the other Directorates on NDC tracking and the development of projections.

The CCD&IM Directorate also coordinates with the adaptation Chief Directorate in terms of Capacity building needs. For example, coordination is done with Monitoring and Evaluation of adaptation on the development of indicators, the Climate Change CCD&IM Directorate overseeing the tracking of support and capacity-building needs. This Directorate collaborates closely with other Directorates to ensure comprehensive reporting. Specifically, it coordinates efforts to track the support and capacity-building needed and received.

The Project Steering Committee (PSC), established by the Director General of the DFFE, continues to support contributing authors in providing technical inputs and oversight on the compilation of these reports. This includes reviewing and commenting on the content of the reports, to ensure that they accurately reflect national circumstances.

4.2 UNDERLYING ASSUMPTIONS, DEFINITIONS AND METHODOLOGIES

The BTR1 covers the period from 1 Jan 2021 – 31 Dec 2022. The format of tables presented in the report was informed by the Common Tabular Formats (CTF) for the electronic reporting in Decision 5/CMA.3, specifically Tables 3.7 to 3.13, but due to limited space in presenting tables in the chapter, selected columns were not illustrated in the chapter. This information for the columns not included in the chapter are included in the Common Tabular Formats (CTFs) for the relevant sections that supported the compilation of the chapter.

4.2.1 Currency conversion

The exchange rate of US$ to ZAR is 17,61 (exchange rate) was used for bilateral project information obtained from the JET Grants Register. The average exchange rate from October 2022 to September 2024 using Oanda has been applied. Grants (with some exceptions) are managed in home currencies – the exchange rate applied is from the home currency to US$, using an average rate from October 2022 to June 2024.

A single exchange rate was required by the UNFCCC tool for 'Financial support received' so an average of the exchange rates for 2021 and 2022 (the exchange rate of US$ to ZAR is 15.63) was used in the reporting tool (Table 4.1). Since, data was manually entered into the UNFCCC Support reporting tool, manual conversion of currency was the option selected in the tool, i.e. "Conversion will not be done automatically, and the Party has to manually input the amounts in both domestic currency and USD". As such, the exchange rates applied were as per Table 4.1, and also using the exchange rate used in the JET Grants register, where relevant.

The currency conversion rate to convert domestic currency into United Stated Dollars (USD), Euros (EUR), and Swiss Franc (CHF) is shown in Table 4.1.

Table 4.1: Currency conversion for reporting period in the BTR1

Currency	2021 (ZAR)	2022 (ZAR)	Average ZAR 2021-2022
USD TO ZAR	14.84	16.41	15.63
EUR To ZAR	17.59	17.31	17.45
CHF To ZAR	16.31	17.29	16.80

4.2.2 Data sources for international funding received

Data is reported as either 'received' or 'committed' for international climate change-related funding, and this is reflected in the 'status' column of the Common tabular formats (CTFs) which accompanies information in this chapter (Table III.7, Information on financial support received by developing country Parties under Article 9 of the Paris Agreement).

Data sources are included in the 'additional information' column of the CTF using the format provided in Table III.7. Data on multilateral and bilateral funding received or committed was provided by National Treasury in the form of grants received from Donors as reflected in the NT Reconstruction and Development Programme (RDP). Data on projects related to climate change were filtered from a larger database and project-related information, where available, was provided by National Treasury.

Other sources of data included the DFFE, including Annual Reports, and websites for donors and implementing agencies, for example, Green Climate Fund (GCF), Global Environment Facility (GEF), Energy Environment Partnership (EEP), United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO), the World Bank, and the JET Grant Register[34]. Funding received/disbursed for 2021 and 2022 was reported in the CTFs and the status of that funding was 'received'. Where data for funding received during the reporting period was not available (for e.g. as part of the NT RDP Fund or data available on donor websites), the funding amounts were reported as 'committed'.

Data on 'Support received for the implementation of Article 13 of the Paris Agreement' (Information on bilateral technical assistance received was included in this chapter in Section 4.9.3 (Capacity support received for preparing reports pursuant to Article 13 of the Paris Agreement).

34 JET Grants Register 2024 (Q3). Available at: https://justenergytransition.co.za/wp-content/uploads/2024/11/JET-Grants-Register-2024Q1-2024Q3-Published-Final.-xlsx.xlsx

Data was shared with the DFFE to cross-check if any relevant funding sources had been inadvertently excluded and to verify funding amounts reported. In addition, the amounts for international climate change funding data 'received' was cross-checked against project titles and funding received as per the National Treasury RDP Grants and Donations and Transfers.

4.2.3 Allocation of funding Green Climate Fund projects approved for South Africa

As per the GCF website[35], or multi-country projects, financial information per country is equally divided unless the allocation % is specified. As such, the total funding committed for South Africa for projects funded by GCF was calculated by dividing the total funding by the number of countries supported.

4.3 FINANCIAL SUPPORT NEEDED

South Africa's climate finance needs are informed by the revised targets proposed in South Africa's revised NDC lodged with the UNFCCC in 2021, as well as on the Just Transition Investment Plan (JET IP) (2023-2027). The basis for South Africa's NDC is the assumption that support will be provided for the implementation of the targets and goals therein, for mitigation, adaptation and loss and damage. The country requires support for a just transition towards net zero CO_2 emissions and with the increased level of mitigation ambition communicated in the NDC, international support will be required, with the key to the increased level of mitigation ambition lying in the electricity sector (RSA, 2021). In addition, support will also be required for longer term decarbonisation, which will require investments in the 2020s towards infrastructure, technology development and capacity-building (RSA, 2021). Over the next decade, the NDC will require a greater investment programme, as specified in IRP 2019, of between R 860 billion and R 920 billion (in 2019 Rands; USD 60-64 billion). The shift away from coal that IRP 2019 requires will require support in the form of transition finance and associated technology and capacity-building (RSA, 2021)

South Africa's JET IP 2023–2027 sets out the scale of need and the early-stage investments required for the country's Just Transition (JT) to a low-carbon and climate-resilient economy in line with its updated Nationally Determined Contribution (NDC). Achieving the JET IP outcomes is dependent on the scale and nature of financial support that South Africa can secure from the international community to complement domestic resources. To decarbonise South Africa's economy within the NDC target range of 350–420 Mt CO_2eq by 2030, will require approximately ZAR 1.48 trillion (US$ 98.7 billion)[36] over five years from multiple sources. These sources include developed countries; private sector investors; Development Finance Institutions (DFIs); Multilateral Development Banks (MDBs); government; and philanthropies.

The JET Implementation Plan 2023-2027 is a roadmap that enables South Africa to take targeted and aligned strides towards meeting its decarbonisation commitments in a manner that will deliver just outcomes for the people affected by the energy transition and that contributes to inclusive economic growth, energy security, and employment (The Presidency of the Republic of South Africa, 2023). Various Just Energy Transition (JET) initiatives are underway in South Africa which are led by government institutions, the private sector, and civil society organisations. Finance for these initiatives is through government programmes, by partner governments, Development Finance Institutions (DFIs), Multilateral Development Banks (MDBs), philanthropies, corporate social investments, impact investors, and commercial investors. However, further funds can and must be mobilised at scale for the JET IP once there are firm pathways to achieving defined outcomes. These pathways need to be underpinned by unambiguous government policy and leadership, good governance, and institutionally co-ordinated effort.

35 GCF - https://data.greenclimate.fund/public/data/projects

36 The exchange rate used throughout the JET IP: 15:1. (The Presidency of the Republic of South Africa, 2022)

Investments are needed in three priority sectors: electricity, New Energy Vehicles (NEVs), and Green Hydrogen (GH_2). More specifically, investment is needed in our electricity transmission and distribution networks and dramatically expanding renewable energy generation, as well as investment in local production of green hydrogen and electric vehicles, and investing in local economies to develop skills and enable economic diversification.

Further investments are needed in two cross-cutting areas: skills development and municipalities (The Presidency of the Republic of South Africa, 2022). The summary of the JET IP funding requirements per sector is presented in Table 4.2. Investments needed for skills development includes support for the development of a national skills plan for a just energy transition and the future of work to ensure that skills are in place to match the growth in new clean sectors and support worker transition. The five-year investment needs for skills development also included funding for pilot skills development Zones in Mpumalanga, Eastern Cape and Northern Cape, as well as mobilising allocations to JET from existing public and private post-school education and training (PSET) funding per annum (The Presidency of the Republic of South Africa, 2022).

The second set of cross-cutting investments needed targets specific support for municipalities to navigate the energy transition and play a dynamic and responsive role in the energy system for the benefit of the communities they serve. This requires functional distribution grids that can accommodate an increasing penetration of renewable energy generation at different scales and connect all residential, public, commercial, and industrial energy users. It also requires the establishment of a financially sustainable service delivery model that provides for equitable access by the whole grid community, all local energy users, including small businesses and low-income and energy-poor households (The Presidency of the Republic of South Africa, 2022)

For each of the three priority sectors, the ZAR1.48 trillion (US$98.7 billion) financing targeted for the JET IP is categorised under infrastructure, planning and implementation capacity, skills development, economic diversification and innovation, along with social investment and inclusion (Table 4.3).

Table 4.2. JET IP funding requirements per sector, 2023–2027 (The Presidency of the Republic of South Africa, 2022)

JET IP funding requirements 2023-2027	ZAR billion	USD billion
Electricity sector	711.4	47.2
New Energy Vehicle (NEV) sector	128.1	8.5
Green Hydrogen (GH_2) sector	319.0	21.2
Skills development	2.7	0.18
Municipal capacity	319.1	21.3
TOTAL	**1 480.3**	**98.38**

The term "municipal capacity" in this table refers not only to the ability of municipalities to manage and navigate the energy transition but also to the associated infrastructure investments and maintenance required to support this role. These include ensuring functional distribution grids capable of accommodating increasing levels of renewable energy generation across scales, as well as establishing financially sustainable service delivery models that promote equitable access for all energy users, including small businesses and low-income households.

Table 4.3: Financing needs of the JET IP for the period, 2023–2027 (The Presidency of the Republic of South Africa, 2022)

ZAR (US$) billions	Electricity	NEV	GH_2	Subtotal
Infrastructure	978	83	313	1 374
Planning and implementation capacity	2.14	2	5.5	9.9
Economic diversification and innovation	40.4	43	-	83.4
Social investment and inclusion	9.6	-	-	9.6
Skills development			2.7	2.7
Subtotal	1 030.4 (68.7)	128 (9)	319 (21)	
TOTAL				**1 480 (98.7)**

The estimated availability of funding per sector and source, together with the outstanding funding to meet targets, is illustrated in . (*Note: The funding gap and scale of need is indicative and assumes the commitments and pledges of the funded portions materialise).

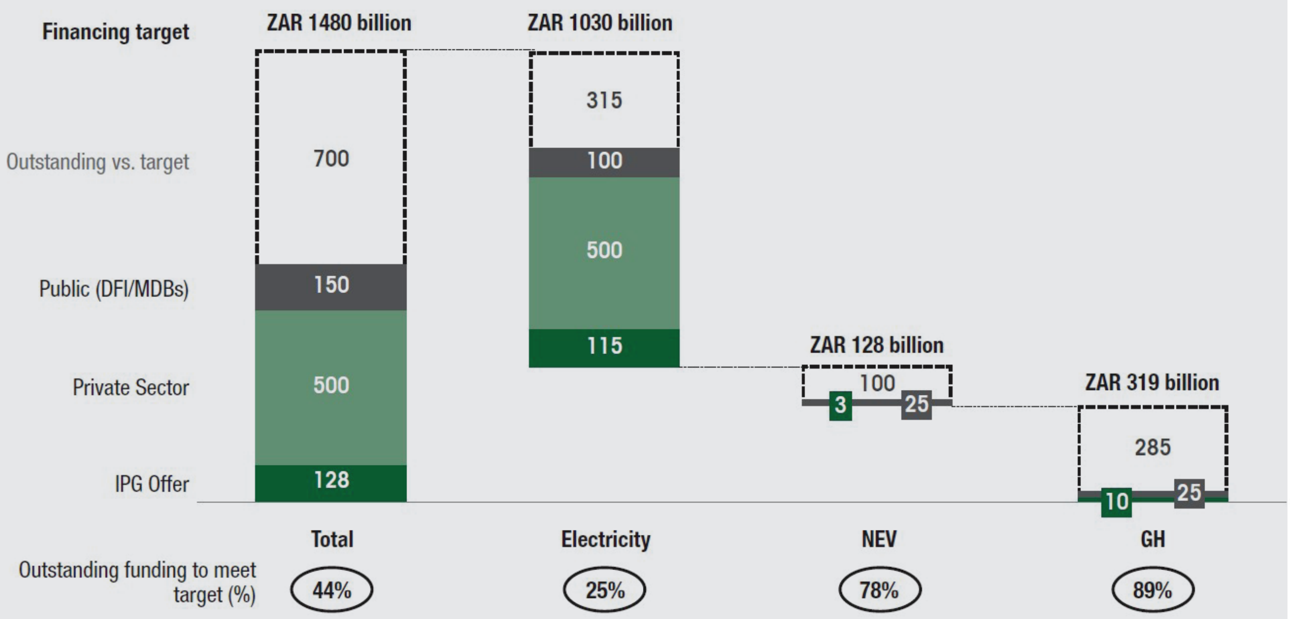


Figure 4.3: Projected funding needs and estimated availability by source (The Presidency of the Republic of South Africa, 2022).

The Paris Agreement and the recent Glasgow Agreement at the 26th Conference of the Parties (COP) in 2021 have led to a major international commitment to financially support the implementation of NDCs in developing and emerging countries. South Africa has been one of the early beneficiaries of the Glasgow Agreement where a Just Energy Transition Partnership (JETP) was forged between South Africa and the governments of France, Germany, United Kingdom, the European Union, and the United States (forming the International Partners Group [IPG]). As part of this partnership, the IPG undertook to mobilise US$8.5 billion over five years to support South Africa's Just Energy Transition. The initial IPG offer of US$8.5 billion is thus a catalytic contribution towards addressing the JET IP priorities. In the context of the JET IP's identified scale of need for investment in the priority sectors of Electricity, New Energy Vehicles (NEVs) and Green Hydrogen (GH_2), the JET IP outlines how the IPG pledge of US$8.5 billion will be allocated to these priorities in South Africa over five years (Figure 4.3).

Table 4.4: Allocation of US$8.5 billion pledge for the period, 2023–2027 (The Presidency of the Republic of South Africa, 2022)

IPG US$8.5 billion allocation, 2023 - 2027	Electricity	NEV	GH_2
Infrastructure	6.9	0.2	0.5
Planning and implementation capacity	0.7		0.2
Skills development	0.012		
Economic diversification & innovation	0.022		
Social investment and inclusion	0.016		

The National Climate Change Adaptation Strategy (NCCAS) is the key domestic policy instrument to guide implementation of adaptation goals included in the country's first Adaptation Communication in the updated NDC; these goals are consistent with elements of decision 9/CMA.1. The projected costs of adaptation over the 2021-2030 period detailed in the adaptation communication include the costs of adaptation measures themselves, as well as the costs of building the relevant human and institutional capacity. A summary of adaptation goals and associated the adaptation investment required for the period 2021- 2030 are included in Table 4.5.

Table 4.5: Adaptation goals and investment needed for the period 2021 – 2030 (Source: RSA, 2021)

Elements	Undertaking for the period 2021-2030	Adaptation investment 2021-2030
Element (a) of the Annex to decision 9/CMA.1 National circumstances, institutional arrangements and legal frameworks	**Goal 1**: Enhance climate change adaptation governance and legal frameworks	USD 13 million to build evidence-based support for policy implementation for the period 2021 to 2030
Element (b) of the Annex to decision 9/CMA.1 Impacts, risk and vulnerability	**Goal 2**: Develop an understanding of the impacts on South Africa of 1.5 and 2 °C global warming and the underlying global emission pathways through geo-spatial mapping of the physical climate hazards and adaptation needs in the context of strengthening the key sectors of the economy	USD 8 million for developing tools, strategies and rollout for the period 2021 to 2030
Element (c) of the Annex to decision 9/CMA.1 National adaptation priorities, strategies, plans, goals and actions	**Goal 3**: Implementation of NCCAS adaptation interventions for the period 2021 to 2030	USD 3 - 4 billion required for the implementation of the NCCAS for a period 2021 to 2030 to support South Africa
Element (d) of the Annex to decision 9/CMA.1 Implementation and support needs of and provision of adaptation support to South Africa	**Goal 4**: Access to funding for adaptation implementation through multilateral funding mechanisms	Adaptation needs and costs for the period 2021 – 2030 is USD 16 –USD 267 billion. Adaptation needs and costs adapted by a minimum of 4% GDP impact is USD 122 billion by 2025 and USD 37 5 billion by 2030

Elements	Undertaking for the period 2021-2030	Adaptation investment 2021-2030
Element (e) of the Annex to decision 9/CMA.1 Implementation of adaptation action and plans including (ii) Adaptation efforts of developing countries for recognition	Goal 5: Quantification and acknowledgement of the national adaptation and resilience efforts	(Not applicable to historical efforts up to 2020)

The projected costs of adaptation over the 2021-2030 period detailed in Table 4.5 include the costs of adaptation measures themselves, as well as the costs of building the relevant human and institutional capacity. In addition, South Africa will face significantly higher costs as a result of climate impacts which cannot be avoided during this period, and further work is underway to accurately quantify the costs (RSA, 2021). South Africa is implementing a variety of strategies to avert, minimize, and address loss and damage from climate change, which include the use of policy frameworks, disaster risk reduction initiatives, ecosystem restoration, infrastructure development, and international collaboration. These strategies are outlined in Chapter 3 (Climate Impacts and Adaptation), Section 3.7 (Information related to averting, minimizing and addressing loss and damage associated with climate change impacts).

South Africa is an active participant in international discussions on L&D under the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts, and has emerged as a leading voice for developing countries in international negotiations for the establishment of a Loss and Damage Fund to address climate change impacts (Chapter 3, Section 3.7.5). Securing support needed for climate-induced loss and damage remains a complex issue, so while the Loss and Damage Fund offers a promising step forward, South Africa will need to pursue a combination of approaches to ensure it receives adequate support for the losses and damages it experiences from climate change. To this end, the DFFE has embarked on a process to improve the ability of South Africa to better report on loss and damage in the country, and has in this context, initiated a National Dialogue on Loss and Damage. A comprehensive Loss and Damage Programme of Work for South Africa will be developed as a primary outcome of this initiative to ensure a collaborative and coordinated response that aligns with global momentum on this issue.

4.4 FINANCIAL SUPPORT RECEIVED

The international climate finance data provided in this section reflects bilateral and multilateral finance support received or committed for the reporting period of the BTR1. Support is classified as 'bilateral' if it comes from one donor country and as 'multilateral' if more than one country/entity provides the support and it is channelled through one donor agency. Bilateral assistance for climate change comes in different forms; through individual donors, through donor agencies, directly in the form of Official Development Assistance (ODA) and through bilateral finance institutions.

Detailed information on the breakdown of the international bilateral and multilateral financial support received has been reported in South Africa's Biennial Update Reports (BURs) since 2014 when the country's first Biennial Update Report was submitted. South Africa has submitted a total of five BURs between 2014 and 2023 (Table 4.6). The BTR1 includes bilateral and multilateral support received for the period 1 Jan 2021 – 31 Dec 2022.

Table 4.6: Reporting of bilateral and multilateral support in South Africa's BURs

BUR	Reporting period	Tables with bilateral and multilateral support	Reference
BUR-1	2000-2010	Tables 28 and 29	DEA, 2014
BUR-2	2010-2014	Tables 34 and 35	DEA, 2017
BUR-3	2015-2017	Tables 4.1 and 4.2	DEA, 2019
BUR-4	2018-2019	Tables B1.1 and B2.1	DFFE, 2021
BUR-5	2020*	Tables 4.1 and 4.2	DFFE, 2023

*Note: *It was agreed that data for 2021 would not be included in the BUR-5 since it will be reported in the country's first Biennial Transparency Report (BTR1).*

In South Africa, bilateral and multilateral development and donor agencies have played a substantial role in funding and providing technical assistance in relation to climate mitigation, climate adaptation, climate finance and climate compatible financial system development.

Climate finance provided via the multilateral climate regime is provided via the Financial Mechanism, established by the UNFCCC in its Article 11, and also serving the Kyoto protocol and the Paris Agreement. The Financial Mechanism includes a number of operating entities and financial mechanisms, which include the GEF, the GCF and the Adaptation Fund.

Sources of bilateral finance included Belgium, Canada, the European Union, Finland, France, Germany, Switzerland, and the United States of America, while sources of multilateral finance included the Green Climate Fund (GCF), Global Environment Facility (GEF), Energy Environment Partnership (EEP), and United Nations Environment Programme (UNEP). Sectors supported by international funding included agriculture, biodiversity, coastal, energy, industry, sanitation, ocean, waste, and water sectors. Bilateral support received or committed was USD $ 816.9 million, and multilateral climate-related support received or committed was USD $ 10.7 million for the period 1 Jan 2021-31 Dec 2022. This support was in the form of grants, concessional loans, and equity (Table 4.7).

Table 4.7: Multilateral and bilateral financial support received or committed between 1 Jan 2021 to 31 Dec 2022

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
Belgium	South African project on climate change adaptation in industries bearing fruit	Bilateral	UNIDO, NCPC, TIA	41 880 720	2 679 834	2022	2025	Grant	Committed	Adaptation	Agriculture
Belgium	Strengthened adaptation capacity for a green and resilient economy in South Africa	Bilateral	UNIDO	4 879 243	279 608	2022	2025	Grant	Committed	Adaptation	Cross-cutting
Belgium	Adaptive Capacity Facility	Bilateral	DFFE	3 200 000	194 963	Nov-18	Dec-24	Grant	Received	Adaptation	Cross-cutting
Canada	A just energy transition: Localization, decent work, SMMEs and sustainable livelihoods.	Bilateral	Institute for Economic Justice (local partner); Just Urban Transition and the Congress of South African Trade Unions	10 573 044	600 400	Nov-21	Nov-24	Grant	Committed	Mitigation	Energy
Canada	Enhancing access to renewable energy: A dividend for a just transition to low-carbon economies.	Bilateral	African Centre for a Green Economy (local partner)	3 345 900	190 000	Nov-21	Nov-24	Grant	Committed	Mitigation	Energy
Energy Environment Partnership (EEP)	Mustapha Energy: Converting Residual Waste in Cape Town	Multilateral	EEP is hosted and managed by the Nordic Development Fund (NDF) with funding from Austria, Finland and NDF. Project partners WOIMA Corporation Oy, Waste Mart, Waste Transformation 4 Energy Association, ENCHA & Mahube Infrastructure Fund, WDC	3 490 060	223 320	2021	NR	Grant	Committed	Mitigation	Energy
Energy Environment Partnership (EEP)	Transforming water heaters into intelligent batteries	Multilateral	EEP is hosted and managed by the Nordic Development Fund (NDF) with funding from Austria, Finland and NDF	5 234 305	334 929	2021	NR	Grant	Committed	Mitigation	Energy
European Union	Presidential Climate Commission (PCC) Energy Modelling	Bilateral	Presidential Climate Commission	2 852 820	162 000	Jan-22	Dec-23	Grant	Received	Mitigation	Energy

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
European Union	The Climate Change Champions	Bilateral	WWF SA, Green Cape, Democracy Works Foundation, Association for Rural Advancement, Social Change Assistance Trust	38 037 600	2 160 000	Nov-21	Dec-25	Grant	Committed	Cross-cutting	Energy
European Union	Response of the Earth System to overshoot, Climate neutrality and negative Emissions under Horizon Europe (RESCUE)	Bilateral	University of Cape Town	3 043 008	172 800	Jan-22	Dec-26	Grant	Committed	Mitigation	Cross-cutting
European Union	Circular economy industrial symbiosis under Horizon Europe	Bilateral	University of Johannesburg	4 754 700	270 000	Jan-22	Dec-26	Grant	Committed	Mitigation	Waste
European Union (EU)	iThemba Phakama People PPP Model for Human Development and Inclusive Environmental Economic Growth	Bilateral	DFFE	6 354 366	406 599	2019	2023	Grant	Received	Adapta-tion	Cross-cutting
Finland	Circular Economy Incubator	Bilateral	WomHub	1 570 527	100 494	Jun-21	Jul-22	Grant	Received	Mitigation	Waste
Finland	Accelerating Circular Economy in Africa (ACE Africa)	Bilateral	ICLEI- Local Government for Sustainability - Africa	3 315 557	212 154	2021	2022	Grant	Received	Mitigation	Waste
Finland	The circular Economy Accelerator	Bilateral	Fetola Foundation	4 345 125	278 033	2021	2022	Grant	Received	Mitigation	Waste
France	CSP Phase 2 - water resilience in metros	Bilateral	AFD - French Development Agency	1 742 116	106 140	2021	2023	Grant	Received	Adapta-tion	Water
France	Sovereign policy loan	Bilateral	AFD - French Development Agency	5 191 710 000	316 309 235	2021	2022	Loan	Received	Cross-cutting	Cross-cutting
France	Coal plant decommissioning - Support to CSIR	Bilateral	Council for Scientific and Industrial Research (CSIR)	5 221 260	297 000	Jan-22	Dec-24	Grant	Committed	Mitigation	Energy
France	Economic diversification support to Steve Tshwete Municipality	Bilateral	Steve Tshwete Municipality	9 493 200	540 000	Nov-21	Dec-24	Grant	Committed	Mitigation	Energy
France	Green bond	Bilateral	DBSA	284 796	16 200	Nov-21	Dec-27	Grant, Green bond	Committed	Cross-cutting	Energy, Water
France	The role of social policies in the framework for the just transition (focusing Steve Tshwete Local Municipality)	Bilateral	Peta Wolpe and Wendy Annecke	284 796	16 200	Nov-21	Dec-22	Grant	Received	Mitigation	Energy

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
France	Revitalisation of Mining Ghost Towns	Bilateral	Oneworld	2 278 368	129 600	Nov-21	Dec-22	Grant	Received	Mitigation	Energy
France	Implementation of the Just Transitions Framework	Bilateral	Western Cape Economic Development Partnership	379 728	21 600	Jan-22	Dec-23	Grant	Received	Cross-cutting	Cross-cutting
Germany	Climate Support Programme - Finance the near-term priority flagship programme and an IT-expert for the implementation of the climate change web-based monitoring and evaluation systems	Bilateral	DFFE	462 846	29 616	Apr-17	Jun-21	Grant	Received	Cross-cutting	Cross-cutting
Germany	Provide support to the coordination and implementation of the South African Ecosystem based Adaptation Strategy	Bilateral	DFFE	522 056	33 405	Nov-17	Apr-21	Grant	Received	Adaptation	Biodiversity
Germany	JETP Policy-based loan to National Treasury	Bilateral	NT	5 277 000 000	337 619 962	2021	2022	Concessional loan	Received	Mitigation	Energy
Germany	Integrated NDC Implementation Support in South Africa	Bilateral	DFFE	63 692 500	4 291 947	2021	NR	Technical Assistance	Committed	Mitigation	Energy
Germany	South African German Energy (SAGEN) Programme 4	Bilateral	DMRE/Various	270 475 000	18 226 078	2021	2025	Technical Assistance	Committed	Mitigation	Energy
Germany	Supporting a South African Green Hydrogen Economy (H2 SA)	Bilateral	Presidency / Various	270 475 000	18 226 078	2021	2025	Technical Assistance	Committed	Mitigation	Energy
Germany	Career Path Development for Employment (CPD4E)	Bilateral	Department of Higher Education and Training (DHET)	296 650 000	19 989 892	2021	2026	Technical Assistance	Committed	cross-cutting	Skills + Employment

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
Germany	Catalyst Research for Sustainable Kerosene (CARE`o`SENE)	Bilateral	Project led by Sasol and Germany's Helmholtz-Zentrum Berlin (Helmholtz Centre for Materials and Energy, HZB). €30 million in funding provided by the German Federal Ministry of Education and Research and a further €10 million by Sasol.	692 400 000	42 193 784	2022	2025	Technical Assistance	Committed	Mitigation	Energy
Germany	Greening the production and use of liquefied fuel gas in Southern Africa (Green-QUEST)	Bilateral	German Federal Ministry of Research and Education (BMBF)	69 240 000	4 219 378	2022	2025	Technical Assistance	Committed	Mitigation	Energy
Germany	Low carbon and climate resilient water and Waste water Management (LCCR)	Bilateral	DWS	100 398 000	6 118 099	2022	2025	Technical assistance	Committed	Cross-cutting	Water and sanition
Germany	C40 Cities Finance Facility (CFF)	Bilateral	City of Cape Town	26 175 000	1 763 814	2021	2024	Technical assistance	Committed	Cross-cutting	Cross-cutting
Germany	CitiesAdapt	Bilateral	DFFE	14 124 960	860 753	2022	2025	Technical assistance	Committed	Cross-cutting	Cross-cutting
Germany	Green Economy Transition (GET 4.0)	Bilateral	DFFE	5 764 230	351 263	2022	2025	Technical assistance	Committed	Cross-cutting	Green Economy
Germany	Cooling Program for Southern Africa (CoopSA)	Bilateral	DFFE	8 725 000	587 938	2021	2026	Technical assistance	Committed	Mitigation	Cross-cutting
Germany	Growing Greener	Bilateral	DFFE	19 041 000	1 160 329	2022	2029	Technical assistance	Committed	Cross-cutting	Agriculture
Germany	Innovation Regions for a Just Energy Transition	Bilateral	Mpumalanga Department of Economic Development and Tourism (DEDT)	3 115 800	189 872	2022	2026	Technical assistance	Committed	Cross-cutting	Energy
Global Environment Facility (GEF)	Accelerating cleantech innovation and entrepreneurship in SMEs to support the transition towards circular economy and create green jobs	Multilateral	UNIDO	8 258 201	528 420	Nov-21	2026	Grant	Received	Mitigation	Energy
Global Environment Facility (GEF)	Sustainable energy systems for urban-industrial development	Multilateral	UNIDO	588 978	35 884	Aug-22	2026	Grant	Received	Mitigation	Energy

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
Global Environment Facility (GEF)	Promoting organic waste-to-energy and other low-carbon technologies in small and medium and micro-scale enterprises (SMMEs): Accelerating biogas market development	Multilateral	UNIDO	9 207 367	601 134	Mar-16	Nov-23	Grant	Received	Mitigation	Cross-cutting
Global Environment Facility (GEF)	Capacity Building Programme to Implement South Africa's Climate National System	Multilateral	UNEP	8 432 681	528 122	Mar-19	Dec-24	Grant	Received	Cross-cutting	Cross-cutting
Green Climate Fund (GCF)	Climate Investor Two	Multilateral	FMO, the Dutch Development Bank	28 735 748	1 750 749	Dec-22	Apr-42	Grant	Committed	Cross-cutting	Cross-cutting
Green Climate Fund (GCF)	CRAFT - Catalytic Capital for First Private Investment Fund for Adaptation Technologies in Developing Countries	Multilateral	Pegasus Capital Advisors	54 711 333	3 333 333	Jan-22	Jan-34	Equity	Committed	Adaptation	Cross-cutting
Green Climate Fund (GCF)	Blue Action Fund (BAF): GCF Ecosystem Based Adaptation Programme in the Western Indian Ocean	Multilateral	Blue Action Fund	975 432	65 718	Apr-21	Apr-28	Grant	Committed	Adaptation	Cross-cutting
Green Climate Fund (GCF)	Pipeline development to deploy clean energy technology solutions in municipal wastewater treatment works of South Africa	Multilateral	UNIDO	2 459 088	149 822	Dec-21	May-24	Grant	Received	Mitigation	Waste
Switzerland	Global Eco-Industrial Parks Programme-South Africa country level intervention	Bilateral	UNIDO	11 825 911	677 691	2021	2028	Grant	Received	Mitigation	Industry
Switzerland	Sustainable Cities - Africa Platform	Bilateral	SECO, IFC; Metropolitan municipalities, secondary cities	127 056 150	7 215 000	Nov-21	Dec-26	Grant	Committed	Cross-cutting	Cross-cutting
United Kingdom	ESMAP (Energy Sector Management Assistance Program)	Bilateral	World Bank	88 334 032	5 016 129	Nov-21	Dec-26	Grant	Committed	Mitigation	Energy

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
United Kingdom	South Africa Programmatic Advisory Services and Analytics (supported through ESMAP)	Bilateral	World Bank	24 497 782	1 391 129	Jan-22	Dec-26	Grant	Committed	Mitigation	Energy
United Kingdom	City of Cape Town Grid Regulation Skill-share (UK PACT)	Bilateral	Ricardo and ECO	2 072 851	117 709	Jan-22	Nov-23	Grant	Received	Mitigation	Energy
United Kingdom	Mapping Mitigation and Adaptation Pathways for a JET - Support for Sector Job Resilience Planning (UK PACT)	Bilateral	Council for Scientific and Industrial Research (CSIR)	7 619 319	432 670	Nov-21	Mar-23	Grant	Received	Cross-cutting	Cross-cutting
United Kingdom	Just Transition Pathways Project (UK PACT)	Bilateral	National Business Initiative (NBI)	11 363 931	645 311	Nov-21	Mar-23	Grant	Received	Cross-cutting	Cross-cutting
United Kingdom	The UK funded Climate Finance Accelerator (CFA)	Bilateral	PwC, GreenCape, National Business Initiative	20 322 358	1 154 024	Nov-21	Dec-24	Grant	Committed	Mitigation	Cross-cutting
United Kingdom	Development of a Green Economy Cluster Organisation to Support Mpumalanga's Role in the Validation, Implementation and Follow-on Research of the South African Renewable Energy Masterplan (SAREM) (UK PACT)	Bilateral	GreenCape	28 838 092	1 637 598	Feb-21	Mar-25	Grant	Committed	Mitigation	Energy
United Kingdom	Distilling the Just Energy Transition in South Africa: Harmonising Conflict and Seeking Opportunities (UK PACT)	Bilateral	Trade & Industrial Policy Strategies (TIPS) (Lead), National Labour and Economic Development Institute (NALEDI), Peta Wolpe, GroundWork	5 582 854	317 028	Feb-21	Nov-22	Grant	Received	Mitigation	Energy
United Kingdom	Trade Forward Southern Africa (TFSA)	Bilateral	Trade Forward Southern Africa and partners	5 833 313	331 250	Jan-22	Feb-24	Grant	Received	Mitigation	Energy
United Kingdom	Alternative Financing Models for Embedded Generation of Renewable Energy in South African Municipalities (UK PACT)	Bilateral	ICLEI Africa	2 709 827	153 880	Nov-21	May-22	Grant	Received	Mitigation	Energy

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
United Kingdom	eThekwini Regional Hydrogen Economy Study (UK PACT)	Bilateral	Arup South Africa	3 306 872	187 784	Nov-21	Aug-22	Grant	Received	Mitigation	Energy
United Kingdom	City of Johannesburg Climate Action Plan Implementation Tracking (UK PACT)	Bilateral	Sustainable Energy Africa (SEA)	6 666 464	378 561	Nov-22	Dec-24	Grant	Committed	Cross-cutting	Cross-cutting
United Kingdom	Urban Climate Action Programme (UCAP)	Bilateral	C40 Cities	112 924 125	6 412 500	Nov-22	Dec-25	Grant	Committed	Mitigation	Energy
United Kingdom	Supporting the Effective Integration of Resilience Building, Alternative Service Delivery Approaches and Climate Change Adaptation and Mitigation into the Implementation of the City of Cape Town's Infrastructure Planning and Delivery Framework (IPDF) (UK PACT)	Bilateral	GreenCape	9 061 005	514 538	Jan-22	Jun-23	Grant	Received	Cross-cutting	Cross-cutting
United Kingdom	Shifting the Transport Paradigm – Electric Vehicles (UK PACT)	Bilateral	Nelson Mandela University and Cenex	6 648 700	377 553	Nov-21	Mar-23	Grant	Received	Mitigation	Transport
United Kingdom	Electric Vehicle Readiness in City of Johannesburg (UK PACT)	Bilateral	Sustainable Energy Africa (SEA)	3 261 658	185 216	Nov-21	Dec-22	Grant	Received	Mitigation	Transport
United Kingdom	Clean Energy Innovation Facility (CEIF 1.0) Phase 1	Bilateral	InnovateUK, Worldbank IFC	35 601 362	2 021 656	Nov-21	Mar-23	Grant	Received	Mitigation	Industry
United Kingdom	Building the Green Hydrogen Economy Just Energy Transition (UK PACT)	Bilateral	South African Institute of International Affairs (SAIIA), Trade and Industrial Policy Strategies (TIPS), University of Cape Town (UCT) Energy Research Centre, KPMG, Bambili Energy	5 419 235	307 736	Nov-21	Apr-22	Grant	Received	Mitigation	Industry
United Kingdom	High Gear	Bilateral	NAACAM and Elangeni TVET College	5 258 918	298 633	Nov-22	Jun-23	Grant	Received	Mitigation	Transport
United Kingdom	Green Skills in IRM	Bilateral	IOPSA,Blu Lever, NBI	1 686 488	95 769	Nov-22	Jun-23	Grant	Received	Mitigation	Energy

Donor	Title of activity, programme, project	Channel	Implementing entity	Amount received (climate-specific)		Time frame		Financial instrument	Status	Type of support	Sector
				Domestic currency (ZAR)	USD	Start date	End date				
United Kingdom	Energy Sector Decarbonisation Pathways to Meet a Net-Zero Emissions Target by 2050 (UK PACT)	Bilateral	Council for Scientific and Industrial Research (CSIR) and University of Cape Town (UCT)	4 385 132	249 014	Oct-22	Mar-24	Grant	Received	Mitigation	Energy
United Kingdom	MAGC will provide a Performance Based Incentive (PBI), for pre-agreed eligibility criteria, that will partly offset greening and EDGE certification costs for developers	Bilateral	IFC and Business Partners Limited	51 480 847	2 923 387	Nov-21	Dec-26	Concessional loan	Committed	Mitigation	Construction
United Kingdom	IFC will provide advisory services in South Africa in line with the aims of the MAGC program	Bilateral	IFC and Nedbank	51 480 847	2 923 387	Nov-21	Dec-26	Concessional loan	Committed	Mitigation	Construction
United Nations Environment Programme (UNEP)	HCFC phase-out management plan (stage I)	Multilateral	UNIDO	19 484 767	1 256 516	Dec-12	Dec-23	Grant	Received	Mitigation	IPPU
United Nations Environment Programme (UNEP)	HCFC phase-out management plan (stage II)	Multilateral	UNIDO	664 088	44 262	Jan-19	Dec-31	Grant	Committed	Mitigation	IPPU
United Nations Environment Programme (UNEP)	Preparation of an HFC phase-down plan	Multilateral	UNIDO	12 646 571	775 301	Sep-21	Dec-23	Grant	Received	Mitigation	IPPU
United Nations Environment Programme (UNEP)	Support for transitioning from conventional plastics to more environmentally sustainable alternatives	Multilateral	UNIDO	17 401 837	1 132 220	Jun-19	May-23	Grant	Received	Mitigation	Cross-cutting

4.5 TECHNOLOGY DEVELOPMENT AND TRANSFER SUPPORT NEEDED

4.5.1 Just Energy Transition

A just transition is at the core of implementing climate action in South Africa, as detailed in both the mitigation and adaptation goals described in the country's revised Nationally Determined Contribution (NDC). As part of ensuring a just transition, measures need to be put in place that plan for workforce reskilling and job absorption, social protection and livelihood creation, incentivising new green sectors of our economy, diversifying coal dependent regional economies and developing labour and social plans as and when ageing coal-fired power plants and associated coal production infrastructure are decommissioned (RSA, 2021). Similar measures are also necessary to adapt to the impacts of climate change.

The Presidential Climate Commission (PCC), established in 2020 to oversee and facilitate a just transition to a low-emissions and climate-resilient economy, adopted the Just Transition Framework in August 2022. The framework lays out a shared vision for shifting to an equitable, zero-carbon economy and identifies key policy areas and principles to achieve this. The Just Transition framework initially focused on four sectors and value chains that are at-risk in the transition, which form part of the formal economy: (1) the coal value chain, (2) the auto value chain, (3) agriculture and (4) tourism, as a first illustration of these risks.

South Africa highlighted various technologies in the country's first NDC that could help the country to further reduce emissions. These technologies included: energy efficient lighting; variable speed drives and efficient motors; energy efficient appliances; solar water heaters; electric and hybrid electric vehicles; solar PV; wind power; carbon capture and sequestration; and advanced bio-energy (RSA, 2016). Since the just transition in South Africa will require international co-operation and support, the revision of the NDC (RSA, 2021) provided an update on the support the country needed in addition to these technologies. Section 4.3 Financial Support Needed highlighted the investments needed in three priority sectors: electricity, New Energy Vehicles (NEVs), and Green Hydrogen (GH_2), specifically, investment needed in our electricity transmission and distribution networks and dramatically expanding renewable energy generation, investment in local production of green hydrogen and electric vehicles and investing in local economies to develop skills and enable economic diversification.

4.5.2 New Energy Vehicles

Globally, technological developments are notably enabling the diversification of drivetrains, away from traditional internal combustion engines (ICE) towards electric and other alternative motors. While electric vehicles (EVs) still account for a marginal share of global vehicle sales, the shift is evident in leading markets. However, South Africa lags behind this global trend, and EVs remain extremely marginal, be it from an offer, demand or manufacturing perspective (TIPS, 2020). South Africa's ambition is to rapidly enter this space. In the New Energy Vehicle (NEV) sector, the focus of the JET IP is on transitioning the automotive sector value chains as the global shift to electric vehicle production gains momentum, building NEV supply chain localisation, and setting the base for NEV manufacturing and component manufacturing, to protect sector employment and promote new growth in sustainable manufacturing (The Presidency of the Republic of South Africa, 2022).

The country's Green Transport Strategy sets out government's vision to radically grow the uptake of EVs in South Africa. The Electric Vehicle White Paper (DTIC, 2023) outlines a comprehensive electric vehicle roadmap for South Africa and the structure of a suite of policy interventions tailored to the automotive industry. The White Paper sets out the policy goals and actions which will be taken to support the transition towards a broader new energy vehicle production and consumption in South Africa, with an immediate focus on electric vehicles. The White Paper is the culmination of substantial research and engagement to chart a viable and sustainable transition path for the industry, and follows the publication of a Green Paper in 2021, extensive industry consultation (assemblers, component makers and organised labour), consideration of public comments, all of which helped to shape the policy actions to be taken. The White Paper also builds on the work of the South African Automotive Masterplan (SAAM 2035), which was published in 2018 with the ambition of increasing productive output and deepening localisation across the value chain.

Key barriers in the NEV sector also relate to lack of a coherent policy environment for public transportation in South Africa, high upfront costs; concerns around scalability; lower flexibility and limited operational experience; delayed procurement decisions (due to expected technology cost declines); changing electricity tariffs and grid stability concerns; the lack of a hydrogen refuelling network; and the lack of charging/refuelling infrastructure standardisation. There is furthermore no electric mini-bus taxis (e-MBT) currently available in South Africa (TIPS, 2020). Active policies and measures are needed to improve the EV offering and stimulate demand, as well as incentives in the South African market to support the demand for EVs. The 2024 Budget Review by National Treasury has proposed incentivising local electric vehicle production to encourage the production of electric vehicles in South Africa, and it is proposed that an investment allowance be made available for new investments from 1 March 2026. Producers will be able to claim 150 percent of qualifying investment spending on production capacity for electric and hydrogen-powered vehicles in the first year of investment (NT, 2024).

On the manufacturing side, the issues revolve around developing the local EV value chain, and this ranges from the mining and beneficiation of minerals to the manufacturing of parts and components, to the manufacturing of vehicles. Complementing vehicle manufacturing, the local components industry plays a crucial role in South Africa's automotive value chain, even though local content levels are relatively low (TIPS, 2020). EVs have several unique components (primarily batteries, fuel cells and electric powertrains). In turn, some components, such as engine parts, radiators and catalytic converters are replaced in two battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). While Lithium-Ion Batteries (LIBs) are currently imported, South Africa has committed to manufacturing LIBs, and efforts are being made by the public and private sector to further promote the manufacturing of LIBs in South Africa. South Africa is also well-endowed in an array of key EV-related minerals.

4.5.3 Hydrogen-related technologies

Hydrogen and its application in various sectors have the potential to reduce emissions and create jobs in its various value chains, which could be used to support the just transition in South Africa (DSI, 2022). New technologies such as green hydrogen are expected to play an important role in SA's low-carbon transition, but some of these technologies still require active support to reach commercial use. While SA is well positioned to benefit from the future economy, the sector is still at an early development stage, and several aspects remain relatively uncertain, including technology options, costs, and the specific role of the public sector. Harnessing the requisite investment to unlock this market will require meaningful stakeholder coordination and the creation of an enabling environment (World Bank Group, 2022).

The DSI had identified hydrogen fuel-cell technologies (HFCT) for their potential to reduce emissions and secure the country's energy future. As well as producing power, fuel cells also produce heat as a by-product. This heat can be exploited by customising fuel cells for use as a Combined Heat and Power (CHP) source and supply decentralised power and heating for buildings and industries. The South African government is driving the R&D on HFCT and related technologies for three main reasons *viz*.:

- South Africa is home to 75% of the global reserves for PGMs and most are used as value-added materials or catalysts in HFCT (DSI, 2022). This provides great potential for socio-economic benefits to be obtained from these natural resources due to the increased global demand for PGM products.
- The Human Capital Development (HCD) required to develop this sector will lead to job creation in South Africa – in order to supply the rest of the world with a much-needed resource.

- R&D of HFCT as a viable alternative, renewable energy source is essential to reduce CO_2 and GHG emissions and help meet the country's commitment to the global targets.

The Hydrogen South Africa (HySA) Research, Development and Innovation (RDI) Strategy was approved by Cabinet in 2007 and officially launched in 2008 by the then Department of Science, Technology and Innovation (now the Department of Science and Innovation (DSI)). The objective of 15-year HySA Programme was to develop the hydrogen economy, with a focus on beneficiation of Platinum-group metals (PGMs) through the development of HCFT.

The development of the Hydrogen Society Roadmap (HSRM) was initiated in 2020 and an Interdepartmental Committee developed the terms of reference for the development of the HSRM. The HSRM was published in February 2022 by the DSI and serves as a national coordinating framework to facilitate the integration of hydrogen-related technologies in various sectors of the South African economy and stimulate economic recovery, in line with the Economic Reconstruction and Recovery Plan (DSI, 2022). The HSRM sets national ambitions and sector prioritisation on the deployment of the hydrogen economy in South Africa, in line with the Integrated Energy Plan.

A proposed South African Green Hydrogen (GH_2) Commercialisation Strategy (GHGS) was released for public comment in December 2022. The GHGS builds on the strong foundation of work done by the DSI with respect to its HySA programme and the Hydrogen Society Road Map. A Green Hydrogen Commercialisation Panel was established in June 2021 by the Minister of Trade, Industry and Competition. The panel consists of private and public sector champions in the potential green hydrogen value chain and is currently being co-ordinated by the Industrial Development Corporation of South Africa (IDC). The purpose of the panel was to specifically focus on the development of a South African Green Hydrogen Commercialisation Strategy and Action Plan. The successful implementation of the Green Hydrogen commercialisation strategy will depend on the execution of the six key elements (DTIC, 2022) outlined in Table 4.8.

Table 4.8: Overview of the six key elements in the Green Hydrogen Commercialisation Strategy (DTIC, 2022)

Key Element	Description
1. Prioritise exports	Target exports of green hydrogen and green chemicals by leveraging on South Africa's proprietary Fischer Tropsch technology and utilising financing support mechanisms including grants, concessional debt and contract for difference / price subsidies to improve the financial viability of these projects.
2. Stimulate domestic markets	In parallel to the export strategy, develop projects along the value chain to stimulate demand for green hydrogen in South Africa. "Low hanging fruit" opportunities to be prioritised to provide confidence in the domestic market. Examples include green steel, hydrogen valley mobility programme and sustainable aviation fuel projects.
3. Support localisation	Develop local industrial capability to produce fuel cells, electrolyser, ammonia cracking and balance of plant equipment and components by leveraging on South Africa's PGM resources. Together with demand stimulation this will drive longer term GH_2 price reduction allowing penetration in various sectors.
4. Secure financing	"Crowd in" and secure funding from various sources and in various forms including grants, concessional debt and contract for differences.
5. Proactive socio-economic development	Maximise development impact (incl. skills and economic development and social inclusion); ensure gender equality, BBBEE and community participation; maximise job creation and alternative options for potential job losses.

Key Element	Description
6. Role of government in policy and regulatory support	Position GH_2 as a key early contributor to decarbonization and a just transition in the country programme of work being collated by the JET-IP Task Team ensuring a fair proportion of climate finance is sourced to enable development of this industry. Prioritize the execution of the green hydrogen commercialisation strategy and the development of a national GH_2 infrastructure plan. Drive the required policy and regulatory changes required to sustain long term growth of the new hydrogen industry. Mobilise and coordinate the Government support required to support the development of this new industry for South Africa.

The costs associated with the development of the Hydrogen Economy are summarised below. The estimates below are high level and will be validated by a comprehensive study (DTIC, 2022):

i. There will be a need for funding from development finance institutions (DFIs) in the form of grants, project development funds or concessional debt facilities. It is estimated that DFIs will need to contribute about R180bn in equity and R400bn in debt at concessional rates by 2050.

ii. Capex funding requirement from private sector. It is estimated that the private sector will need to contribute about R410bn in equity and would need to source a further R956bn in debt from commercial banks.

iii. Government subsidies and incentives will be required to support the catalytic hydrogen projects by the introduction of supportive policies and a regulatory framework for GH_2 that aids GH_2 price parity to increase domestic GH_2 demand.

iv. Costs associated with changes / new regulations and policies.

v. R&D spending to stay ahead of innovation and technology and remain competitive (amount still to be determined).

vi. Gradual reduction in income from petrochemical levies (impact to the economy still to be determined).

vii. Development of state procurement programme/s.

viii. Costs to develop hydrogen infrastructure.

ix. Cost associated with establishing global partnerships and bilateral government to government agreements.

x. Costs to develop training and skills development programmes to support job creation within the GH_2 sector.

4.6 TECHNOLOGY DEVELOPMENT AND TRANSFER SUPPORT RECEIVED

4.6.1 Technology development and transfer support received – technical assistance

Technology development and transfer support, in the form of technical assistance, received by South Africa during the BTR1 reporting period included bilateral support from Germany. The projects outlined in the common tabular format for technology development and support related to technical assistance received are provided in Table 4.9.

In addition, internationally-funded climate change related projects which have contributed to technology development and transfer objectives (indicated by '1' in the CTFs for Financial Support Received) are also included in the CTFs for technology development and transfer support received (Decision 5/CMA.3 Annex III, Table III.9) are provided in Table 4.10.

Table 4.9. Internationally funded climate change-related projects technology development and transfer support received in the form of technical assistance

Title of activity, programme, project or other	Type of technology	Time frame	Recipient Entity	Implementing Entity	Type of support	Sector	Subsector	Status of activity
Supporting a South African Green Hydrogen Economy (H_2 SA)	Green Hydrogen	2021-2025	The Presidency, HySA Network, Infrastructure SA, SANEDI, HSRC	Presidency / Various	Technical assistance	Energy	H_2	Ongoing
Catalyst Research for Sustainable Kerosene (CARE-o-SENE)	Green Sustainable Aviation Fuel (SAF)	2022-2025	Research partners for the next generation of Fischer-Tropsch catalysts in CARE-O-SENE include Sasol Germany GmbH, Sasol Limited and the Helmholtz-Zentrum Berlin fuer Materialien und Energie (Helmholtz Centre for Materials and Energy, HZB). Others are the Fraunhofer Institute for Ceramic Technologies and Systems (IKTS), the Karlsruhe Institute of Technology (KIT), The University of Cape Town (UCT) and INERATEC GmbH.	Project led by Sasol and Germany's Helmholtz-Zentrum Berlin (Helmholtz Centre for Materials and Energy, HZB). €30 million in funding provided by the German Federal Ministry of Education and Research and a further €10 million by Sasol.	Technical assistance	Energy	Aviation	Ongoing

Title of activity, programme, project or other	Type of technology	Time frame	Recipient Entity	Implementing Entity	Type of support	Sector	Subsector	Status of activity
Greening the production and use of liquefied fuel gas in Southern Africa (Green-QUEST)	Green liquefied fuel gas (green-LFG)	2022-2025	The three-year Green QUEST research partnership includes Nelson Mandela University's Department of Chemistry, the University of Cape Town (UCT), Helmholtz Zentrum Berlin (HBZ) and several other German and South African partners	German Federal Ministry of Research and Education (BMBF)	Technical assistance	Energy	Fuel	Ongoing
South African German Energy (SAGEN) Programme 4	Renewable energy	2021-2025	DMRE/Various	DMRE/Various	Technical assistance	Energy	Renewable Energy	Ongoing
Growing Greener	Climate-adapted livestock farming and sustainable land management	2021-2029	DFFE	DFFE	Technical assistance	Agriculture	Livestock	Ongoing

Table 4.10 Internationally funded climate change-related projects which contributed to technology development and transfer objectives

Donor	Title of activity, programme, project or other	Type of technology	Time frame	Recipient Entity	Implementing Entity	Type of support	Sector	Status of activity
Belgium	South African project on climate change adaptation in industries bearing fruit	Climate smart agro-processing technologies	2022-2025	NCPC, TIA	UNIDO	Grant	Agriculture	Ongoing
Energy Environment Partnership (EEP)	Mustapha Energy: Converting Residual Waste in Cape Town	Modular waste-to-energy plant	2021-	Witech Africa	EEP is hosted and managed by the Nordic Development Fund (NDF) with funding from Austria, Finland and NDF. Project partners WOIMA Corporation Oy, Waste Mart, Waste Transformation 4 Energy Association, ENCHA & Mahube Infrastructure Fund, WDC	Grant	Energy	Ongoing
Energy Environment Partnership (EEP)	Transforming water heaters into intelligent batteries	Intelligent thermal heaters	2021-	Plentify	EEP is hosted and managed by the Nordic Development Fund (NDF) with funding from Austria, Finland and NDF.	Grant	Energy	Ongoing
France	Coal plant decommissioning - Support to CSIR	Solar PV and battery storage	2022-2024	CSIR; DHET, Eskom	Council for Scientific and Industrial Research (CSIR)	Grant	Energy	Ongoing
Global Environment Facility (GEF)	Accelerating cleantech innovation and entrepreneurship in SMEs to support the transition towards circular economy and create green jobs	Cleantech solutions	2021-2026	Technology Innovation Agency (TIA), Impact Amplifier (IA)	UNIDO	Grant	Energy	Ongoing
Global Environment Facility (GEF)	Sustainable energy systems for urban-industrial development	Energy supply and energy demand technologies	2022-2025	National Cleaner Production Centre of South Africa (NCPC-SA)	UNIDO	Grant	Energy	Ongoing
Global Environment Facility (GEF)	Promoting organic waste-to-energy and other low-carbon technologies in small and medium and micro-scale enterprises (SMMEs): Accelerating biogas market development	Energy supply and energy demand technologies	2016 to 2023	Department for Environmental Affairs (DEA), Department of Energy (DoE), Department of Trade and Industry (DTI), Southern Africa Industry Biogas Association (SABIA)	UNIDO	Grant	Cross-cutting	Completed

Donor	Title of activity, programme, project or other	Type of technology	Time frame	Recipient Entity	Implementing Entity	Type of support	Sector	Status of activity
Green Climate Fund (GCF)	Climate Investor Two	Technologies to support the water, sanitation, and ocean sector	2022-2042	Pirvate sector	FMO, the Dutch Development Bank	Grant	Cross-cutting	Ongoing
Green Climate Fund (GCF)	CRAFT - Catalytic Capital for First Private Investment Fund for Adaptation Technologies in Developing Countries	Technologies for climate resilience and adaptation	2022-2034	Private sector	Pegasus Capital Advisors	Equity	Cross-cutting	Ongoing
Green Climate Fund (GCF)	Blue Action Fund (BAF): GCF Ecosystem Based Adaptation Programme in the Western Indian Ocean	Ecosystem-based adaptation	2021-2028	Public Sector	Blue Action Fund	Grant	Cross-cutting	Ongoing
Green Climate Fund (GCF)	Pipeline development to deploy clean energy technology solutions in municipal wastewater treatment works of South Africa	Clean energy technologies	2021-2024	Department for Environmental Affairs (DEA)	UNIDO	Grant	Waste	Completed
United Kingdom	eThekwini Regional Hydrogen Economy Study (UK PACT)	Hydrogen technologies	2021-2022	eThekwini Metropolitan Municipality	Arup South Africa	Grant	Energy	Completed
United Kingdom	City of Johannesburg Climate Action Plan Implementation Tracking (UK PACT)	Monitoring and Evaluation tools	2022-2024	City of Johannesburg	Sustainable Energy Africa (SEA)	Grant	Cross-cutting	Ongoing
United Kingdom	Clean Energy Innovation Facility (CEIF 1.0) Phase 1	Green hydrogen technologies	2021-2023	Worldbank IFC	InnovateUK	Grant	Industry	Completed
United Kingdom	High Gear	New Energy Vehicles	2022-2023	Elangeni TVET College	NAACAM	Grant	Transport	Completed
United Nations Environment Programme (UNEP)	HCFC phase-out management plan (stage I)	Alternative Refrigerants	2012-2023	National Ozone Unit, Department of Environmental Affairs (DEA, now DFFE)	UNIDO	Grant	IPPU	Completed
United Nations Environment Programme (UNEP)	HCFC phase-out management plan (stage II)	Alternative Refrigerants	2019-2031	National Ozone Unit, Department of Environmental Affairs (DEA, now DFFE)	UNIDO	Grant	IPPU	Ongoing
United Nations Environment Programme (UNEP)	Preparation of an HFC phase-down plan	Alternative Refrigerants	2021-2023	National Ozone Unit, Department of Environmental Affairs (DEA, now DFFE)	UNIDO	Grant	IPPU	Completed
United Nations Environment Programme (UNEP)	Support for transitioning from conventional plastics to more environmentally sustainable alternatives	Environmentally sustainable alternatives to plastic	2019-2023	CSIR	UNIDO	Grant	Cross-cutting	Completed

4.6.2 Green Technologies Stocktake

A 'Green Technologies Stocktake' study in support of achieving a just transition to a low carbon and climate resilient economy and society was commissioned by the Technology Innovation Agency (TIA) in 2024. The project aimed to undertake a technology readiness and capability stocktake to identify mature or near-market green technologies developed in South Africa that are ready for deployment into local supply chains, and/ or mature technologies developed internationally that can be localised in South Africa and deployed into local supply chains.

The study comprised two phases:

- Phase one consists of mapping the current low-carbon and climate-resilient technologies landscape in South Africa to identify gaps and opportunities; identifying those technologies in the research and development phase that are at an advanced stage for commercialisation and localisation; and investigating the readiness of low-carbon and climate resilient technologies in the energy and transport sectors for responding to the transition.
- In Phase two, the work would assess the country's capabilities to deploy low-carbon and climate resilient technologies in the economic sectors and their ability to attract finance at various scales.

The project is ongoing and results of which will be communicated in subsequent BTRs.

4.7 CAPACITY-BUILDING SUPPORT NEEDED

4.7.1 Capacity needs for Climate Budget Tagging

There are many capacities that should be developed for Climate Budget Tagging, these include priorities such as (NT, 2022b):

- Developing the core human resource capacities through training for CBT, i.e. in the NT, members of the different governance structures etc. (training will cover topics such as climate change relevance; identification of climate benefits; improved tagging consistency; etc.);
- There is a need for standing CBT training capacity, as CBT rolls out, to develop knowledge on climate change and capacities to implement the CBT methodology in departments of national and provincial government and municipalities. There is also a need for training programmes for institutions as they come onto the system.

4.7.2 Capacity needs for Just Energy Transition (JET) Skills Implementation Plan

The overarching goal of the JET skills implementation plan is to contribute to building a well co-ordinated, responsive, resourced, and effectively functioning skills ecosystem. This skills ecosystem will include communities, business, government, and other institutions to ensure that South Africa has an employable, skilled, and capable workforce to implement the JET and support economic growth in the core value chains (The Presidency of the Republic of South Africa, 2023). Several challenges within the skills sector that must be overcome for South Africa to deliver on the JET were outlined in the JET implementation plan (The Presidency of the Republic of South Africa, 2023). Based on these challenges, the following needs were identified:

- A centralised, coherently organised co-ordination for skills development for the JET – There is a need to establish a co-ordination mechanism for the national planning and development of sustainability skills in South Africa.
- A coherent national picture of supply and demand of JET skills - fragmentation has resulted in many small studies on skills supply and demand, and it is not possible to aggregate information or data to build a clear national picture of supply and demand of JET due to differing methodologies used.

- Skills anticipation systems – development and implementation of frameworks for skills anticipation for employers
- Better insight of factors shaping skill formation systems at a national level - the object of analysis is education and training at a systemic level, including workplace-based and informal learning, and its interaction with economic and social institutions.
- Disconnect between training institutions and specific needs of local communities in the context of clean energy – A concerted effort is needed to bridge the gap between training institutions and communities, ensuring that skills development is inclusive, relevant, and accessible to all, thereby fostering a JET in South Africa.

4.7.3 Capacity needs for Gender Climate Mainstreaming

Adoption and implementation of gender-climate mainstreaming will require capacity building and awareness raising to ensure that it reaches all spheres and levels of the public and private sectors in South Africa. Transformational change will not be achieved with a single training event, or awareness-raising programme, and a long-term plan is needed. One of the strategic actions proposed in South Africa's draft Gender Action Plan (DFFE, 2022), Strategic Action 6, is to 'Implement a gender awareness raising and capacity building programme'.

Activities needed to support this programme are (DFFE, 2022):

i) A gender-climate mainstreamed cost-benefit analysis should be undertaken that deepens and contextualises available research on the direct benefits of women-led and inclusive climate change responses across sectors and societal systems, and in addition, enumerates the gendered co-benefits of climate change responses. The results of this analysis will be used to inform capacity building and awareness raising at different levels.

ii) A programmatic gender–climate education and awareness raising campaign should be designed to be implemented across sectors, systems and society. Integrating the results of the cost benefit analysis — among other resources. This campaign will be complimented by a parallel five-year capacity building and awareness raising programme which will also conduct continuous and formative monitoring and evaluation, applying gender-sensitive indicators.

iii) Capacity building programmes are needed across all NDC sectors and government, to support and capacitate officials responsible for implementing gender-climate mainstreaming activities — including the GFPs. This will also be key to supporting the achievement of their future Key Performance Indicators for gender and climate change. These officials should be encouraged to take ownership of in-house gender-climate mainstreamed activities — including ongoing capacity building and awareness raising in their departments.

4.7.4 Capacity needs for Adaptation

The Adaptation Chief Directorate also requires:

- Capacity building support to develop indicators to monitor and track progress of the implementation of the National Adaptation Strategy (refer to Chapter 3, Section 3.8.4 and 3.8.5).
- Capacity building support at the local/municipal level related to the planning and implementation of adaptation to support addressing gaps in local-level reporting and data-sharing which is often due to limited resources and capacity in municipalities (refer to Chapter 3, Section 3.8.2).
- Capacity building support is needed to support the collection, assessment and analysis of loss and damage related data in South Africa (refer to Chapter 3, Section 3.9.3.2),

4.8 CAPACITY-BUILDING SUPPORT RECEIVED

Capacity building support received from developed countries in the form of technical assistance, in the 1 Jan 2021-31 Dec 2022 reporting period, is summarised in Table 4.10.

In addition, internationally-funded climate change-related projects which contribute to capacity-building objectives (indicated by '1' in the CTFs for Financial Support Received) are also included in the CTFs for capacity-building support received (Decision 5/CMA.3 Annex III, Table III.11) (Table 4.11).

Table 4.11: Capacity building training received in the form of technical assistance

Title of activity, programme, project or other	Programme/project description	Time frame	Recipient entity	Implementing entity	Type of support	Sector	Status of activity
Climate Vulnerability and adaptation assessment	Assessment is intended to aid non-Annex I Parties in selecting their V&A assessment approaches, methods and tools, by providing as wide a range of methods and tools as possible.	Apr-21	DFFE	UNEP/UNDP Global Support Programme	Adaptation	Cross-cutting	Completed
Energy Secretariat Skill-share (UK PACT)	The skill-share provided Monitoring, Evaluation and Learning (MEL) support to DSI and SANEDI to develop a Theory of Change and a MEL framework for the Energy Secretariat at an organisation-level and for the draft Energy, Science, Technology and Innovation Plan (ESTIP).	Nov 2021-Sep 2023	DSI, SANEDI	Ricardo	Mitigation	Cross-cutting	Completed
SAGEN-CET (Capacities for the Energy Transition)	Technical Assistance, specifically capacity building on power sector reform topics, organizational development and gender mainstreaming	Nov 2021-Dec 2026	DMRE, Eskom, NT, SALGA, NERSA, Universities, NTCSA, SACN and the private sector	DMRE	Mitigation	Energy	Ongoing
Career Path Development for Employment (CPD4E)	Employment Promotion in Green Economy/Energy Transition	2022-2026	Department of Higher Education and Training (DHET)	Department of Higher Education and Training (DHET)	Cross-cutting	Energy	Ongoing

Title of activity, programme, project or other	Programme/project description	Time frame	Recipient entity	Implementing entity	Type of support	Sector	Status of activity
Integrated NDC Implementation Support in South Africa	Socio economic studies and consultancy to support coal phase out and implementation of NDC	2021-	DFFE	DFFE	Mitigation	Energy	Ongoing
Career Path Development for Employment (CPD4E)	Employment Promotion in Green Economy/Energy Transition	2021-2026	Department of Higher Education and Training (DHET)	Department of Higher Education and Training (DHET)	cross-cutting	Skills + Employment	Ongoing
Low carbon and climate resilient water and Waste water Management (LCCR)	addressing critical issues in the water and sanitation sector, enhancing climate resilience, reducing GHG emissions, and strengthening institutional capacities; supports the implementation of the National Water and Sanitation Master Plan and the Climate Change Response Strategy.	2022-2025	DWS	DWS	Cross-cutting	Water and sanition	Ongoing
C40 Cities Finance Facility (CFF)	Financing climate protection in cities: support cities in preparing finance-ready infrastructure projects that contribute to climate action; helps cities reduce greenhouse gas emissions, mobilize funding, and build capacity for climate-relevant projects	2021-2024	City of Cape Town	City of Cape Town	Cross-cutting	Cross-cutting	Ongoing
CitiesAdapt	Strengthening Climate Change Adaptation in cities; adapting cities to climate change by implementing nature-based and pro-poor solutions	2022-2025	DFFE, CoGTA	DFFE	Cross-cutting	Cross-cutting	Ongoing

Title of activity, programme, project or other	Programme/project description	Time frame	Recipient entity	Implementing entity	Type of support	Sector	Status of activity
Green Economy Transition (GET 4.0)	Improving Political Framework for Inclusive Green Economy (IGE); supporting Sustainable Infrastructure and Green Fiscal Policy; improving climate action transparency, policy frameworks, and sustainable development initiatives.	2022-2025	DFFE	DFFE	Cross-cutting	Green Economy	Ongoing
Cooling Program for Southern Africa (CoopSA)	prepare framework conditions of an AC replacement programme; aims to implement national support programmes for green air conditioning systems with heat pump functions; setting up MEPS and energy labels for air conditioning systems.	2021-2026	DFFE	DFFE	Mitigation	Cross-cutting	Ongoing
Innovation Regions for a Just Energy Transition	Addresses the economic and social impacts of phasing out coal in coal-mining regions; supports the planning and implementation of transformation paths and comprehensive plans for a just energy transition away from coal towards a low-carbon energy system in coal regions	2022-2026	Mpumalanga Department of Economic Development and Tourism (DEDT)	Mpumalanga Department of Economic Development and Tourism (DEDT)	Cross-cutting	Energy	Ongoing

Table 4.12. Internationally funded climate change-related projects which contributed to capacity-building objectives

Title of activity, programme, project or other	Time frame	Implementing entity	Type of support	Sector	Status of activity
Strengthened adaptation capacity for a green and resilient economy in South Africa	2022-2025	UNIDO	Adaptation	Cross-cutting	Ongoing
Adaptive Capacity Facility	2018-2024	DFFE	Adaptation	Cross-cutting	Ongoing
Response of the Earth System to overshoot, Climate neutrality and negative Emissions under Horizon Europe (RESCUE)	2022-2026	University of Cape Town	Mitigation	Cross-cutting	Ongoing
Circular economy industrial symbiosis under Horizon Europe	2022-2026	University of Johannesburg	Mitigation	Waste	Ongoing
iThemba Phakama People PPP Model for Human Development and Inclusive Environmental Economic Growth	2019-2023	DFFE	Adaptation	Cross-cutting	Ongoing
Circular Economy Incubator	2021-2022	WomHub	Mitigation	Waste	Completed
Accelerating Circular Economy in Africa (ACE Africa)	2021-2022	ICLEI- Local Government for Sustainability - Africa	Mitigation	Waste	Completed
The circular Economy Accelerator	2021-2022	Fetola Foundation	Mitigation	Waste	Ongoing
CSP Phase 2 - water resilience in metros	2021-2023	AFD - French Development Agency	Adaptation	Water	Ongoing
Sovereign policy loan	2021-2022	AFD - French Development Agency	Cross-cutting	Cross-cutting	Completed
Climate Support Programme - Finance the near-term priority flagship programme and an IT-expert for the implementation of the climate change web-based monitoring and evaluation systems	2017-2021	DFFE	Cross-cutting	Cross-cutting	Ongoing
Provide support to the coordination and implementation of the South African Ecosystem based Adaptation Strategy	2017-2021	DFFE	Adaptation	Biodiversity	Ongoing
Promoting organic waste-to-energy and other low-carbon technologies in small and medium and micro-scale enterprises (SMMEs): Accelerating biogas market development	2016-2023	UNIDO	Mitigation	Cross-cutting	Completed

Title of activity, programme, project or other	Time frame	Implementing entity	Type of support	Sector	Status of activity
Capacity Building Programme to Implement South Africa's Climate National System	2019-2024	UNEP	Cross-cutting	Cross-cutting	Ongoing
Climate Investor Two	2022-2042	FMO, the Dutch Development Bank	Cross-cutting	Cross-cutting	Ongoing
Blue Action Fund (BAF): GCF Ecosystem Based Adaptation Programme in the Western Indian Ocean	2021-2028	Blue Action Fund	Adaptation	Cross-cutting	Ongoing
Pipeline development to deploy clean energy technology solutions in municipal wastewater treatment works of South Africa	2021-2024	UNIDO	Mitigation	Waste	Completed
Sustainable Cities - Africa Platform	2021-2026	SECO, IFC; Metropolitan municipalities, secondary cities	Cross-cutting	Cross-cutting	Ongoing
ESMAP (Energy Sector Management Assistance Program)	2021-2026	World Bank	Mitigation	Energy	Ongoing
South Africa Programmatic Advisory Services and Analytics (supported through ESMAP)	2022-2026	World Bank	Mitigation	Energy	Ongoing
City of Cape Town Grid Regulation Skill-share (UK PACT)	2022-2023	Ricardo and ECO	Mitigation	Energy	Completed
The UK funded Climate Finance Accelerator (CFA)	2021-2024	PwC, GreenCape, National Business Initiative	Mitigation	Cross-cutting	Ongoing
Trade Forward Southern Africa (TFSA)	2022-2024	Trade Forward Southern Africa and partners	Mitigation	Energy	Completed
Shifting the Transport Paradigm – Electric Vehicles (UK PACT)	2021-2023	Nelson Mandela University and Cenex	Mitigation	Transport	Completed
Electric Vehicle Readiness in City of Johannesburg (UK PACT)	2021-2022	Sustainable Energy Africa (SEA)	Mitigation	Transport	Completed
Building the Green Hydrogen Economy Just Energy Transition (UK PACT)	2021-2022	South African Institute of International Affairs (SAIIA), Trade and Industrial Policy Strategies (TIPS), University of Cape Town (UCT) Energy Research Centre, KPMG, Bambili Energy	Mitigation	Industry	Completed
Green Skills in IRM	2022-2023	IOPSA,Blu Lever, NBI	Mitigation	Energy	Completed

Title of activity, programme, project or other	Time frame	Implementing entity	Type of support	Sector	Status of activity
MAGC will provide a Performance Based Incentive (PBI), for pre-agreed eligibility criteria, that will partly offset greening and EDGE certification costs for developers	2021-2026	IFC and Business Partners Limited	Mitigation	Construction	Ongoing
IFC will provide advisory services in South Africa in line with the aims of the MAGC program	2021-2026	IFC and Nedbank	Mitigation	Construction	Ongoing
HCFC phase-out management plan (stage I)	2012-2023	UNIDO	Mitigation	IPPU	Completed
HCFC phase-out management plan (stage II)	2019-2031	UNIDO	Mitigation	IPPU	Ongoing
Preparation of an HFC phase-down plan	2021-2023	UNIDO	Mitigation	IPPU	Completed
Support for transitioning from conventional plastics to more environmentally sustainable alternatives	2019-2023	UNIDO	Mitigation	Cross-cutting	Completed

4.9 SUPPORT NEEDED AND RECEIVED FOR THE IMPLEMENTATION OF ARTICLE 13 OF THE PARIS AGREEMENT AND TRANSPARENCY-RELATED ACTIVITIES, INCLUDING FOR TRANSPARENCY-RELATED CAPACITY-BUILDING

4.9.1 Strengthening South Africa's capacity to comply with the Enhanced Transparency Framework (ETF) requirements under Article 13 of the Paris Agreement

South Africa received multilateral financial support from the Global Environment Facility (GEF) as part of the Capacity Building Initiative for Transparency (CBIT) Project for South Africa. An overview of project details is provided in Table 4.13.

Table 4.13. Support received for the implementation of Article 13 of the Paris Agreement (Source: DFFE)

Project Title: Strengthening South Africa's capacity to comply with the Enhanced Transparency Framework (ETF) requirements under Article 13 of the Paris Agreement	
Country	South Africa
GEF Agency	United Nations Environment Programme
Executing Partner	The Department of Forestry, Fisheries and the Environment
GEF Focal Area	Climate Change
Submission date	20 June 2018
Project implementation start date	01 June 2019
Project Duration (Months)	66
GEF Project Financing	USD 1,100,000
Co-financing	USD 1,018,969 from the DFFE (SA Government)
Project End Date	31 December 2024

The objective of the project is 'To enhance human and institutional capacity related to the enhanced transparency framework in South Africa such that South Africa will be able to meet the enhanced transparency framework requirements under the Paris Agreement' (Table 4.14). Project outputs include:

- An institutional arrangement that supports operationalization of South Africa's Climate Change Monitoring & Evaluation (M&E) System established.
- Long-term strategy on GHG inventory compilation and mitigation actions' assessment developed.
- Relevant entities trained on international MRV guidance as well as the ETF.
- South Africa having built a sufficient Roster of Experts to participate in the ETF reviews.

The total amount of GEF funding received was USD 1 100 000. The CBIT project falls under GEF's support for convention-related reporting and assessment and is implemented on an agreed full cost basis requiring only in-kind contribution by GEF-eligible countries. For this project, the confirmed co-financing at CEO endorsement phase totals USD 1 018 969. The amount of funding received by SA, for 2021 and 2022 only, has been included as part of the overall funding received from the GEF for funding received.

Table 4.14. The Capacity Building Initiative for Transparency project objectives, expected outcomes and activities

Description	Expected outcomes	Activities
Technical Expert in Greenhouse Gas Inventory information systems	Hiring of a technical expert in GHG inventory to provide expertise in GHG inventory within the DFFE.	The service provider has been hired for the provision of greenhouse gas inventory expertise within the DFFE in the GHG Inventory Directorate and the Inception meeting was held on 30 May 2023. The service provider consists of Project leader, Project manager and a Junior consultant. The service provider provides support on the implementation of the requirements of the Enhanced Transparency Framework(ETF), with regards to the National Inventory Report (NIR) for all the IPCC sectors. Supports the DFFE in updating the National GHG Emissions Inventory data on the National GHG Inventory Management System. Provides training for DFFE officials and other data providers on GHG Inventory compilation and GHG tools.
Regional Adaptation Workshops	Organising of 15 M&E System information management system training workshops for Adaptation	17 workshops were organized across the different provinces of South Africa. The workshops focused on engaging the province and building their capacities on the use of the National Climate Change Information System to provide the DFFE with data on adaptation. Furthermore, the workshops also focussed on capacitating provinces on how they can develop their own provincial climate change information systems as well as provincial climate change databases that can be linked to national ones to support monitoring and evaluation as well as reporting under the ETF. There were also workshops on Indigenous Knowledge Systems and how data from that can be obtained for reporting under the ETF.
Gender differentiation and equality in climate change workshops	Organising of gender differentiation workshops in climate change.	Activity completed. South Africa has organised 2 workshops on Gender differentiation and equality in climate change. However, the Directorate Climate Change Development and International Mechanisms anticipates on supporting the Directorate: United Nations Framework Convention on Climate Change with organizing a gender mainstreaming workshop in 2023.

Description	Expected outcomes	Activities
Peer to peer exchange for international experts to share knowledge and experiences at DFFE.	Organising of peer-to-peer exchange for international experts to share knowledge and experiences on implementation of the MRV framework as well as preparation for the ETF	South Africa, through the DFFE has visited the USA September 2023 and Canada in February 2024. These visits were for the DFFE officials to learn from developed countries on how they developed and maintained as well as used their climate change monitoring and evaluation systems as well as institutional arrangements for international reporting on climate action. This is imperative as South Africa's enhances its monitoring and evaluation system as well as institutional arrangements to align with the reporting under the enhanced transparency framework. The DFFE has also done a peer-to-peer exchange with the UK in August 2024. South Africa, through the DFFE has also hosted other African countries for the peer-peer workshop that organised in March 2024 in Pretoria to learn the same. The visiting countries were Kenya, Nmibia, Malawi, Ghana, Gambia, and Zambia.
A consortium of experts to support the long-term capacity building strategy on GHG inventory compilation and mitigation actions' assessment	Hiring of a consortium of experts to support the long-term capacity building strategy on GHG inventory and mitigation actions at national and provincial level.	A service provider has been hired to develop the long-term capacity building strategy. The strategy also included the development of training program on Greenhouse Gas Inventory compilation and Mitigation Actions' assessment. A hands-on training course was developed and offered for GHG Inventory compilation focussing on the general overview, and the four IPCC sectors including Energy, IPPU, AFOLU and Waste. It was offered to 30 officials from national government departments with cross cutting mandates on climate change as well as data providers such as the Agricultural research Council.

4.9.2 GEF Expedited Enabling Activity "South Africa: Enabling Activities for the Preparation of Initial Biennial Transparency Report (BTR1) to the United Nations Framework Convention on Climate Change (UNFCCC)"

South Africa also received multilateral financial support from the GEF as part of GEF Expedited Enabling Activity (EEA) for South Africa for the preparation of its initial Biennial Transparency Report to the UNFCCC. An overview of project details is provided in Table 4.15.

Table 4.15. Support received for the implementation of Article 13 of the Paris Agreement – GEF EEA (Source: DFFE)

Project Title: GEF Expedited Enabling Activity (EEA) "South Africa: Enabling Activities for the Preparation of Initial Biennial Transparency Report (BTR1) to the UNFCCC"	
Country	South Africa
Executing Agency	South-South-North (SSN)
Executing Partner	The Department of Forestry, Fisheries and the Environment
GEF Focal Area	Climate Change
Submission Date:	April 2025
Project Duration (Months)	21 months
Project implementation Period	11 August 2023 to 30 April 2025*
GEF Project Financing	USD 600 000
Co-financing	In kind - DFFE

**Note: This funding for this project is not included in the section on international support received since it does not fall within the 1 Jan 2021-31 Dec 2022 reporting period for the BTR1.*

The project aims to support the Republic of South Africa, through the Department of Forestry, Fisheries and Environment (DFFE), to prepare and submit its First Biennial Transparency Report (BTR1) which complies with the UNFCCC and the Paris Agreement reporting requirements, while responding to its national development goals. The project is being implemented using the UNEP as the implementing agency of the GEF and the SSN is the executing agency on behalf of the South African Government (DFFE). The third-party modality was adopted in order to avoid bureaucratic processes often faced by the DFFE when implementing projects directly, thereby ending up causing delays in projects' implementation. This is part of the lessons learned from the previous implementation of other GEF-funded projects such the enabling activities projects and the 1st CBIT project. The project is being implemented with full strategic and technical oversight by the DFFE. The CSIR has been procured to assist the DFFE to develop the BTR1. The CSIR works with the entire Climate Change and Air Quality Branch to draft and finalize the BTR, though the work is coordinated and overseen under the International Climate Change Relations and Reporting Chief Directorate. The CSIR will also assist the DFFE with the electronic reporting including generating the Common Reporting Tables (CRTs) for the GHG Inventory as well as the Common Tabular Formats (CTFs) for the NDC tracking and Support needed and Received Chapters using the UNFCCC reporting tool. Furthermore, the University of Cape Town has been procured as the independent reviewers of BTR1 of South Africa. The independent review will review compliancy with the MPGs in terms of both completeness and transparency and recommendations on what can be addressed in the first BTR well as in subsequent BTRs.

Project outputs include:

1. South Africa's First BTR prepared and submitted to UNFCCC by December 2024, and
2. Stocktaking report for preparation of the project proposal for subsequent reports under the UNFCCC and Paris Agreement completed.

The DFFE is providing in kind co-finance in the implementation of the BTR project. The Project Coordinator under the project receives an additional 37% of their salary from the DFFE as well as internet service and a mobile cellular device with airtime. Additionally, the extended Project Management Unit, from the International Relations and Reporting Chief Directorate is a permanent structure under the DFFE comprising the Deputy Director, the Director and the Chief Director.

4.9.3 Capacity support needed for preparing GHG inventory reports pursuant to Article 13 of the Paris Agreement

Capacity support needed by South Africa for preparing the country's greenhouse gas inventory using the 2006 IPCC Guidelines was provided in Chapter 1, Section 1.10, as part of the National Greenhouse Gas Improvement Programme (GHGIP). These capacity needs are reiterated in Table 4.16 for improvements to the GHG Inventory that were listed as projects under implementation or planned projects.

Table 4.16. Capacity support needed for preparing reports pursuant to Article 13 of the Paris Agreement – Capacity needs related to improvements to the GHG Improvement Plan

Title of activity, programme, project or other	Objectives and description	Expected time frame	Recipient entity	Status of activity	Additional information - Barriers and constraints
GHG Improvement Plan	Improve uncertainty data for all sectors by incorporating more country specific uncertainty values	Incorporated as data becomes available	DFFE	In progress	Lack of uncertainty data constrains this activity. As data becomes available it will be incorporated. In this inventory a more detailed analysis of uncertainty for LULUCF sector was completed.
GHG Improvement Plan	Improve QA/QC process by addressing all issues in external review	Future inventories	DFFE	In progress	Challenges in addressing external review comments have been limited by resources and process management. The DFFE inventory team has increased in size, which should assist in addressing this issue. There are still many issues not resolved but the inventory team is working through them. It is an ongoing process.
GHG Improvement Plan	Improve the improvement plan by incorporating all review activities not addressed in current inventory	Ongoing	DFFE	In progress	Partly resolved. Challenges around inclusion of further improvements into the improvement plan are limited resources and process management. The DFFE inventory team has increased in size, but it is still taking time to completely address all the issues. The review outputs are included in this report as a reminder of what still needs to be completed.
GHG Improvement Plan	Improve explanation of large changes in trends	Ongoing	DFFE	In progress	Partly resolved. Additional explanations have been provided, but there are still areas where this can be improved further. Ongoing process.
GHG Improvement Plan	Incorporate all background data for the Tier 2 calculations of enteric fermentation	2024 inventory	DFFE	In progress	All the background equations have been included, but average data is still being used for most of the factors (instead of annual data) due to a lack of a sustainable data source. Data sources are being investigated and data will be included once it becomes available.
GHG Improvement Plan	There is a need for an alternate data source for Lime data	2024 inventory	DFFE	In progress	Past inventory reviews have mentioned upgrading this information and investigating the alternate method of calculating potential lime use.

Title of activity, programme, project or other	Objectives and description	Expected time frame	Recipient entity	Status of activity	Additional information - Barriers and constraints
GHG Improvement Plan	Complete a full uncertainty analysis for the Land sector, including area bias corrections	2024 inventory	DFFE	In progress	A more detailed uncertainty analysis was included for biomass, DOM and SOC data in the LULUCF sector. Mapping uncertainties were improved; however, these will be improved further during the land change improvement plan.
GHG Improvement Plan	Improvement of land change data through detailed assessment of maps and tracking of land parcels	The land use improvement plan will be completed over the next 3 years so data will be incorporated as it becomes available (2024 and 2026 inventory)	DFFE	In progress	This 2022 inventory incorporated a more detailed assessment of the land change data and identified the most important land change categories that need attention. The assessment also identified improvements that need to be done moving forward and the priority of these improvements. Removing changes due to seasonality is the top priority and this will be improved as more land change maps are obtained. The 2022 SANLC map will already assist with making improvements. Tracking land parcels over time is the second most important issue and training on Collect Earth to assist in this process is underway.
GHG Improvement Plan	Include deadwood in the DOM pool for all land categories	2024 inventory	DFFE	In progress	Deadwood has been included for the forest land category. The other land categories with woody components are settlements and perennial crops, but data is very limited for these land categories. Deadwood in these categories is assumed to be very small, but an explanation of this will be included in the next inventory.
GHG Improvement Plan	Move to a higher tier level for DOM in forest lands	2024 inventory	DFFE	In progress	This was considered in the 2022 inventory and more detailed disturbance matrix data was included to determine the amount of biomass entering the DOM pool, however there were still one or two pieces of data missing which requires further investigation. This will be completed and included in the next inventory.

Title of activity, programme, project or other	Objectives and description	Expected time frame	Recipient entity	Status of activity	Additional information - Barriers and constraints
GHG Improvement Plan	Data collection on quantities of waste disposed of into managed and unmanaged landfills	2024 inventory	DFFE	In progress	Project is underway so data will be included in 2024 inventory.
GHG Improvement Plan	Investigate inconsistencies in lime activity data (for lime production in IPPU and lime application emission in Agriculture), explore alternative data sources or improve consistency.	BTR 3	DFFE	Planned	Not resolved. Various methods were compared but gave varying results. Alternative data sources have not yet been found, but it may be possible to collect further data through the SAGERS system in future.
GHG Improvement Plan	Incorporate NOx, CO, NMVOC, and SOx emissions	BTR 3	DFFE	Proposed	Not resolved.
GHG Improvement Plan	Further disaggregation of 1A2	Future inventories	DFFE	Planned	Current inventory breaks down 1A2 into 1A2a, 1A2b and 1A2-ab. Further work is required to further disaggregate this sector and have emissions calculated per sub-sector.
GHG Improvement Plan	More activity data for estimating emissions associated with non-energy fuel use	Future inventories	DFFE	Planned	Research to be initiated in future.
GHG Improvement Plan	Inclusion of methodology documentation/ summary/approval process for tier 3 methods	Future inventories	DFFE	Planned	To be collated and included in future.
GHG Improvement Plan	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams	Future inventories	DFFE	Planned	Research to be initiated in future.
GHG Improvement Plan	CH_4 emissions from abandoned mines	Future inventories	DFFE	Planned	Research to be initiated in future.
GHG Improvement Plan	Investigate pipeline transport	Future inventories	DFFE	Proposed	Proposed but nothing planned.
GHG Improvement Plan	Investigate ground activities at airports and harbours	Future inventories	DFFE	Proposed	Proposed but nothing planned.
GHG Improvement Plan	Update of the VKT study, including segregation of on-road/off-road	Future inventories	DFFE	Proposed	Proposed but nothing planned.
GHG Improvement Plan	Comparison of the next VKT approach with fuel statistics	Future inventories	DFFE	Proposed	Proposed but nothing planned.

Title of activity, programme, project or other	Objectives and description	Expected time frame	Recipient entity	Status of activity	Additional information - Barriers and constraints
GHG Improvement Plan	Segregation of military energy use.	Future inventories	DFFE	Proposed	Proposed but nothing planned.
GHG Improvement Plan	Incorporate emissions from biogas	Future inventories	DFFE	Proposed	This would require a study and so should be recommended as a project under the GHGIP.
GHG Improvement Plan	CO2 transport and storage	Future inventories	DFFE	Proposed	Proposed but nothing planned.
GHG Improvement Plan	CO_2, CH_4 and N_2O emissions from combined heat and power (CHP) combustion systems	Future inventories	DFFE	Proposed	Proposed but nothing planned.
GHG Improvement Plan	Development of T3 methods for CTL-GTC and GTL	Future inventories	DFFE	Proposed	Resources and funding are required to complete this study so it will be incorporated into the GHGIP.
GHG Improvement Plan	Include emissions from electronics industry		DFFE	Planned	A study needs to be undertaken to understand emissions from this source so it should be highlighted as a project for the GHGIP.
GHG Improvement Plan	Incorporate emissions SF_6 emissions		DFFE	In progress	Lack of data is still a challenge.
GHG Improvement Plan	Improve manure management data, including biogas digesters as a management system	2024 inventory	DFFE	Proposed	Proposed project as there is a high variability in this dataset.
GHG Improvement Plan	Incorporate organic soils study to include emissions from organic soils	Future inventories	DFFE	Planned	Not resolved. Due to the other more pressing issues relating to land this was not a priority and will be incorporated once the land mapping system is running.
GHG Improvement Plan	Undertake a National Forest Inventory and include SOC in the inventory	Future inventories	DFFE	Proposed	This is an activity which would need to be completed by the Department of Forestry, therefore the date for completion is not known.
GHG Improvement Plan	Complete an assessment of crop types and areas and investigate discrepancies between crop statistics and NLC data	2024 inventory	DFFE	Planned	This was partially investigated in this inventory; however, a proper assessment will be included in the land use change improvement plan that will run over the next few years.

Title of activity, programme, project or other	Objectives and description	Expected time frame	Recipient entity	Status of activity	Additional information - Barriers and constraints
GHG Improvement Plan	Perform a more detailed assessment of HWP to include a wider range of products		DFFE	Proposed	Proposed project that could be considered under the GHGIP. For future evaluation.
GHG Improvement Plan	Report activity data and parameters (e.g. half-life) used for HWP emission estimation for the whole time-series	2024 inventory	DFFE	Planned	This will be included in the 2024 inventory.
GHG Improvement Plan	Report on the frequency of the HWP activity data collection	2024 inventory	DFFE	Planned	This will be included in the 2024 inventory.
GHG Improvement Plan	Collect data on other disturbances besides fire in forest lands	Future inventory	DFFE	Proposed	This would require a study so it will be recommended as a project under the GHGIP.
GHG Improvement Plan	Assess the significance of peatlands	2026 inventory	DFFE	Proposed	Assessing the areas of peatlands would be the first step and this part could be done as part of the land use improvement plan.
GHG Improvement Plan	Improve the transparency and accuracy of the LULUCF estimation file and report	2026 inventory	DFFE	Planned	This will start next year but will continue through to the following year.
GHG Improvement Plan	Address the LULUCF section corrections	Next inventory	DFFE	In progress	The LULUCF sector estimates will be assessed and corrections made to address the issues. This has already started.
GHG Improvement Plan	Further assessment of impacts of fires	Next inventory	DFFE	Planned	This will involve the provision of a more detailed assessment and methodology for determining impacts of fire, particularly natural disturbance.
GHG Improvement Plan	Improve MCF and rate constants	BTR 3	DFFE	Proposed	This would require a study so will be recommended as a project under the GHGIP.
GHG Improvement Plan	Include economic data for different population groups	BTR 3	DFFE	In progress	Will be included in the 2024 inventory
GHG Improvement Plan	Include information on population distribution in rural and urban areas as a function of income	BTR 3	DFFE	In progress	Insufficient data.
GHG Improvement Plan	Include HWP in solid waste	BTR 4	DFFE	Proposed	Once HWP data is improved (see above) it will be incorporated into solid waste.
GHG Improvement Plan	Obtain data on waste streams and the bucket system	BTR 3	DFFE	Planned	Insufficient data.

Title of activity, programme, project or other	Objectives and description	Expected time frame	Recipient entity	Status of activity	Additional information - Barriers and constraints
GHG Improvement Plan	CH_4, N_2O emissions from biological treatment of waste	BTR 3	DFFE	Planned	Insufficient data.
GHG Improvement Plan	CO_2, CH_4 and N_2O from waste incineration	BTR 3	DFFE	Planned	Insufficient data.

4.9.4 Capacity support received for preparing reports pursuant to Article 13 of the Paris Agreement

Capacity support received by the DFFE for preparing reports pursuant to Article 13 of the Paris Agreement are outlined in Table 4.17. Planned improvements to the National Greenhouse Gas Improvement Programme (GHGIP) which have been completed are outlined in Table 1.4 (Chapter 1, Section 1.10). However, it is important to note that the data in the GHG improvement plan listed under 'completed' has not been disaggregated to reflect when that support was received and when the specific improvements were completed.

Table 4.17. Capacity support received for preparing reports pursuant to Article 13 of the Paris Agreement

Title of activity, programme, project or other	Programme/ project description	Time frame	Recipient entity	Implementing entity	Type of support	Sector	Use, impact and estimated results
Greenhouse Gas (GHG) Management Institute 501 IPCC: Introduction to Crosscutting issues	This course is a rigorous introduction to the Institute's series on greenhouse gas inventories using the 2006 IPCC Guidelines.	Nov 2022 - Jun 2023	DFFE	UNFCCC	Mitigation	Crosscutting	Improved understanding of the fundamental processes and techniques for compiling an inventory of GHG emissions and removals before you learn to estimate emissions and removals from specific sectors and activities in the other courses in this series.
GHG Management Institute Proficiency Certificate 551 IPCC: Waste	This course provides a rigorous training on the emission sources and estimation methodologies for the waste sector based on the internationally endorsed 2006 IPCC Guidelines.	Nov 2022 - Jun 2023	DFFE	UNFCCC	Mitigation	Waste	Improved understanding of expert level knowledge and skills necessary to use and or prepare GHG emission estimates from waste-related emission sources.
GHG Management Institute 511 IPCC Guidelines: Energy Sector	This course provides a rigorous training on the emission sources and estimation methodologies for the energy sector based on the internationally endorsed 2006 IPCC Guidelines.	Nov 2022 - Jun 2023	DFFE	UNFCCC	Mitigation	Energy	Improved understanding of expert level knowledge and skills necessary to use and or prepare GHG emission estimates from energy-related emission sources.

Title of activity, programme, project or other	Programme/ project description	Time frame	Recipient entity	Implementing entity	Type of support	Sector	Use, impact and estimated results
GHG Management Institute 541 IPCC Guidelines: Forestry and Other Land Uses	This course provides a rigorous training on the emission sources and removal sinks and estimation methodologies for the forestry and other land use sector based on the internationally endorsed 2006 IPCC Guidelines.	Nov 2022 - Jun 2023	DFFE	UNFCCC	Mitigation	Forestry and Other Land Uses	Improved understanding of expert level knowledge and skills necessary to use and or prepare GHG emission estimates from Forestry and Other Land Uses-related emission sources.
GHG Management Institute 521 IPCC Guidelines: Industrial Processes and Product Use	This course provides a rigorous training on the emission sources and estimation methodologies for the industrial processes and other product use sector based on the internationally endorsed 2006 IPCC Guidelines.	Nov 2022 - Jun 2023	DFFE	UNFCCC	Mitigation	Industrial Processes and Product Use	Improved understanding of expert level knowledge and skills necessary to use and or prepare GHG emission estimates from Industrial Processes and Product Use-related emission sources.
GHG Management Institute 531 IPCC Guidelines: Agriculture Sector	This course provides a rigorous training on the emission sources and estimation methodologies for the agriculture sector based on the internationally endorsed 2006 IPCC Guidelines.	Nov 2022 - Jun 2023	DFFE	UNCCCC	Mitigation	Agriculture	Improved understanding of expert level knowledge and skills necessary to use and or prepare GHG emission estimates from Agriculture sector-related emission sources.

Title of activity, programme, project or other	Programme/ project description	Time frame	Recipient entity	Implementing entity	Type of support	Sector	Use, impact and estimated results
Consultative Group of Experts (CGE) African Training Workshop on Tracking of NDCs, Bonn Germany	Enhance the technical capacity of experts from developing country Parties in establishing or building upon the understanding and application of the reporting provisions relevant for the tracking of progress of NDCs, including identifying indicators, as well as for the support needed and received in relation to tracking progress of NDCs.	Dec-22	DFFE	UNFCCC	Cross-cutting	Cross-cutting	Improve understanding of existing MRV arrangements and the ETF by acquiring knowledge of the key components involved in tracking NDC progress, including the support needed and received, main stakeholders, and data ownership. Additionally, it is important to understand how to compile relevant information and establish sustainable institutional arrangements for tracking NDCs

05 INFORMATION ON FLEXIBILITY

5. Information on Flexibility

As per paragraph 6 of the annex to decision 18/CMA.1, a summary table (Table 5.1) is provided below summarising the use of flexibilities in this BTR. Four flexibilities are used in total.

Table 5.1: Summary of the application of flexibility provisions

Flexibility provision (numbers refer to the paragraph number in the annex to decision 18/CMA.1)	Application and capacity constraint	Self-determined timeframe for improvement
57. Each Party shall report a consistent annual time series starting from 1990; those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead report data covering, at a minimum, the reference year/period for its NDC under Article 4 of the Paris Agreement and, in addition, a consistent annual time series from at least 2020 onwards.	Applied to all GHG emissions sources reported in the NID. Data to estimate emissions from 1990-1999 is not readily available, due to the fact that the transition from apartheid to democracy took place in 1994. Data on major emitting sectors was not readily available during apartheid, and access was restricted by law in some cases. Other data sources (e.g. land use data) also pose significant challenges. The GHG inventory team is currently compiling data on GHG emissions I the 1990s, and hope to have completed this process by 2028.	2028
32. Each Party may use the notation key "NE" (not estimated) when the estimates would be insignificant in terms of level according to the following considerations: emissions from a category should only be considered insignificant if the likely level of emissions is below 0.05 per cent of the national total GHG emissions, excluding LULUCF, or 500 kilotonnes of carbon dioxide equivalent (kt CO_2 eq), whichever is lower. The total national aggregate of estimated emissions for all gases from categories considered insignificant shall remain below 0.1 per cent of the national total GHG emissions, excluding LULUCF. Parties should use approximated activity data and default IPCC emission factors to derive a likely level of emissions for the respective category. Those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead consider emissions insignificant if the likely level of emissions is below 0.1 per cent of the national total GHG emissions, excluding LULUCF, or 1,000 kt CO_2 eq, whichever is lower. The total national aggregate of estimated emissions for all gases from categories considered insignificant, in this case, shall remain below 0.2 per cent of the national total GHG emissions, excluding LULUCF.	Applied to: • Energy: Emissions from abandoned underground mines and post-mining activities (methane and CO_2, CH_4, and N_2O). • IPPU: Subcategories involving N_2O, HFCs, PFCs, and SF_6, specifically in the electronics industry, solvents, and other product uses. • LULUCF: Emissions from organic soils (CO_2 and N_2O). • Waste: Emissions from waste incineration (CH_4). South Africa currently lacks the data to determine more accurately the magnitude of these subcategories, and will undertake further work on their occurrence and magnitude in the SA economy.	2028

Flexibility provision (numbers refer to the paragraph number in the annex to decision 18/CMA.1)	Application and capacity constraint	Self-determined timeframe for improvement
95. Projections shall begin from the most recent year in the Party's national inventory report and extend at least 15 years beyond the next year ending in zero or five; those developing country Parties that need flexibility in the light of their capacities with respect to this provision have the flexibility to instead extend their projections at least to the end point of their NDC under Article 4 of the Paris Agreement.	Applied to the GHG emissions projection for the "with measures" scenario, which extends to 2030 (the end point of South Africa's most recent NDC). The in-house model which was used to develop the projection currently only produced results up to 2030 which match SA's requirements. The model's capabilities will be extended to produce projections 15 years beyond the next year ending in zero or five by 2028.	2028
102. Those developing country Parties that need flexibility in the light of their capacities with respect to paragraphs 93–101 above can instead report using a less detailed methodology or coverage.	Applied to the GHG emissions projection for the "with measures" scenario, for which only aggregate national emissions projections are reported (without any disaggregation), and for which a less detailed methodology is reported, and to the projection of key indicators, which is not reported. As above, the current in-house modelling framework does not report comprehensive disaggregated GHG emissions by gas, sector and source, and so these were not reported. The methodology and assumptions for the model are still being documented. The indicator used to track progress was not projected due to limitations in data, and a currently inadequate understanding of the key drivers for natural disturbances. Data challenges are reported in Annex VII of the NID.	2028

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06 IMPROVEMENTS IN REPORTING OVER TIME

6. Improvements in Reporting over Time

6.1 PLANNED IMPROVEMENTS OVER TIME TO SA'S 2022 NATIONAL INVENTORY REPORT

As outlined in Chapter 1, Section 1.10 - Improvements were made to emission estimates from each sector and therefore recalculations were completed for the full time series. As the current inventory applied the AR5 GWPs, the previous inventory data was converted to CO_2 equivalents by using the AR5 GWP to gauge the actual impacts of the improvements made. The data shows that the current inventory estimates (excl. LULUCF) are between 0.4% and 5.3% lower than the 2020 inventory estimates, while the estimates including LULUCF are between 0.2% and 4.9% lower than the 2020.

The Energy sector improvements contribute the most to the reduction in the estimates in this inventory, with an average reduction of 14 294 Gg CO_2e since 2007 compared to the previous inventory. The LULUCF sector showed an average reduction of 16 929 Gg CO_2e between 2003 and 2014, after which it increases emissions by an average of 14 899 Gg CO_2e until 2018. This then changes to a reduction of 9 832 Gg CO_2e in 2020. The agriculture sector shows an increase in emissions by an average of 5 234 Gg CO_2e across the time-series, while waste emissions are reduced by an average of 7 082 Gg CO_2e over the same period.

6.2 IMPROVEMENT PLAN FOR SA'S 2022 NATIONAL INVENTORY REPORT

A National Greenhouse Gas Improvement Programme (GHGIP) is being implemented to improve activity data, country-specific methodologies and emission factors used in the most significant sectors. It is through the GHGIP that the country is working to resolve the main challenge to the GHG inventory on available data. Table 6.1 reiterates a summary of projects under implementation and the status of tasks (as outlined in Chapter 1, Section 1.10).

Table 6.1: List of planned improvements for South Africa's GHG

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Tasks in progress						
Cross-cutting	Improve uncertainty data for all sectors by incorporating more country specific uncertainty values	Medium	Accuracy	In progress	Incorporated as data becomes available	Lack of uncertainty data constrains this activity. As data becomes available it will be incorporated. In this inventory a more detailed analysis of uncertainty for LULUCF sector was completed.
	Improve QA/ QC process by addressing all issues in external review	High	Transparency	In progress	Future inventories	Challenges in addressing external review comments have been limited by resources and process management. The DFFE inventory team has increased in size, which should assist in addressing this issue. There are still many issues not resolved but the inventory team is working through them. It is an ongoing process.
Energy	Improve the improvement plan by incorporating all review activities not addressed in current inventory	High	Transparency	In progress	Ongoing	Partly resolved. Challenges around inclusion of further improvements into the improvement plan are limited resources and process management. The DFFE inventory team has increased in size, but it is still taking time to completely address all the issues. The review outputs are included in this report as a reminder of what still needs to be completed.
	Improve explanation of large changes in trends	High	Transparency	In progress	Ongoing	Partly resolved. Additional explanations have been provided, but there are still areas where this can be improved further. Ongoing process.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Agriculture	Incorporate all background data for the Tier 2 calculations of enteric fermentation	High	Key category; Accuracy; Transparency	In progress	2024 inventory	All the background equations have been included, but average data is still being used for most of the factors (instead of annual data) due to a lack of a sustainable data source. Data sources are being investigated and data will be included once it becomes available.
	There is a need for an alternate data source for Lime data	Medium	Key category; Accuracy	In progress	2024 inventory	Past inventory reviews have mentioned upgrading this information and investigating the alternate method of calculating potential lime use.
LULUCF	Complete a full uncertainty analysis for the Land sector, including area bias corrections	High	Key category; Accuracy	In progress	2024 inventory	A more detailed uncertainty analysis was included for biomass, DOM and SOC data in the LULUCF sector. Mapping uncertainties were improved; however, these will be improved further during the land change improvement plan.
	Improvement of land change data through detailed assessment of maps and tracking of land parcels	High	Key category; Accuracy; Consistency	In progress	The land use improvement plan will be completed over the next 3 years so data will be incorporated as it becomes available (2024 and 2026 inventory).	This 2022 inventory incorporated a more detailed assessment of the land change data and identified the most important land change categories that need attention. The assessment also identified improvements that need to be done moving forward and the priority of these improvements. Removing changes due to seasonality is the top priority and this will be improved as more land change maps are obtained. The 2022 SANLC map will already assist with making improvements. Tracking land parcels over time is the second most important issue and training on Collect Earth to assist in this process is underway.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
LULUCF	Include deadwood in the DOM pool for all land categories	Low	Completeness	In progress	2024	Deadwood has been included for the forest land category. The other land categories with woody components are settlements and perennial crops, but data is very limited for these land categories. Deadwood in these categories is assumed to be very small, but an explanation of this will be included in the next inventory.
	Move to a higher tier level for DOM in forest lands	Medium	Key category; Accuracy	In progress	2024	This was considered in the 2022 inventory and more detailed disturbance matrix data was included to determine the amount of biomass entering the DOM pool, however there were still one or two pieces of data missing which requires further investigation. This will be completed and included in the next inventory.
Waste	Data collection on quantities of waste disposed of into managed and unmanaged landfills		Key category; Accuracy	In progress	2024	Project is underway so data will be included in 2024 inventory.
Tasks outstanding						
Cross cutting	Investigate inconsistencies in lime activity data (for lime production in IPPU and lime application emission in Agriculture), explore alternative data sources or improve consistency.	Low	Consistency	Planned	BTR 3	Not resolved. Various methods were compared but gave varying results. Alternative data sources have not yet been found, but it may be possible to collect further data through the SAGERS system in future.
	Incorporate NOx, CO, NMVOC, and SOx emissions	Medium	Completeness	Proposed	BTR 3	Not resolved.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Energy	Further disaggregation of 1A2	Medium	Accuracy	Planned	Future inventories	Current inventory breaks down 1A2 into 1A2a, 1A2b and 1A2-ab. Further work is required to further disaggregate this sector and have emissions calculated per sub-sector.
	More activity data for estimating emissions associated with non-energy fuel use	Low	Accuracy	Planned	Future inventories	Research to be initiated in future.
	Inclusion of methodology documentation/ summary/ approval process for tier 3 methods	Low	Transparency	Planned	Future inventories	To be collated and included in future.
	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams	Low	Completeness	Planned	Future inventories	Research to be initiated in future.
	CH_4 emissions from abandoned mines	Low	Completeness	Planned	Future inventories	Research to be initiated in future.
	Investigate pipeline transport	Low	Completeness	Proposed	Future inventories	Proposed but nothing planned.
	Investigate ground activities at airports and harbours	Low	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Update of the VKT study, including segregation of on-road/off-road	Medium	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Comparison of the next VKT approach with fuel statistics	Low	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Segregation of military energy use.	Low	Accuracy	Proposed	Future inventories	Proposed but nothing planned.
	Incorporate emissions from biogas	Low	Completeness	Proposed	Future inventories	This would require a study and so should be recommended as a project under the GHGIP.
	CO_2 transport and storage	Low	Completeness	Proposed	Future inventories	Proposed but nothing planned.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Energy	CO_2, CH_4 and N_2O emissions from combined heat and power (CHP) combustion systems	Medium	Completeness	Proposed	Future inventories	Proposed but nothing planned.
	Development of T3 methods for CTL-GTC and GTL	Low	Accuracy	Proposed	Future inventories	Resources and funding are required to complete this study so it will be incorporated into the GHGIP.
IPPU	Include emissions from electronics industry	Medium	Completeness	Planned		A study needs to be undertaken to understand emissions from this source so it should be highlighted as a project for the GHGIP.
	Incorporate emissions SF_6 emissions	Medium	Completeness	In progress		Lack of data is still a challenge.
Agriculture	Improve manure management data, including biogas digesters as a management system	Medium	Accuracy	Proposed	2024	Proposed project as there is a high variability in this dataset.
LULUCF	Incorporate organic soils study to include emissions from organic soils	Low	Completeness	Planned	Future inventories	Not resolved. Due to the other more pressing issues relating to land this was not a priority and will be incorporated once the land mapping system is running.
	Undertake a National Forest Inventory and include SOC in the inventory	High	Key category; Accuracy	Proposed	Future inventories	This is an activity which would need to be completed by the Department of Forestry, therefore the date for completion is not known.
	Complete an assessment of crop types and areas and investigate discrepancies between crop statistics and NLC data	Medium	Consistency; Comparability	Planned	2024 inventory	This was partially investigated in this inventory; however, a proper assessment will be included in the land use change improvement plan that will run over the next few years.
	Perform a more detailed assessment of HWP to include a wider range of products	Medium	Key category; Accuracy	Proposed		Proposed project that could be considered under the GHGIP. For future evaluation.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
LULUCF	Report activity data and parameters (e.g. half-life) used for HWP emission estimation for the whole time-series	Medium	Transparency	Planned	2024 inventory	This will be included in the 2024 inventory.
	Report on the frequency of the HWP activity data collection	Low	Transparency	Planned	2024 inventory	This will be included in the 2024 inventory.
	Collect data on other disturbances besides fire in forest lands	Low	Key category; Accuracy	Proposed	Future inventory	This would require a study so it will be recommended as a project under the GHGIP.
	Assess the significance of peatlands	Low	Completeness	Proposed	2026 inventory	Assessing the areas of peatlands would be the first step and this part could be done as part of the land use improvement plan.
	Improve the transparency and accuracy of the LULUCF estimation file and report	High	Key category; transparency	Planned	2026 inventory	This will start next year but will continue through to the following year.
	Address the LULUCF section corrections	High	Accuracy	In progress	Next inventory	The LULUCF sector estimates will be assessed and corrections made to address the issues. This has already started.
	Further assessment of impacts of fires	Medium	Accuracy	Planned	Next inventory	This will involve the provision of a more detailed assessment and methodology for determining impacts of fire, particularly natural disturbance.

Sector	Improvement	Priority	Reason	Status	Completion timeframe	Barriers and constraints
Waste	Improve MCF and rate constants	Medium	Key category; Accuracy	Proposed	BTR 3	This would require a study so will be recommended as a project under the GHGIP.
	Include economic data for different population groups	Medium	Key category; Accuracy	In progress	BTR 3	Will be included in the 2024 inventory
	Include information on population distribution in rural and urban areas as a function of income	Medium	Key category; Accuracy	In progress	BTR 3	Insufficient data.
	Include HWP in solid waste	Medium	Key category; Completeness	Proposed	BTR 4	Once HWP data is improved (see above) it will be incorporated into solid waste.
	Obtain data on waste streams and the bucket system	Medium	Accuracy	Planned	BTR 3	Insufficient data.
	CH_4, N_2O emissions from biological treatment of waste	Medium	Completeness	Planned	BTR 3	Insufficient data.
	CO_2, CH_4 and N_2O from waste incineration	High	Completeness	Planned	BTR 3	Insufficient data.

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ANNEXURE

ANNEXURE 1: Methodologies and assumptions used to estimate the GHG emission reductions or removals due to each action, policy and measure

South Africa reports on the methodologies and assumptions used to estimate the GHG emission reductions or removals due to each PAM to the extent available. Reporting is hindered by a number of factors, including no formal arrangement existing between DFFE and data providers, the high cost of membership fees required for DFFE to access data, the frequent turnover of professional staff leading to personnel shortages, delays in report approvals affecting the timing and availability of data for certain PAMs, and the need for additional capacity-building support to prepare data for reporting under the ETF.

As there are challenges with the collation of activity data for to each PAM, the data collated do not cover the full time period of 2010 to 2022. Where there are gaps in the data time series, assumptions have been made where appropriate to account for the emission reductions up to and including 2022. These assumptions are reported under each PAM below where appropriate.

For all PAMs for which emission reductions were estimated, GWP metrics are from the 5th Assessment Report. The emission reduction accounting methods described in this section are embedded within the Mitigation Quantification Tool that is used to quantify emission reductions of PAMs. DFFE completed the development of this tool in 2020 as an output from the assessment of GHG effects related to shortlisted PAMs. The quantification of emission reductions is limited to ex-post evaluations of the shortlisted PAMs. No primary research was undertaken for the quantification of emission reductions and no verification or assurances of the data sets were undertaken. Different calculation methodologies were applied in the case of different PAMs. Typically, the calculations involved the multiplication of the activity data by a relevant emission factor. The results, i.e. the GHG emissions that were mitigated by the project, were presented in million tonnes of carbon dioxide equivalent (Mt CO_2e) on an annual basis in the tool.

National Development Plan, 2030

Estimates of expected and achieved GHG emission reductions are not reported for the NDP 2030. The NDP 2030 is not a mitigation intervention in itself but underpins the government paradigm for medium term planning in all sectors of the economy to take appropriate actions to reduce GHG emissions. The strategic objectives of the NDP 2030 has contributed to legal and policy development post 2012. Including the emission reductions from NDP 2030 will lead to double accounting of GHG emission reductions; as the GHG effect of the NDP 2030 cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of NDP 2030 are not reported.

National Climate Change Response Policy

Estimates of expected and achieved GHG emission reductions are not reported for the NCCRP. The NCCRP is the umbrella framework that underpins the country's NDC and all of government's regulatory mitigation instruments. Including the emission reductions from the NCCRP will lead to double accounting of GHG emission reductions; as the GHG effect of the NCCRP cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of NCCRP are not reported.

Climate Change Act 22 of 2024 that includes sectoral emission targets and carbon budgets

Estimates of expected and achieved GHG emission reductions are not reported for instruments under the Climate Change Act 22 of 2024 including SETs and carbon budgets. These measures are not mitigation interventions in themselves but incentivise government departments and private companies to take appropriate actions for example energy saving measures. Some of these interventions will also be facilitated by the implementation of sectoral mitigation PAMs as mentioned in this chapter. As such there is double accounting of mitigation effects involved should the emission reductions of cross-cutting measures like SETs and carbon budgets as provisioned by the Climate Change Act be included in the accounting of emission reductions alongside sectoral PAMs.

National GHG Emission Reporting Regulations

Estimates of expected and achieved GHG emission reductions are not reported for the NGERs. The NGERS are applicable for carbon tax, sectoral emission target, carbon budget and pollution prevention plan reporting. Including the emission reductions from the NGERS will lead to double accounting of GHG emission reductions as the GHG effect of the NGERS cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of NGERS are not accounted for and not reported.

Carbon Tax Act

The tax is integrated with other tools like sectoral emission targets and carbon budgets mentioned in the sub-section about the Climate Change Act 22 of 2024. Including the emission reductions from the carbon tax will lead to double accounting of GHG emission reductions; as the GHG effect of the tax cannot be separately distinguished and quantified from the other mitigation PAMs described in this chapter. The GHG emission reductions of the carbon tax are not reported.

Hydrogen Commercialisation Strategy

Reporting years for GHG emission reductions of PAMs are from 2010 to 2022 in this BTR. As the strategy was implemented in 2023; there are no emissions in the years before this.

Just Energy Transition Implementation Plan

Reporting years for GHG emission reductions of PAMs are from 2010 to 2022 in this BTR. As the JET-IP was implemented in 2023; there are no emissions in the years before this.

12L Tax Incentive Program

No direct calculations were made on the initial data provided by SANEDI. The $kgCO_2e$ savings for each project were supplied directly by SANEDI, reflecting the various energy carriers involved. The emission data sets from SANEDI are based on information submitted by claimants and verified by an accredited entity. The process starts with the creation and submission of a baseline benchmarking model and report to SANEDI for approval, which describes the business-as-usual scenario where the energy-saving measure would not have been implemented.

Integrated Demand Management (IDM) Programme

The emission reductions were determined by taking the activity data, which was provided by the Eskom IDM Department, and multiplying it by the South African grid emission factor specific to each year. This grid emission factor is published annually by Eskom in their reports. It was assumed that the measures implemented up to 2018 would still be operational in 2022.

Municipal Energy Efficiency and Demand Side Management programme

The emission reductions were calculated by using activity data sourced from DFFE and, multiplied by the grid emission factor specific to each year. This grid emission factor is published annually by Eskom in their reports. The last reported year with data was 2018 with data coverage for the period 2011 to 2018. It was assumed that the measures continued, so the annual emission reductions from 2019 to 2022 were considered the same as those for 2018.

The National Cleaner Production Centre South Africa program

The emission reductions are estimated from emission saving data sourced from the NCPC. The NCPC determines the emission savings for each project based on the specific energy carrier involved. These emissions were aggregated and reported by the NCPC for each year the program has been active. It was assumed that the NCPC projects are ongoing and continue to save the same amount of emissions as recorded in the last year 2020.

Private Sector Energy Efficiency Programme

The emission reductions are estimated from secondary data sets, specifically energy savings, sourced from the National Business Initiative's report on the program's outcomes. These activity data sets are then multiplied by the South African grid emission factor for the corresponding year, as determined from the Eskom annual reports, to calculate the emission reduction. It is assumed that the projects initiated during the program are still operational to date and continue to save the same amount of emissions up till 2022.

Private sector embedded solar generation

The emission reductions are estimated from secondary activity data sets, specifically about new installed capacity additions in MW, which are converted to GWh. These data sets were obtained from the South Africa Solar PV Update Report by the Association for Renewable Energy Practitioners. A capacity factor of 15% for the solar PV panels and an operational time of 6 hours per day were assumed. These assumptions were used to estimate the annual electricity generation from the installed solar PV. This estimated generation was then multiplied by the grid emission factor (specific to each year), sourced from Eskom's annual reports, to determine the emission reductions. It is assumed that the projects are still ongoing and continue to achieve the same emission savings as last recorded in 2020.

Renewable Energy Independent Power Producer Procurement programme

The emission reductions are estimated from secondary activity data sets, which detail the electricity generated by renewable energy projects each year and are sourced from Eskom Integrated Annual Reports, and multiplied by the grid emission factor specific to each to determine the emissions avoided through renewable energy generation. A conversion factor of 0.277778 was used to convert GJ to MWh, ensuring the coal emission factor is in the correct unit. A coal generation baseline was assumed. It is also assumed that these projects are still operational and continue to achieve the same emission savings as last recorded in 2020.

Natural Gas Fuel Switch Programmes

Excluded to avoid double accounting as there are projects registered under carbon credit mechanisms

Bus Rapid Transport System

Applied the ASIF approach (Eichhorst et al. 2018). Activity data included the number of BRT passenger trips; the average trip length and the fuel split between petrol and diesel of road transport modes. It is also assumed that these projects are still operational and continue to achieve the same emission savings as last calculated in 2020.

Transnet Road-to-Rail Programme

The amount of emission reductions were sourced from Transnet's Annual Integrated Reports.

Electric vehicles

The primary activity data used for the estimation of the emission reductions is the electric vehicle population in 2010 as reported in Merven et al. 2018 and then updated with annual number of electric vehicles sold as reported by The Automotive Business Council (NAAMSA) in their quarterly sales reports which covered the period from 2010 to 2022. Other activity data includes the average annual distance travelled by cars; fuel split between petrol and diesel of road transport modes and vehicle fuel economy for different road transport types. The first heavy duty electric vehicles entered the domestic market in 2023, so it is assumed that from 2010 to 2022; all electric vehicles on the road were private cars.

Nitrous Oxide Reduction Projects

Excluded to avoid double accounting as there are projects registered under carbon credit mechanisms.

Conservation Agriculture

The AFOLU strategy (DEFF, 2020) reports that in 2018, conservation areas constituted 14% of the annual crop area, which was 11,126,022 hectares (DEA, 2019). These conservation areas have been expanding at an annual growth rate of 7.5%. The mitigation potential factor is estimated at 0.2 tC/ha/yr, although DEFF 2020 initially applied a higher value of 0.3 tC/ha/yr. However, due to the partial adoption of conservation activities (Findlater et al., 2019), the lower value of 0.2 tC/ha/yr was used. It is assumed that soil carbon will accumulate over the IPCC default period of 20 years, with the annual growth rate in conservation areas remaining constant at 7.5% per year.

Grassland Restoration

Emission reductions were estimated based on GHG emission values from the NIR 2022, for GHG emission reductions from cropland converted to grassland, settlements converted to grassland and other land converted to grassland.

Afforestation

Emission reductions were estimated based on GHG emission values from the NIR 2022, for GHG emission reductions from conversions of cropland/ grassland/ wetland/ settlements/ other land to indigenous forest/plantation/ woodland.

Thicket Restoration

Emission reductions were estimated based on GHG emission values from the NIR 2022, for GHG emission reductions from conversions of indigenous forest/plantation/woodland /cropland/grassland/wetland/settlements/other land to thicket.

Shrubland Restoration and Afforestation

Emission reductions were estimated based on GHG emission values from the NIR 2022, for the GHG emission reductions from land use conversions that include forestland converted to indigenous forest and woodlands.

Municipal Landfill Gas Destruction

Excluded to avoid double accounting as there are projects registered under carbon credit mechanisms.

National Waste Management Strategy

Emission reductions were sourced from secondary data sets sourced from DFFE for the years 2010-2020. For reporting emission reductions in years 2021 and 2022; it was assumed that the waste diversion projects were ongoing and saving the equivalent amount of emissions as in the last recorded year of 2020. There are registered carbon credit mechanism projects for waste management. The total annual emission reductions of these projects are very small, and therefore negligible and therefore not accounted for.

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