SOUTH AFRICA'S 4TH BIENNIAL UPDATE REPORT TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Department of Forestry, Fisheries and the Environment

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SOUTH AFRICA'S 4TH

BIENNIAL UPDATE REPORT

APRIL 2021

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- the 2000-2017 National Greenhouse Gas Inventory,
- progress on mitigation policies, measures and actions for the same period, including quantification of emission reductions to the extent possible, and
- financial, capacity and technological support received including support for reporting needs.

In this regard, the government of South Africa would like to thank and acknowledge the following stakeholders for their assistance with data provision and development of the 4th BUR:

SOUTH AFRICAN GOVERNMENT:

Department of Mineral Resources and Energy (DMRE) and Department of Agriculture, Land Reform and Rural Development (DALRRD).

STATE OWNED ENTITIES:

South African National Energy Development Institute (SANEDI), Industrial Development Corporation (IDC), Transnet, South African Petroleum Industry Association (SAPIA), Passenger Rail Agency of South Africa (PRASA), ESKOM and Gautrain Management Agency.

NON-GOVERNMENT ORGANISATIONS:

Forestry South Africa (FSA), Promethium Carbon, Council for Scientific and Industrial Research (CSIR), Agricultural Research Council (ARC), United Nations Environment Programme (UNEP), Global Environment Facility (GEF), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Carbon Disclosure Project (CDP).

MINISTERIAL FOREWORD

As part of South Africa's efforts to meet the Climate Change Paris Agreement objectives, South Africa, in partnership with other role players, reiterates its commitment to making a contribution to limiting the world's average temperature rise to below 2°C as compared to pre-industrial levels and pursuing efforts to limit the global average temperature rise to 1.5°C. To that end, South Africa has updated and enhanced its ambition in its revised Nationally Determined Contribution (NDC) which it anticipates to submit later this year before the twenty-sixth session of the Conference of the Parties (COP 26).

To maximize the potential of meeting South Africa's emission reduction targets, several policies and measures are under implementation. The main measures that have been key in reducing greenhouse gas (GHG) emissions are mainly in the energy sector including the Integrated Resources Plan, the National Energy Efficiency Strategy as well as the Green Transport Strategy. The Waste Management Strategy has been key in reducing GHG emissions in the waste sector, whilst several aforestation and reforestation measures have been key in reducing GHG emissions in the Agriculture, Forestry and Other Land Use sector (AFOLU). The annual greenhouse gas emission reductions were estimated at 16.8 $MtCO_2e$, 18.5 $MtCO_2e$ and 24.3 $MtCO_2e$ in 2015, 2016 and 2017, respectively. In 2017, the energy sector reductions account for 79.1% of the total emission reductions, while the Industrial Processes and Product Use (IPPU) sector contributed 10.3%. The AFOLU and Waste sectors contributed insignificantly at 8.2% and 2.2%, respectively.

As a developing country, in line with the principles of equity, as well as common but differentiated responsibilities and respective capabilities, our ability to respond to climate change is likely to be far slower than our developed world counterparts. In view of this latter point, we would like to reiterate that effective responses to climate change can be accomplished with appropriate financial, technological, and capacity-building support from the developed world in line with their corresponding obligations to provide such support. South Africa received in excess of 4 billion US dollars in financial support from bilateral and multilateral sources towards climate change action. It is worth noting, with concern, that the majority of reported financial climate support has not been in the form of grants, but mostly in the form of loans. Be that as it may, South Africa remains committed to doing its best to combat climate change through various measures, drawing on the much appreciated capacity-building, technical and financial support of developed countries.

South Africa is equally committed to the decisions that give effect to the Paris Agreement to report in line with the Enhanced Transparency Framework (ETF) under Article 13 of the Paris Agreement. South Africa, through the Capacity Building Initiative for Transparency (CBIT) project, continues to enhance its capacity to report in line with the ETF under Article 13. Effectively, South Africa anticipates submitting South Africa's first Biennial Transparency Report (BTR) by December 2024.

The outbreak of the Coronavirus disease (COVID-19) has had a significant impact on South Africa, which compounded the triple challenges of poverty, unemployment and inequality. South Africa reported its first case of COVID-19 on the 5th of March 2020, and now has one of the continent's highest case occurrences. Following that, the South African President, His Excellency, Cyril Ramaphosa announced plans to fight the spread of COVID-19 across the country, which included a risk-adjusted strategy to curtail the spread of this novel coronavirus. Nonetheless, South Africa's government has done an excellent job of making efforts to combat the COVID-19 pandemic. Vaccine distribution is well underway and giving a glimmer of hope to normalcy that we once enjoyed. It has become abundantly clear that the process of developing this Biennial Update Report (BUR) was significantly affected by the COVID-19 pandemic, however thanks to dedicated personnel and stakeholders, strides were made to successfully work on this BUR and finalise it.

The South African government is therefore pleased to present to you South Africa's 4th Biennial Update Report to the United Nations Framework Convention on Climate Change (UNFCCC). This report provides an update on the Greenhouse Gas (GHG) emissions inventory for the period 2000 to 2017, including the GHG mitigation achieved between the years 2000 and 2017 along with the support needed and received. The South African government is equally looking forward to COP 26 to the UNFCCC that will take place in November 2021 in Glasgow which will allow the Parties to finalise the Paris Agreement rule book.

Barbara Creecy

Minister: Forestry, Fisheries and
the Environment (South Africa)

EXECUTIVE SUMMARY

ES1 NATIONAL CIRCUMSTANCES

Information on the country's population, economy, energy dynamics and climate variability impacts provide context on the country's opportunities and challenges in addressing climate change. South Africa is located at the southern tip of Africa and is bordered by the Atlantic Ocean to the west, and the Indian Ocean to the south and east. Its neighboring countries are Namibia, Botswana, Zimbabwe, Mozambique, eSwatini and Lesotho. The country experiences both subtropical and temperate climates with a mean daily temperature of 20°C. South Africa had a population of 56.52 million in 2017, growing to 58.78 million in 2019. The rate of unemployment grew by 2.4 percentage points between 2017 and 2019 to 28.5% in 2019. South Africa has an emerging economy and is the world's largest exporter of gold, platinum and natural resources. Mining, finance, trade and government services are the main drivers of economic growth.

South Africa's carbon dioxide (CO_2) emissions per capita are amongst the highest per capita emissions in the developing world. This is due to South Africa's strong reliance on a coal-based energy production system, and heavy emissions from the transport sector. The increase in the number of floods and droughts recorded around the country currently are projecting the future narrative of climate change impacts – deepening the conditions of poverty and food insecurity for many South Africans living in rural and urban poor communities. It is in the interest of the country to invest in the transitioning to a low carbon society, which will reduce the risks and impacts of climate change, alleviate poverty and improve livelihoods and wellbeing. South Africa, as a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), remains committed in stabilising the greenhouse gas (GHG) concentration in the atmosphere and halting the global average warming below 2°C above pre-industrial levels.

The Department of Forestry, Fisheries and the Environment (DFFE) formerly known as the Department of Environment, Forestry and Fisheries (DEFF) plays a central coordinating and policy-making role as the designated authority for environmental conservation and protection in South Africa. The work of the DFFE is underpinned by the Constitution of the Republic of South Africa (Act 108 of 1996), the National Development Plan (NDP) (NPC, 2011), National Environmental Management Act (NEMA) (Act No. 39 of 2004), National Climate Change Response Policy (NCCRP) (DEA, 2011) and other relevant legislation and policies applicable to government to address environmental management, including climate change.

The DFFE coordinates the work on the preparation of the Biennial Update Reports (BURs) under the Chief Directorate: International Climate Change Relations and Reporting. This function has been restructured as it was previously under the Climate Change Monitoring and Evaluation Chief Directorate. 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 reports' content to ensure that they accurately reflect the national circumstances.

ES2 NATIONAL GHG EMISSIONS INVENTORY

The National Greenhouse Gas (GHG) Inventory (the Inventory) for South Africa is presented for the period of 2000 to 2017. The Inventory covers all four sectors, namely, Energy; Industrial Process and Product Use (IPPU); Agriculture, Forestry and Other Land Use (AFOLU); and Waste. South Africa's GHG emissions (excl. FOLU) have increased by 14.2% since 2000, and emissions (incl. FOLU) have increased by 10.4%. Between 2000 and 2017 the average annual growth in GHG emissions was 0.6%. The Energy sector is the main contributor to this increase. South Africa's GHG emissions (excl. FOLU) declined by 2.8% since the 2015 Inventory submission (DFFE, 2017) and if the FOLU sink is included, there was a decline of 4.4% since 2015.

CO_2 gas is the largest contributor to South Africa's emissions, contributing 83.2% of emissions (excl. FOLU) in 2000 and 84.5% in 2017. This is followed by CH_4 and N_2O contributing 9.7% and 5.0%, respectively, in 2017. The contribution from CH_4 and N_2O declined between 2000 and 2017, while CO_2 and F-gases increased over the same period. The F-gas contribution is, however, still below 1.0%.

Energy emissions have increased over time (Figure ES 1) due to increased demand for liquid fuels in the road transportation, manufacturing, construction, civil aviation, residential and the commercial sectors, but are stabilising. There has been a slow increasing trend in emissions from the IPPU sector, except for the reduced emissions during the recession. The main drivers in the IPPU sector are the metal industries, particularly iron and steel production and ferroalloy production. Emissions from agriculture (equivalent to AFOLU excl. FOLU) are fairly stable but have declined slightly due to a slight reduction in the livestock population, particularly cattle.

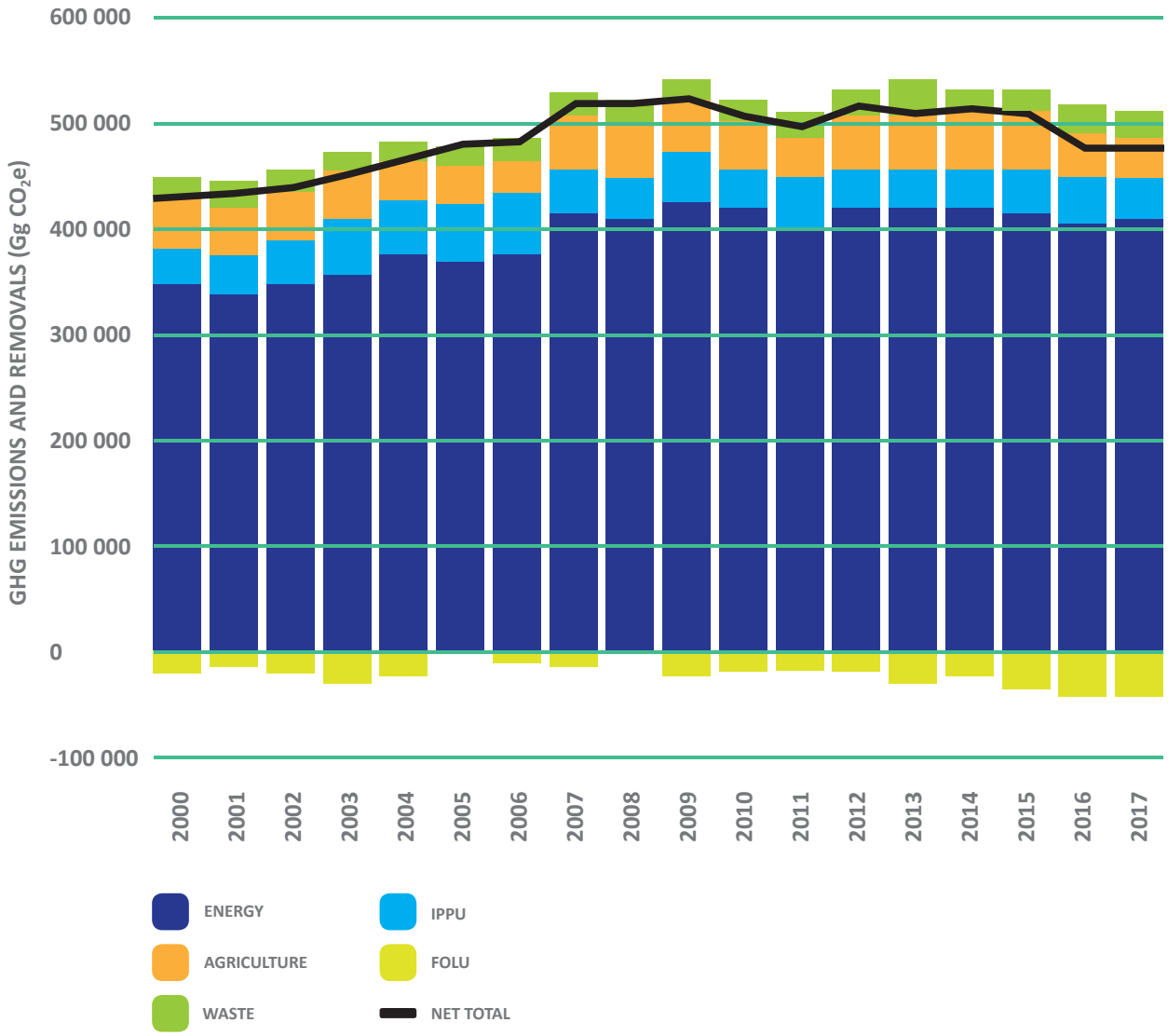
The land sector (FOLU) sink has increased in recent years due to increasing forest land area (particularly thickets and woodlands/open bush) and a decline in wood losses. The increase in emissions from the waste sector can be attributed to the growing population.

South Africa has conducted uncertainty analysis across all sectors, which is progress since the previous BUR submission where this form of analysis had only been completed for Energy and IPPU sectors. The IPCC good practice tier 1 (Approach 1) method was used to determine the overall aggregated uncertainty on South Africa's Inventory estimate for 2017. The analysis shows that the overall uncertainty on the 2017 estimate is 10.2%, while the uncertainty in the emission trend is estimated at 7.1%. If FOLU is excluded, then the overall uncertainty is reduced to 9.4% with the uncertainty in trend being 0.7%.

The main challenge in the compilation of South Africa's GHG Inventory remains the availability of accurate activity data. Due to the recent introduction of the GHG Reporting Regulations, companies have started to report emissions data through the South African GHG Emissions Reporting System (SAGERS). Improved information from this reporting has started to be included in the Inventory, but updates and improvements will continue in the next inventory. South Africa has still not included SF_6 emissions and emission estimates for the period 1990 to 2000. However, these are expected to be included in the 2021 Inventory.

Figure ES 1:

TREND IN SOUTH AFRICA'S GHG EMISSIONS BETWEEN 2000 AND 2017 BY SECTOR.



ES3 MITIGATION ACTIONS AND THEIR EFFECTS

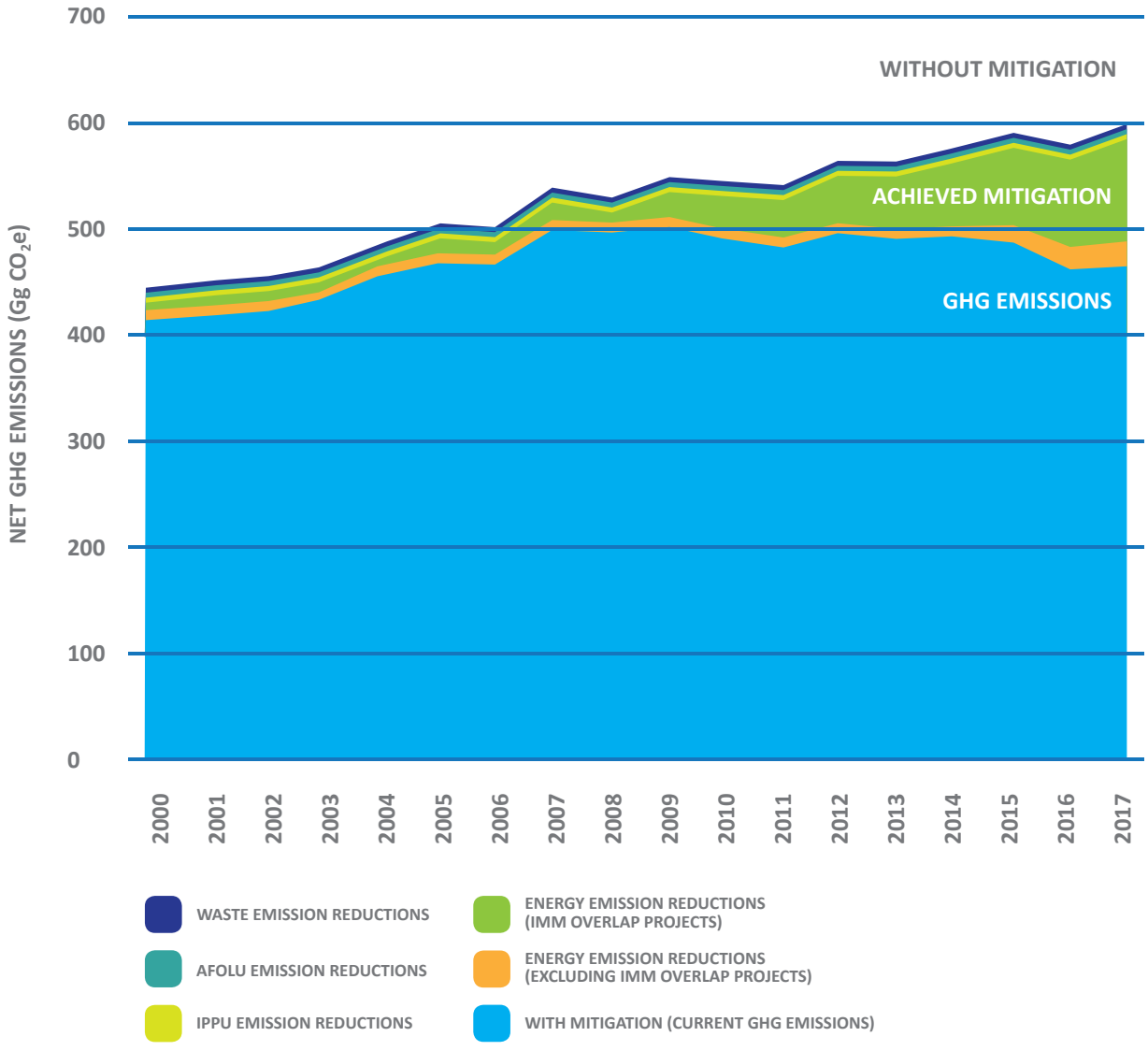
An introduction to the policy background for climate change and mitigation is provided. The driving policies for climate change (National Development Plan, National Climate Change Response Policy and the Climate Change Bill) are summarised and updates on the National Emissions Trajectory and Nationally Determined Contributions are provided. The Low Emissions Development Strategy, which is the policy through which the mitigation activities will be implemented, is highlighted.

Several policies and measures, both cross-sectoral (Carbon Budgets, the National GHG Emission Reporting Regulations (NGERs), the Carbon Tax Act together with Carbon Offset Regulations) and sectoral, are identified in order to assist South Africa in achieving its emission reduction targets. In the Energy sector, eleven measures to mitigate climate change have been identified with the main policy drivers being the Integrated Resource Plan, National Energy Efficiency Strategy and, for transport, the Green Transport Strategy. In the IPPU sector it is the Carbon Budgets and Pollution Prevention Plans for process emissions which support the identified measures. In the AFOLU sector, five measures (afforestation, forest rehabilitation, thicket restoration, grassland rehabilitation and conservation agriculture) are provided and these are supported through the Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries, the Draft Conservation Agriculture Policy and the DFFE Strategic Plan. The policies in the AFOLU sector are not strictly designed for mitigation purposes and are aimed more at improving biodiversity and sustainability. The National Waste Management Strategy is the main driver for mitigation in the Waste sector. Challenges, gaps and constraints related to these mitigation measures and policies are discussed for each sector.

An update to the information on mitigation actions with quantified effects since the BUR3 is presented for the period 2000 to 2017. The annual greenhouse gas emission reductions were estimated at 16.8 $MtCO_2e$, 18.5 $MtCO_2e$ and 24.3 $MtCO_2e$ in 2015, 2016 and 2017, respectively (Figure ES 2). The energy sector reductions accounted for 79.1% of the total emission reductions in 2017, while the IPPU sector contributed 10.3%. The AFOLU and Waste sectors contributed 8.2% and 2.2%, respectively. In this BUR, any action that had projects which were also included under the International Market Mechanisms (IMMs) were excluded from these totals and reported separately. These projects were all in the Energy sector and these projects added an additional 66.2 $MtCO_2e$ in 2015 and 88.9 $MtCO_2e$ in 2017. A list of IMM projects, along with their emission reductions is provided. These projects, across all sectors, contributed 23.7 $MtCO_2e$ in 2015, 25.3 $MtCO_2e$ in 2017 and 25.3 $MtCO_2e$ in 2019, with the energy sector contributing 77.8% to the total in 2017.

Figure ES 2:

SOUTH AFRICA'S EMISSION REDUCTIONS BETWEEN 2000 AND 2017.



ES4 FINANCE, TECHNOLOGY, CAPACITY-BUILDING NEEDS & SUPPORT RECEIVED

International and domestic climate-related finance flows, alongside non-monetised support received between January 2018 and December 2019, are reviewed to assess the financial, capacity and technical support South Africa received to transition to a lower-carbon and climate resilient economy and society. Needs for the future are also analysed.

The bilateral and multilateral support received was analysed and 88.9% of the funds were in the form of loans. In terms of bilateral funds, 48.4% (USD 2 019 million) was contributed by Germany, and the largest amount of multilateral support (USD 537 million) received during the reporting period was the Green Climate Fund administered by the Development Bank of Southern Africa (DBSA) and the South African National Biodiversity Institute (SANBI). These funds were mostly used for energy efficiency and renewable energy projects, but the Waste Management Flagship Programme was also included.

The South African government still plays a vital role in the creation of conditions for inclusive economic growth and development, as well as in establishing an appropriate economic framework to encourage and facilitate the country's shift to environmentally cleaner technologies and low carbon activities.

The South African government has invested approximately USD 238 million to support climate action at the national level. The national government, through the DFFE and managed by the DBSA, established the Green Fund in 2012 with an initial USD 60 million. The fund's objective is to lay the groundwork for the country's transition to a low-carbon, resource efficient and climate resilient development path.

Technical and capacity building needs were identified related to both the National GHG Inventory and mitigation needs. Priority technologies for mitigation were identified in the IPPU and Waste sectors. For IPPU, the priorities are the aluminium industry (energy monitoring and management, secondary production and recycling) and the use of waste material as fuel in cement production. In the Waste sector the priorities are around by-products from food waste, waste recovery and anaerobic digestion. Priority technologies for adaptation were also identified, including urban forestry, conservation agriculture, wetland restoration, biorefinery, early warning systems, disaster risk reduction, rainwater harvesting and desalination technologies. Barriers to both mitigation and adaptation technologies are discussed and interventions for overcoming the barriers are proposed.

ES5 SUPPORT RECEIVED FOR PREPARATION OF BUR

Bilateral financial support was received from the German Government for the development of the 4th South African BUR. Funding was administrated through the Gesellschaft für Internationale Zusammenarbeit (GIZ) as part of the Climate Change Support Programme to South Africa. Chapters of the BUR4 were drafted internally by DFFE personnel and the CSIR. Promethium and Gondwana Environmental Solutions provided additional technical support.

ES6 MEASUREMENT, REPORTING AND VERIFICATION IN SOUTH AFRICA

South Africa is developing a comprehensive, integrated National Climate Change Information System (NCCIS), also referred to as the National Monitoring and Evaluation (M&E) system. This is a web-based platform for the tracking, analysis and enhancement of South Africa's progress towards the country's transition to a low-carbon economy and climate-resilient society. It showcases vital climate action to inform domestic and international reporting and includes information on GHG emission reductions achieved, observed and projected climate change, impacts and vulnerabilities, the impact of adaptation and mitigation actions, financial flows and technology transfer activities. The NCCIS, therefore, encompasses the measurement, reporting and verification (MRV) of the National GHG Inventory (the Inventory), mitigation actions and support.

The system is composed of several modules, which include the National Climate Change Response Database, National Desired Adaptation Outcomes, Climate Information Centre, Tracking and Evaluation System and various maps and search capabilities. This platform will provide a visualisation capability for the various outputs and products of the M&E system and enhance the DFFE's capacity to communicate national information on climate change to a wide range of audiences.

Institutional arrangements for the MRV of GHG inventories and mitigation actions is discussed in this chapter. With the introduction of the National Greenhouse Gas Emission Reporting Regulations (NGERs) in 2017, the South African GHG Emissions Regulation Reporting System (SAGERS) data collection system has been put in place. This will formalise the data collection process for the energy and IPPU sectors and will also allow for the collection of Inventory input data from forest plantations. GHG data collected through SAGERS will be utilised for Inventory estimates for the next Inventory cycle. Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry were developed by The Department of Environmental Affairs (DEA) in consultation with industry, and the details of the verification process are provided.

In addition to SAGERS, the Carbon Offset Administration System has also been developed, and this allows for the approval of projects, listing of projects, transfer of ownership and retirement of credits. This system is aimed at tracking the carbon credit projects in South Africa.

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LIST OF ABBREVIATIONS

AFOLU	Agriculture, Forestry & Other Land Use
ARC	Agricultural Research Council
BRT	Bus Rapid Transit
BUR	Biennial Update Report
BUR3	Third Biennial Update Report
BUR4	Fourth Biennial Update Report
CBIT	Capacity-Building Initiative for Transparency
CCM&E	Climate Change Monitoring & Evaluation Unit
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CDP	UK based organisation- formerly the Carbon Disclosure Project
CERs	Certified Emission Reductions
CGE	Consultative Group of Experts
CH_4	Methane
CHP	Combined Heat and Power Combustion Systems
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPI	Consumer Price Index
CS	Country Specific Emission Factor
CSA	Climate Smart Agriculture
CSIR	Council for Scientific & Industrial Research
CSP	Concentrated Solar Power
CTLs	Coal-to-liquids
DAFF	Department of Agriculture, Forestry & Fisheries (now DFFE and DALRRD)
DALRRD	Department of Agriculture, Land Reform and Rural Development
DAOs	Desired Adaptation Outcomes
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs (now DFFE)
DEFF	Department of Environment, Forestry & Fisheries (previously DEA)
DF	IPCC Default Emission Factor
DFFE	Department of Forestry, Fisheries and the Environment (previously DEFF)
DMR	Department of Minerals & Resources (now DMRE)
DMRE	Department of Mineral Resources & Energy
DoE	Department of Energy (now DMRE)
DOM	Dead Organic Matter
DoT	Department of Transport
DPWI	Department of Public Works & Infrastructure
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EF	Emission Factor
EGIP	Embedded Generation Investment Programme
FAO	The Food and Agriculture Organisation of the United Nations
FASA	Fertiliser Association of South Africa
FOD	First Order Decay
FOLU	Forestry and Other Land Use
FSA	Forestry South Africa
FSV	Facilitative Sharing of Views
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gondwana	Gondwana Environmental Solutions International
Gg	Gigagram = 10^9 grams or 10^3 tonnes
GHG	Greenhouse Gas
GHGIP	National Greenhouse Gas Improvement Programme
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GS	Gold Standard
GTCs	Gas-to-chemicals
GTI	GeoTerraImage, Pty Ltd.
GTLs	Gas-to-liquids
GWh	Gigawatt hours
GWPs	Global Warming Potentials
HFCs	Hydrofluorocarbons
HWP	Harvested Wood Products
ICA	International Consultation and Analysis

IDM	Integrated Demand Management
IDP	Integrated Development Plan
IMM	International Market-Based Mechanisms
IMCCC	Inter-Ministerial Committee on Climate Change
IPCC	International Panel on Climate Change
IPP	Independent Power Producers
IPPU	Industrial Processes and Product Use
IPTN	Integrated Public Transport Network
KCA	Key Category Analysis
LEDS	Low Emissions Development Strategy
LFG	Landfill Gas
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change, & Forestry
M&E	Monitoring and Evaluation
MCA	Multi-criteria Analysis
MJ	Megajoule
MODIS	Moderate Resolution Imaging Spectroradiometer
MPA	Mitigation Potential Analysis
MRV	Measurement, Reporting & Verification
$MtCO_2e$	Megatonnes of Carbon Dioxide Equivalents
MTN	Mobile Telephone Networks
MW	Megawatt
N	Nitrogen
N_2O	Nitrous Oxide
NA	Not Applicable
NAEIS	National Atmospheric Emissions Inventory System
NC	National Communications
NCCAS	National Climate Change Adaptation Strategy
NCCIS	South African National Climate Change Information System
NCCRP	National Climate Change Response Policy
NCPC	The National Cleaner Production Centre
NDC	Nationally Determined Contribution
NDMC	National Disaster Management Centre
NDP	National Development Plan
NE	Not Estimated
NEM:AQA	National Environmental Management: Air Quality Act
NEMA	National Environmental Management Act
NGERs	National Greenhouse Gas Emission Reporting Regulations
NGHGIS	National GHG Inventory Management System
NGOs	Non-governmental Organisations
NH_3	Ammonia
NIRs	National Inventory Reports
NLTTA	National Land Transportation Transition Act (repealed)
NMVOCs	Non-methane Volatile Organic Compounds
NO	Not occurring
NOx	Oxides of Nitrogen
NPC	National Planning Commission
NRF	National Research Foundation
NTCSA	National Terrestrial Carbon Sinks Assessment
NLTA	National Land Transport Act
NWMS	National Waste Management Strategy
ODS	Ozone Depleting Substances
PAGE	Partnership for Action on Green Economy
PAMs	The Policies and Measures
PATPA	Partnership on Transparency in the Paris Agreement
PFCs	Perfluorocarbons
PPP	Pollution Prevention Plans
PSEE	Private Sector Energy Efficiency programme
PSC	Project Steering Committee
PSEE	Private Sector Energy Efficiency programme
PV	Solar Photovoltaics
QA	Quality Assurance
QC	Quality Control
REIPPPP	Renewable Energy Independent Power Producers Procurement Programme
SAGERS	South African Greenhouse Gas Emissions Reporting System
SAISI	South African Iron and Steel Institute
SALGA	South African Local Government Association
SAMI	South African Minerals Industry
SANAS	South African National Accreditation System

SANBI	South African National Biodiversity Institute
SANEDI	South African National Energy Development Institute
SANOCEAN	SA/Norway joint research programme on ocean research including blue economy, climate change, the environment and sustainable energy
SANS	South Africa National Standard
SAPIA	South African Petroleum Industry Association
SAR	Second Assessment Report
SARS	South African Revenue Service
SAWS	South African Weather Services
SDG	Sustainable Development Goal
SET	Sectoral Emission Target
SF_6	Sulfur Hexafluoride
SME	Small to Medium Enterprise
SMME	Small, Medium and Micro Enterprises
SOC	Soil Organic Carbon
SPIPA	Strategic Partnerships for the Implementation of the Paris Agreement
StatsSA	Statistics South Africa
T&E	Tracking & Evaluation system
tCO_2e	Tons of Carbon Dioxide Equivalent
TJ	Terajoule
toe	tonne of oil equivalent
TPES	Total Primary Energy Supply
TWh	Terawatt-hour, a measure of electrical energy, 1012 watt-hours
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UP	University of Pretoria
USD	United States Dollar
VCS	Verified Carbon Standard
VCUs	Verified Carbon Units
VERs	Verified Emissions Reductions
VKT	Vehicle Kilometres Travelled
WWF	World Wide Fund for Nature (World Wildlife Fund)
ZAR	South African Rand

1. NATIONAL CIRCUMSTANCES

1.1. INTRODUCTION

South Africa is making substantial progress towards becoming a low carbon and climate resilient society. As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), the South African government, in partnership with climate change stakeholders and role players, continue to strengthen their efforts of achieving and stabilising greenhouse gas (GHG) concentrations in the atmosphere, hence reducing carbon footprints and preventing harmful human activity interference in the climate system.

Climate change remains a threat to sustainable development and livelihoods, thus there is an urgent need to scale up efforts to address the effects of climate change and further adhere to the UNFCCC. South Africa's process of transitioning to a low carbon and climate resilient economy remains ongoing. This is evident through the many projects and programmes targeted at addressing climate change, the mainstreaming of climate change into development policies and plans and the effective monitoring and reporting on GHG emissions, mitigation and adaptation actions (DEA, 2018b).

The information reported in this Biennial Update Report (BUR) on national circumstances builds on the work initiated and included in the BUR3 and the third National Communication.

Climate change remains a threat to sustainable development and livelihoods, thus there is an urgent need to scale up efforts to address the effects of climate change and further adhere to the UNFCCC.

1.2. SUMMARY INDICATORS FOR SOUTH AFRICA

Key indicators for the country are provided in Table 1.1

Table 1.1: KEY INDICATORS FOR SOUTH AFRICA IN 2017

KEY INDICATOR	2017	SOURCE
GENERAL		
Latitude	22° S – 35° S	CGIS, 2019
Longitude	17° E – 33° E	CGIS, 2019
Area	1 219 602 km^2	CGIS, 2019
ENVIRONMENT		
Mean daily temperature	20°C	
Annual average rainfall	470 mm	
SOCIAL		
Population	56.52 million	StatsSA, 2017
Population growth rate	1.46%	StatsSA, 2019
Female life expectancy at birth	66.7	StatsSA, 2017
Male life expectancy at birth	61.2	StatsSA, 2017
Infant mortality rate	32.8 per 1000 live births	StatsSA, 2017
Unemployment rate	26.7%	StatsSA, 2018
Total number of people living with HIV	7.06 million	StatsSA, 2017
Human Development Index	0.704	
ECONOMIC		
GDP	USD 349 554 Billion	World Bank, 2019a;
GDP per capita	6 132.48	World Bank, 2019b
GNI per capita, PPP (current international USD)	12 240	
ENERGY SECTOR		
Primary energy supply	6 658 368 TJ	DoE, 2017
Access to electricity (% of population)	84.2%	StatsSA, 2019
Energy power consumption (kWh per capita)	4365.92	World Bank, 2019b
LAND AND AGRICULTURE		
Total commercial agricultural area	46.4 million ha	StatsSA, 2020
Grazing land	36.5 million ha	StatsSA, 2020
Arable land	7.6 million ha	StatsSA, 2020
Total forest area	21.1 million ha	DEA, 2019
Forest plantation area	12 124 km^2	FSA, 2018
Cattle population	13 million	DAFF, 2019
Commercial sheep and goats	21.5 million	DAFF, 2019
Commercial swine	1.5 million	DAFF, 2019
WASTE		
Waste generated	54.2 million tonnes	DEA, 2018a
Waste to landfill	61.7%	DEA, 2018a
Waste recovered and/or recycled	38.3%	DEA, 2018a

1.3. ENVIRONMENTAL CONTEXT

1.3.1. Geography

South Africa, located on Africa's southern tip (22°S - 35°S; 17°E – 33°E), is bordered by the Atlantic Ocean along the west coast and by the Indian Ocean along the south and east coast. The coastline stretches for more than 2 850 km. To the north, South Africa is bordered by Botswana, Namibia and Zimbabwe and to the east, eSwatini and Mozambique. It surrounds the small Kingdom of Lesotho. South Africa covers an area of 1 219 602 km^2 (GCIS, 2019) and can be divided into the interior plateau and land between the plateau and the coast. These two areas are divided by the Great Escarpment which varies between 1 500 m and 3 482 m above sea level. The interior plateau has an average height of 1 200 m above sea level and is characterised by wide plains.

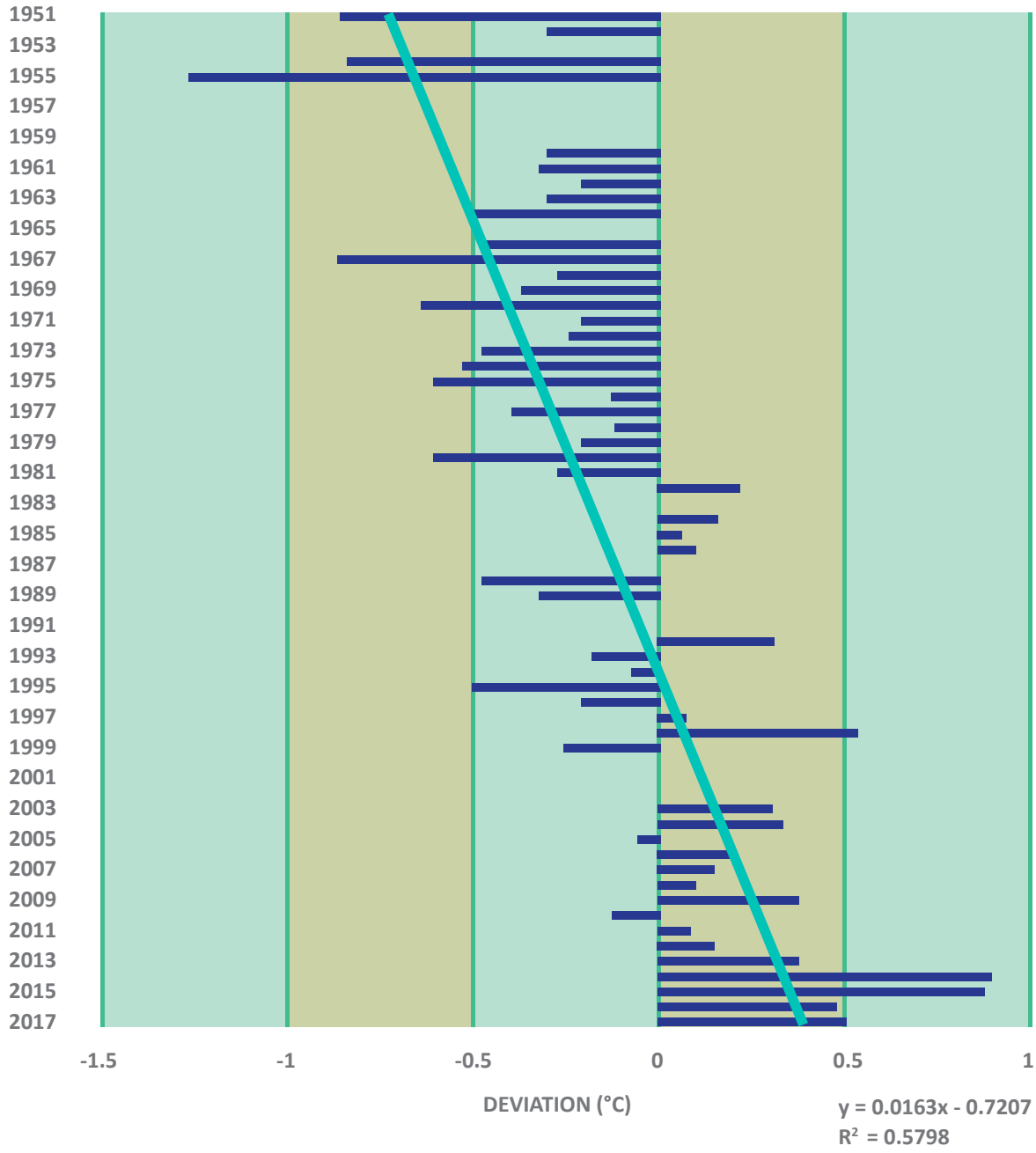
1.3.2. Climate

South Africa's climate is influenced by the oceans to the east, south and west. The warm Agulhas current found to the east leads to warmer coastal temperatures than those experienced on the west coast, which is influenced by the cold Benguela current. The country has both sub-tropical and temperate climate conditions. A cool, wet climate is found in the Drakensberg region, with warm, sub-tropical conditions in the north east. The south west of the country experiences Mediterranean climatic conditions and there is a warm dry desert environment in the central west and north west. Average temperatures in South Africa range from 15°C to 36°C in summer and -2°C to 26°C in winter (GCIS, 2019). South Africa is a relatively dry country, with an average annual rainfall of 464 mm. The country receives summer rainfall, except in the Western Cape where most of the rain falls in winter.

South Africa continues to be subjected to extreme weather events, which is a consequence that can be attributed to observed changes in the climate system. The mean annual temperature for 2018 for South Africa was in general 0.52°C above the 1981-2010 climatological normal. Based on the 1981-2010 climatological normal, 2018 is ranked the 4th warmest year for the 68 years from 1951 to 2018 (Figure 1.1).

The country is experiencing significant increases in temperature, as well as increased variability in rainfall and vulnerability to extreme weather events. Drought, fire and floods have been some of the extreme events experienced since 2017. South Africa has been exposed to prolonged, intensified drought conditions since 2013 which has devastated a number of sectors and jurisdictions in the country. The intensity of the drought in the period 2016–2017 saw eight provinces in the country declare drought as a disaster (NDMC, 2017). Following the consistent assessments of drought-stricken areas, particularly in the provinces of the Western Cape, Eastern Cape and Northern Cape, the then Minister of Cooperative Governance and Traditional Affairs, Dr Zweli Mkhize, declared drought a national disaster for South Africa in March 2018 (NDMC, 2018). The prolonged and severe drought conditions in the Western Cape together with gale-force winds are considered to have set the conditions for the Knysna fires in 2017 (Le Maitre et al., 2019). These were the most extreme wildfire disasters recorded in the history of South Africa. During the fire blaze, natural vegetation, forest, homes and livelihoods were destroyed over a stretch of 19 000 hectares and seven people died (Le Maitre et al., 2019). The insurance and forestry industries were the most severely impacted by the fire disaster. Together with government, they suffered at least ZAR 3 billion in direct costs as result of the disaster.

Figure 1.1:
MEAN TEMPERATURE DEVIATIONS OF 26 CLIMATE STATIONS FROM 1951 TO 2018 (BASE PERIOD: 1981 – 2010) (SAWS, 2019).



1.4. SOCIAL CONTEXT

1.4.1. Population

The population of South Africa increased from 40.6 million in 1996 to 51.7 million in 2011 and 55.6 million in 2016 (StatsSA, 2019a). According to the most recently released 2019 mid-year population estimates, South Africa's population is estimated at 58.7 million (StatsSA, 2019a). The population is estimated to have grown by 1.4% in 2019.

1.4.1.1. Population distribution

Based on information provided by StatsSA (2019b) the youth (aged 18–34) are estimated to constitute a third of the population (17.8 million) in South Africa, with 8.80 million females and 9.0 million males. An estimated 28.6% of the youth (or 5.1 million) are based in Gauteng, 19.4% (or 3.4 million) in KwaZulu-Natal, 4.7% in the Free State and the Northern Cape (2.0%) has the lowest percentage of youth. A quarter of South Africa's entire population resides in Gauteng, with KwaZulu-Natal comprising the next highest contribution to the total population of 19%.

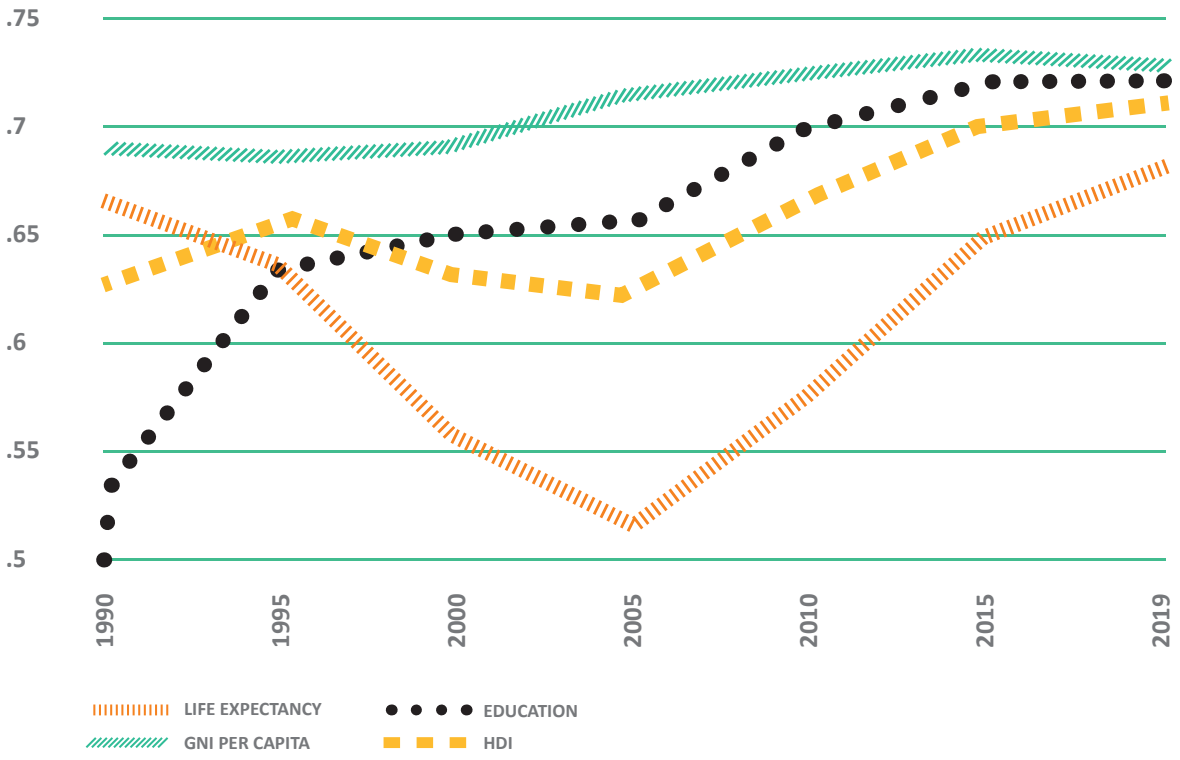
1.4.2. Social Development

Poverty in South Africa remains a key developmental challenge in social, economic and political terms even though the country's development framework is anchored in the alleviation of poverty and addressing inequality. Poverty is closely linked with unemployment and the unemployment rate currently sits at 29.1% (StatsSA, 2020c). According to the national poverty line for 2019, over half of South Africa's population (55.5%) are living below the upper-bound poverty line (ZAR 1 227 per month) from a series low of 53.2% in 2011, with 81.3% of people residing in rural areas and 40.6% in urban areas. This is in spite of poverty alleviation measures implemented by government departments and other public sector agencies, including providing access to no-fee government services and social grants. The post-apartheid government has committed to implementing various anti-poverty policies and programmes in order to meet the objectives of the sustainable development goals (SDGs) and continues to pledge to fight against the struggle of poverty (StatsSA, 2017b).

The current life expectancy of males and females at birth is 61.5 and 67.7 years, respectively. The infant mortality rate has declined from 32.8 to 22.1 per 1000 live births between 2017 and 2019 (StatsSA, 2018b). In addition, in 2019, there were 8.0 million people living with HIV in South Africa (StatsSA, 2019c).

The Human Development Index (HDI) is an average measure of basic human development achievements in a country comprising of life expectancy, education and income in the Index. South Africa, through its National Development Plan (NPC, 2011), identifies human development as a critical part of inclusive growth. In 2019, the Human Development Index value for South Africa was at 0.709 which represents an improvement relative to 2016 (0.666) (Figure 1.2). This has been boosted by increases in life expectancy at birth, mean schooling years and Gross National Income per capita.

Figure 1.2:
SOUTH AFRICA HUMAN DEVELOPMENT INDEX (UNDP, 2019).



1.4.3. Education

The education system is governed by the Department of Basic Education and Department of Higher Education and Training. Education remains a major priority in South Africa, accounting for 21% of the national budget in 2020/21 (National Treasury, 2021). South Africa's education system consists of Early Childhood Development (ECD) programmes (0-6 years), followed by primary (6-13 years), secondary (14-17 years) and tertiary education phases. There were 12. million learners at school in 2018, increasing to 13.0 million in 2019 (EMIS, 2019; EMIS, 2020). A Statistics SA report (StatsA, 2018c) showed that 56.9% of children below the age of 6 years had attended an early development educational institute, which is down from 63.0% in 2014. It also stated that 98.9% of children between the ages of 6 and 13 years attend school, while this is reduced to 95.5% for children aged 14 to 17 years. The largest percentage of learners attended schools in KwaZulu-Natal (22.2%) and Gauteng (19.6%) (StatsSA, 2018a). The number of people aged 15 and more above who have completed Grade 12 had increased from an estimated 3.7 million in 1996 to 11.6 million in 2016; and the number of people aged 15 and above who had completed higher

education institution courses had increased from an estimated 1.3 million in 1996 to 3.6 million in 2016 (StatsSA, 2017c).

Enrolment at public and private Higher Education Institutes reached 1.1 million enrolled by in 2016, with the National Development Plan (NDP) setting a target of 1.6 million by 2030 (DHET, 2018). Moreover, public Higher Education Institutes produced 203 076 graduates in 2016, which was 11 552 more than in 2015 and 57 692 more than in 2009. Of these graduates, 29.1% were in the Science, Engineering and Technology fields, followed by 27.8% in Business and Management and 22.4% in other Humanities. Registrations for Sector Education and Training Authority Supported Learning Programmes were up by 8.0% between 2015/16 and 2016/17, and the National Student Financial Aid Scheme allocation was 33;.6% higher in 2016/17 than in 2015/16. Educational attainment outcomes continue to improve with improved access to educational facilities and services (StatsSA, 2017a).

1.5. ECONOMIC PROFILE

South Africa's economy is categorised as 'upper-middle income' in capital markets and as an 'emerging economy'. The country remains one of the largest economies on the African continent, is known to be the world's largest exporter of gold, platinum and natural resources and, over the years, has progressed in establishing mining, finance, trade and government services as the main drivers of growth. Unemployment, poverty and inequality are amongst the key socio-economic challenges that South Africa is dealing with.

1.5.1. GDP

South Africa's GDP increased from USD 349 554 billion to USD 358 839 billion between 2017 and 2019 (World Bank, 2019a). The country's GDP growth has been trending downward since 2011, with unstable growth due to several events of inflation, recession, declining investments, and unemployment yielding the economy into slower economic growth (StatsSA, 2020a). In 2019, the GDP was at its lowest and has not recovered much since the 2008 recession (Figure 1.3). The years 2010–2013 showed some promise as the growth rate hovered slightly above 2%, albeit still below the policy expected growth rate of 5%. South Africa's economy grew by 0.2% in 2019, in particular, the growth rate of the 4th quarter shifted the economy into a technical recession.

In 2020, the impacts of the COVID-19 lockdown can be seen with South Africa's economy suffering a contraction in the second quarter of 2020. GDP fell by 6.1% between the first and second quarters with an annualised growth rate of -51%. Economic activity for the year decreased by 7.0% in 2020 compared to 2019 and household final consumption expenditure decreased by 5.4% (StatsSA, 2021b).

Debt as a percentage of GDP increased from 48.9% in the 2015/16 financial year to about 56.2% for the year 2019/20 and is projected to increase to 60% in the medium term (Figure 1.4). This means that borrowing costs will increase, with the majority of the debt to be used for infrastructure investment. It will, therefore, be strategic for South Africa to factor in mitigation and adaptation related infrastructure, thereby creating employment whilst dealing with climate change challenges.

Figure 1.3:
SOUTH AFRICA'S ANNUAL GDP GROWTH SINCE 2006 (STATSSA, 2021A).

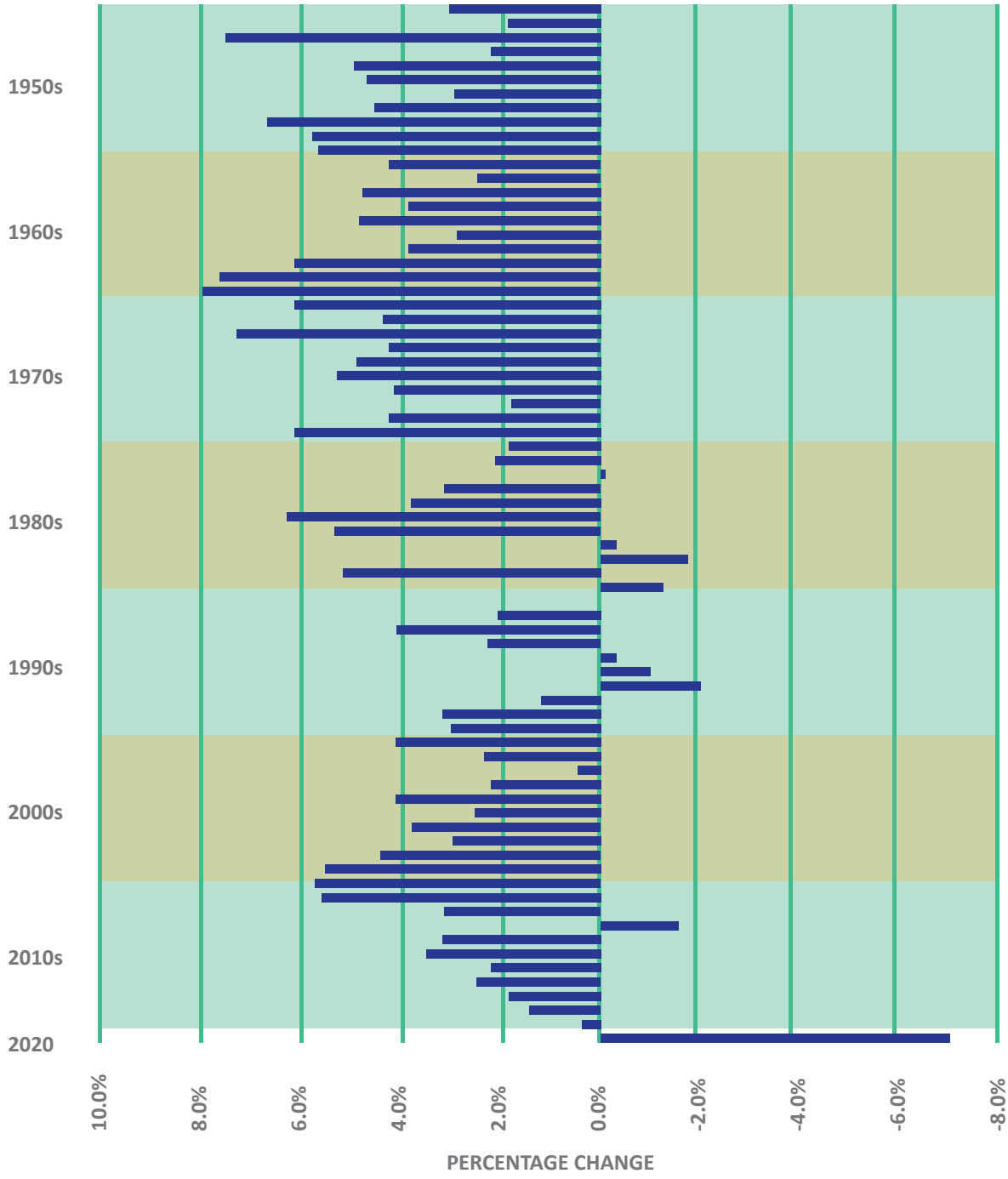
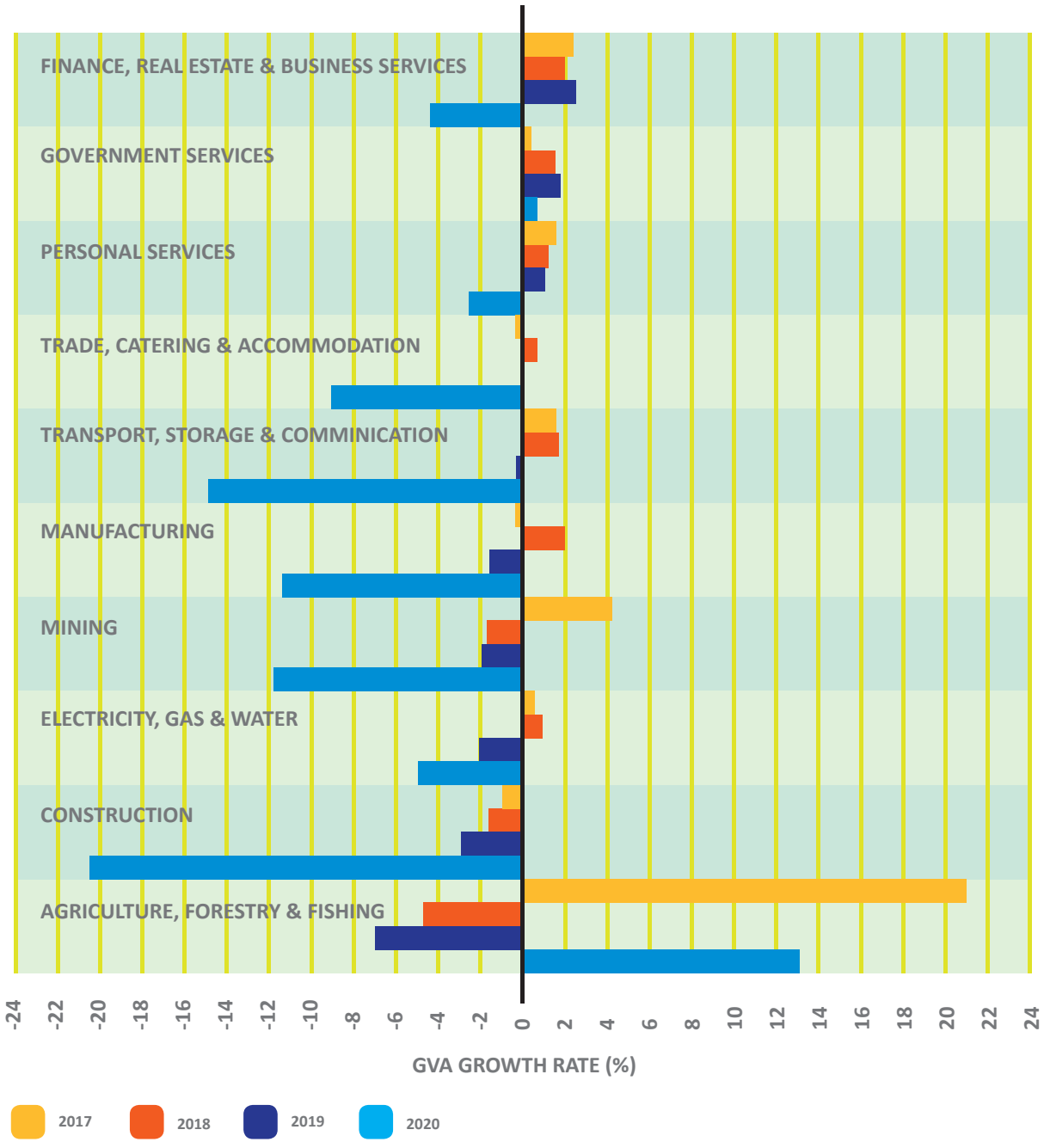


Figure 1.4:
GROSS DEBT-TO-GDP OUTLOOK (NATIONAL TREASURY, 2019).

1.5.2. Sectoral Performance

Historically, South Africa's economy was built mainly on primary and secondary industries, such as mining and manufacturing, but over time, and in line with global trends, growth (prior to 2020) shifted to services (Figure 1.5) which accounted for a significant proportion of GDP. In terms of the real sectoral contribution to GDP, the tertiary sector contributes 68%, the secondary sector contributes 21% and the primary sector contributes approximately 11%. According to Statistics SA (StatsSA, 2021b) annual estimates of real GDP for 2019 increased by 0.2% compared to 2018 and the highest annual real economic growth rates by region were recorded in Gauteng (0.6%), Western Cape (0.4%) and Kwa-Zulu Natal (0.1%). In 2020, the annual real GDP growth rate of -7.0% was led by decreases in manufacturing; trade, catering and accommodation; and transport, storage and communication (StatsSA, 2021b). Only agriculture, forestry and fishing along with general government services showed an increase in real GDP growth rate.

Figure 1.5:
GROWTH RATES IN INDUSTRY VALUE ADDED BETWEEN 2017 AND 2020 (STATSSA, 2021B).



1.6. INFRASTRUCTURE

The public-sector capital expenditure displayed an increasing trend from 2012 to 2016. However, capital expenditure decreased from ZAR 284 billion in 2016 to ZAR 249.6 billion in 2018, with an average decline of 17.2% per year (StatsSA, 2018a). Infrastructure investments facilitate economic activities and thus enable economic growth, job creation and poverty alleviation. Public-sector infrastructure spending over the medium-term expenditure framework period (2021 – 2023) is estimated at ZAR 815 billion (National Treasury, 2020). State-owned companies continue to be the largest contributor to capital investment, with a projected spend of ZAR 314 billion over the next three years. Infrastructural spending also underpins some of the goals of the NDP (NPC, 2011), in particular, the provision of service delivery and infrastructural development, which has a target of 30% as a percentage of GDP by 2030.

1.7. ENERGY

1.7.1. Energy Expenditure

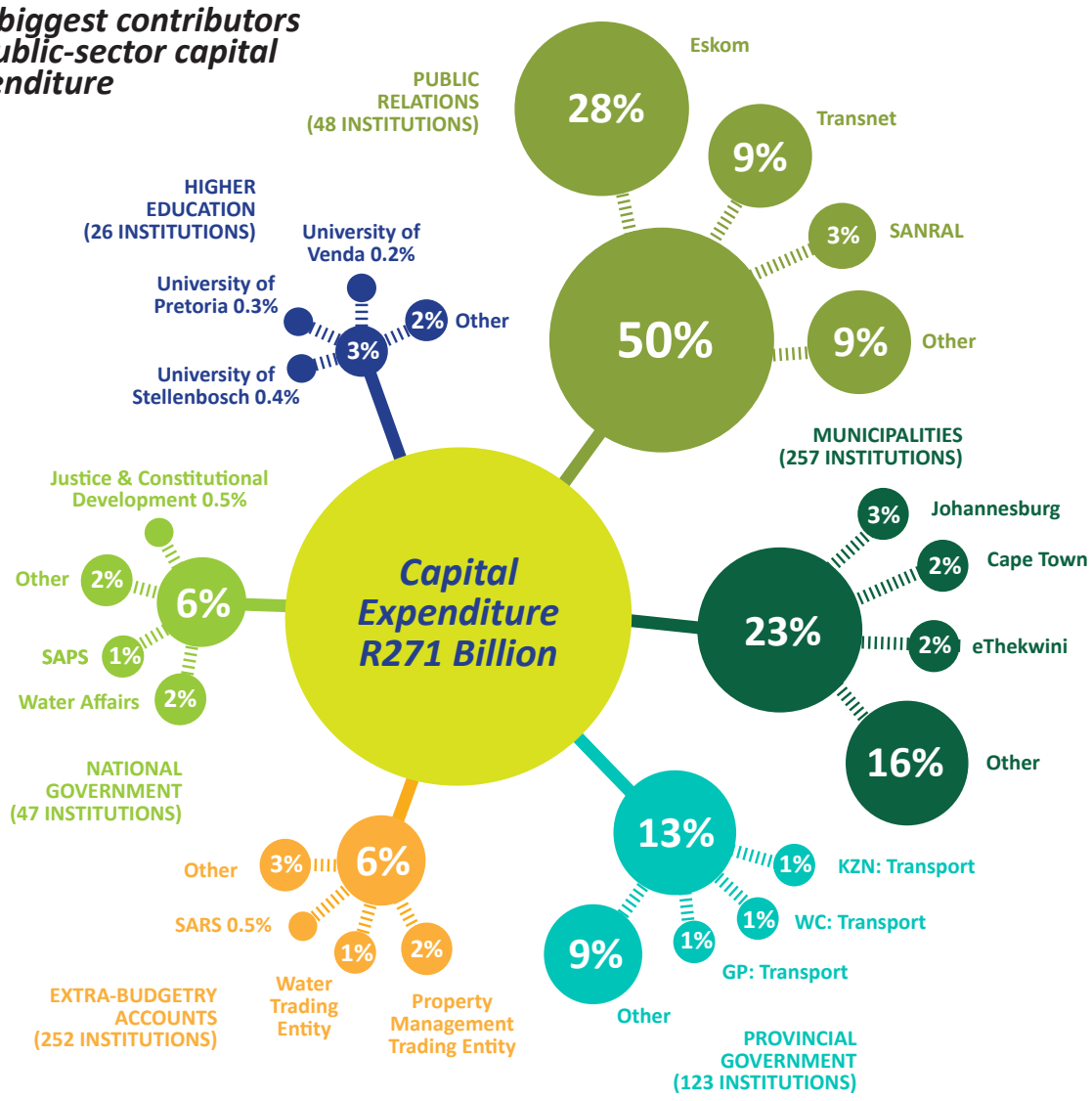
Globally, South Africa continues to be one of the major suppliers of mineral commodities. Hence, the total energy consumption per unit of GDP is about 50% higher than the world's average. This high consumption rate is caused by industries that are energy intensive and the type of coal used in the energy supply system. The South African manufacturing industry at present depends largely on primary extraction and relatively low-grade processing, making it a heavy user of energy. The public sector continues to invest in infrastructure, with particular focus on new construction related to electricity generation. Well-maintained energy infrastructure facilitates trade, improves connectivity, attracts investment, and provides communities with greater access to services.

More than a quarter of the South Africa's public-corporations capital expenditure in 2017 went to the power utility Eskom (Figure 1.6) (StatsSA, 2018a). Eskom has remained the single largest contributor over the last three years, contributing 25.7%, 28.0% and 25.3% to the public sector capital expenditure in 2016, 2017 and 2018 respectively. Eskom reduced spending from ZAR 73 billion in 2016 to ZAR 63 billion in 2018. This spending was mainly focused on the power generation projects at Kusile, new electricity distribution programmes, and vehicle build programmes (StatsSA, 2018a). Energy expenditure is expected to total ZAR 150 billion over the next three years (2020 – 2023), accounting for 18.4% of total infrastructure spending. Eskom accounts for 85.3% of this (National Treasury, 2020). The Department of Mineral Resources and Energy (DMRE) will focus on increasing household access to electricity over the medium term. A total of ZAR 691 million has been allocated to energy efficiency and demand-side management grant over the medium term to assist municipalities in upgrading their infrastructure with more energy-efficient technology.

1.7.2. Energy Sources

Coal remains South Africa's dominant primary energy source (Figure 1.7), but its contribution to the energy mix has declined from 69% in 2016 to 61% in 2017 (DoE, 2017; DoE, 2019). The costs of traditional fossil fuel-based energy have been steadily increasing, and so renewable energy uptake is growing andbecoming a more viable option (DoE, 2019). The DMRE continues to support the renewable energy market, in line with the national commitment to transition to a low-carbon economy. Government has committed to procuring 14 725 megawatts (MW) of power from renewable energy sources in terms of the Integrated Resource Plan 2010 to 2030. Up to 2019, 6 422 MW had been procured from 112 renewable energy

Figure 1.6:
PUBLIC-SECTOR CAPITAL EXPENDITURE FOR 2017 (STATSSA, 2018A).

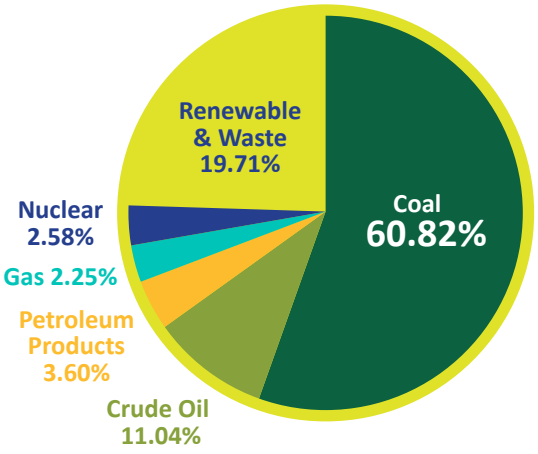


PERCENTAGE BREAKDOWN ON SPENDING ON CONSTRUCTION, LAND, EQUIPMENT AND OTHER FIXED ASSETS ACROSS 751 INSTITUTIONS FOR THE YEAR 2017.

*Percentages have been rounded and may not sum to 100%
Source: Capital expenditure by the public sector for 2017 (unit data)

independent power producer projects and 3 976 MW of electricity generation capacity from 64 projects has been added to the national grid (National Treasury, 2020). South Africa is currently rated as the 12th most attractive investment detination for renewable energy. The Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) has, to date, attracted investment (equity and debt) to the value of ZAR 209.7 billion, of which ZAR 41.8 billion (20%) is foreign investment (DoE, 2019).

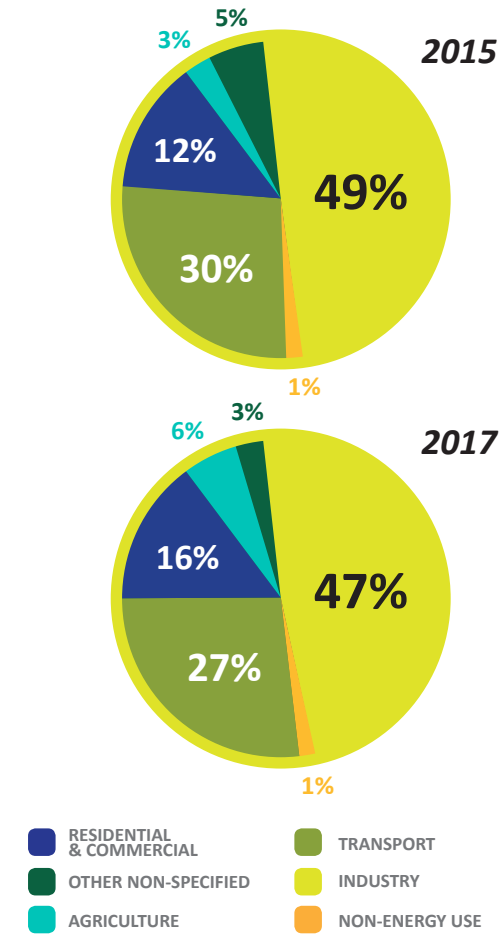
Figure 1.7:
TOTAL PRIMARY ENERGY SUPPLY IN SOUTH AFRICA IN 2017 BROKEN DOWN BY SOURCE (DOE, 2017).



1.7.3. Energy Consumption

The largest consumer of energy is the industrial sector, accounting for 47% of the total energy consumption in 2017 (Figure 1.8). This is followed by the transport sector at 27% and the residential and commercial sector at 16% of total energy consumption. The agricultural sector energy consumption increased by 3% and the residential and commercial sector by 4% between 2015 and 2017. In 2018 it was reported that 84.7% of households had access to electricity, which is up from 84.2% in 2017 (StatsSA, 2019c).

Figure 1.8:
ENERGY CONSUMPTION PER SECTOR IN 2015 & 2017 (DOE, 2015, 2017).



1.8. INSTITUTIONAL ARRANGEMENTS FOR CLIMATE CHANGE

1.8.1. Domestic Institutional Arrangements for Climate Change

1.8.1.1. National level institutional arrangements

South Africa is a constitutional democracy, with three spheres of government, namely national, provincial and local. The Constitution of the Republic of South

Africa (RSA, 1996) mandates the autonomy of each of these government spheres. Local government has a more autonomous role in terms of raising revenue and designing by-laws that are aligned to the Constitution, and national and provincial government policies. The underlying framework to such autonomy is that of cooperative governance which is also anchored through such acts as the Intergovernmental Relations Framework Act (Act 13 of 2005). With regards to climate change, the National Climate Change Response Policy (NCCRP) (DEA, 2011) provides a clear framework for the mainstreaming of climate change planning and action between the different spheres of government. Many government departments and municipalities have started mainstreaming climate change into their government strategies, policies and Integrated Development Plans (IDPs) which signals South Africa's readiness to tackle climate change whilst delivering services to the people of South Africa.

1.8.1.2. Provincial and Local Government institutional arrangements

At a provincial level, departments responsible for the environment are assigned to lead climate change response action in collaboration with their respective environmental departments and provincial entities. The majority of the lead departments have established provincial climate change structures to provide a platform for provincial stakeholders to jointly learn about climate change and coordinate their respective climate change responses. The South African Local Government Association (SALGA) is mandated to support, represent and advise local governments on issues pertaining to governance at a community level. The role of local government in South Africa is critical because it is the sphere of government closest to the people. Therefore, municipalities coordinate the implementation of service delivery within communities. The local sphere is the most appropriate level to create public awareness and assist communities to build a better and more sustainable environment and enhance resilience. Cities are taking the lead in driving climate action because they have enough capacity to do so. District and Local Municipalities are undertaking Climate Vulnerability Assessments and are mainstreaming climate action into their policies, strategies and plans under the guidance of the Department of Forestry, Fisheries and the Environment (DFFE) and SALGA.

1.8.2. Institutional Arrangements for the Preparation of the BUR4

1.8.2.1. National Focal Point

The Department of Environmental Affairs (DEA) was renamed the Department of Environment, Forestry and Fisheries (DEFF) in June 2019, incorporating the forestry and fisheries functions from the previous Department of Agriculture, Forestry and Fisheries. In 2021, the name was updated again to the Department of Forestry, Fisheries and the Environment (DFFE), which is its current name as at the publication of this document. The DFFE plays a central coordinating and policy making role as the designated authority for environmental conservation and protection in South Africa. It monitors national environmental information, policies, programmes and legislation related to climate change. The department is responsible for providing guidance and ensuring that there is a clear alignment of policies and international obligations when it comes to climate change. For example, there is a need to align the Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction and the Paris Agreement. All of these frameworks and policies play a significant role in the current efforts required to enable developing countries to become low carbon and climate resilient economies.

The work of the DFFE is underpinned by the Constitution of the Republic of South Africa (Act 108 of 1996), the NDP, National Environmental Management Act (NEMA) (Act 39 of 2004), NCCRP and other relevant legislation and policies applicable to government to address environmental management, including climate change. The DFFE is responsible for coordination and management of all climate change-related information such as mitigation, adaptation and monitoring and evaluation programmes.

The DFFE is responsible for the implementation of the UNFCCC, Kyoto Protocol and Paris Agreement, on behalf of the South African Government. The DFFE has been appointed as the UNFCCC National Focal Point and the Global Environment Facility Political Focal Point. The Department leads the work on the ongoing preparation of BURs under the Chief Directorate: International Climate Change Relations and Reporting.

This function has been restructured as it was previously under the Climate Change Monitoring and Evaluation Chief Directorate. The Project Steering Committee (PSC) established by the Director General of the DFFE continues to support contributing authors and in providing technical inputs and oversight on the compilation of these reports. This includes reviewing and commenting on technical information to ensure that the reports reflect the national circumstances.

1.8.2.2. Project steering committee

The PSC is chaired by the DFFE and comprises government officials from the following national departments:

- Department of Forestry, Fisheries and the Environment
- Department of Agriculture, Land Reform and Rural Development
- Department of Women, Youth and Persons with Disabilities
- Department of Cooperative Governance and Traditional Affairs
- Department of Health
- Department of Higher Education and Training
- Department of Human Settlements
- Department of International Relations and Cooperation
- Department of Mineral Resources and Energy
- Department of Planning, Monitoring and Evaluation
- Department of Public Enterprises
- Department of Public Works and Infrastructure
- Department of Science and Innovation
- Department of Trade, Industry and Competition
- Department of Transport
- Department of Water and Sanitation
- National Treasury
- Statistics South Africa

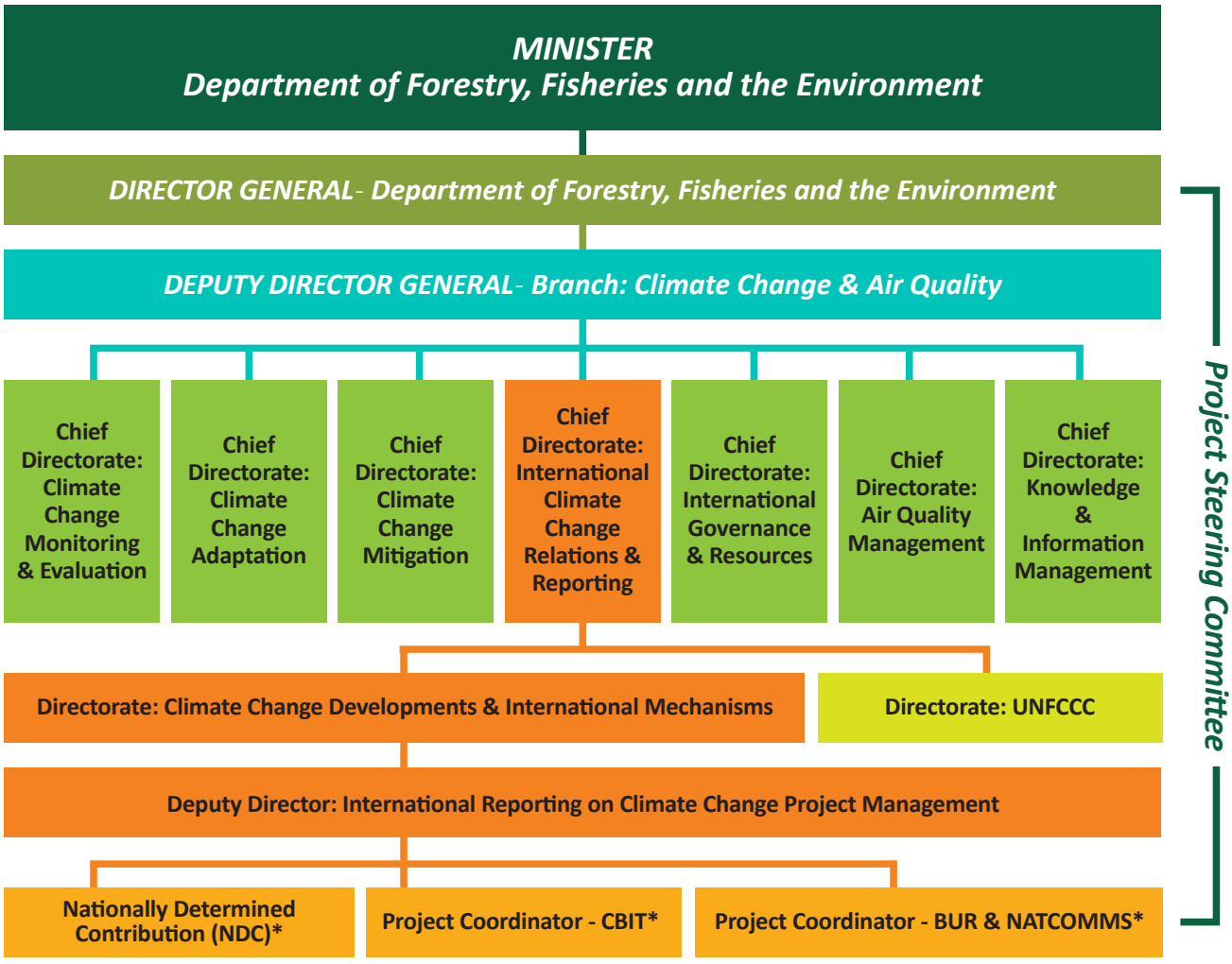
The PSC meets every four months to evaluate progress of work, advise on project execution, and where necessary provide overall direction and oversight of the project. The PSC informs the members of the Intergovernmental Committee on Climate Change and the National Climate Change Committee of the progress made on the BUR Project, on a regular basis (at least once a year).

The BUR and National Inventory Reports (NIRs) are endorsed by the PSC before they are submitted to Cabinet for approval. Once the reports are approved by Cabinet, they are submitted to the UNFCCC by the Chief Directorate for Climate Change International Relations and Reporting and undergo an international review process.

The Project Management Unit is in charge of project implementation activities as per the agreed Project Implementation Plan and is responsible for the day-to-day management of the project, as well as monitoring and evaluation. The Project Management Unit coordinates all activities and provides services to carry out activities such as procurement and delivery of project inputs, and their conversion into the project outputs.

The National Project Manager serves as the Project Management Unit head and is responsible for the effective, efficient and timely implementation of project activities. The National Project Manager reports to the Steering Committee of the DFFE and UNEP and coordinates the implementation of all project activities with them.

Figure 1.9:
INSTITUTIONAL ARRANGEMENTS FOR PREPARING THE BUR4.



South Africa has to date submitted three BURs and three National Communications to the UNFCCC. The 1st BUR was submitted in December 2014 together with the NIR covering GHG emissions from 2000-2010; the 2nd BUR was submitted in December 2017 with the NIR covering GHG emissions from 2000-2012 and the 3rd BUR was submitted in June 2019 with the NIR covering GHG emissions from 2000-2015. All NIRs submitted with the BURs were compiled using the 2006 IPCC guidelines. All of the BURs submitted to the UNFCCC have undergone both the technical analysis and Facilitative Sharing of Views (FSV) processes of the International Consultation and Analysis (ICA). Summary reports of the technical analysis have been published on the UNFCCC website. South Africa aims to improve with every BUR taking into consideration the recommendations from the previous ICA processes and such improvements have been reported in the relevant chapters.

*Posts below deputy director are dependent on donor funding, such as the GEF, since these are not permanent.

2. NATIONAL GHG INVENTORY

2.1. INTRODUCTION

This chapter presents a summary of the National Greenhouse Gas (GHG) Inventory (the Inventory) for South Africa for the period of 2000 to 2017. The complete Inventory was subjected to an independent review process and the data was finalised and incorporated into this report. As with the previous Inventory of 2015, this Inventory was compiled in accordance with the International Panel on Climate Change (IPCC) 2006 guidelines for Inventories and covers all four sectors, namely:

(i) Energy
(ii) Industrial Processes and Product Use (IPPU)
(iii) Agriculture, Forestry and Other Land Use (AFOLU)
(iv) Waste

The emissions for the reporting period are presented as trends by gas and sector covering carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Sulfur hexafluoride (SF_6) emissions are not reported due to a lack of data. The Department of Forestry, Fisheries and the Environment (DFFE) are in discussions with South Africa's main electricity producer (Eskom) to obtain historical SF_6 data so that it can be included in the next inventory. Furthermore, a threshold has been set for SF_6 in the new GHG Reporting Regulations so that companies will start reporting SF_6 data. The trends per sector are also presented, highlighting the methods, data and quality control (QC) measures that have been implemented. This chapter concludes with a summary of the key focus areas for improving future inventories.

2.2. SUMMARY OF PROGRESS ON INVENTORY SINCE BUR3

2.2.1. Inventory Improvements

In the Energy sector, a recent fuel consumption study (DFFE, 2020) was completed for the transport sector which provided consumption data based on vehicle kilometres travelled (VKT). In this inventory, the petrol, diesel and natural gas consumption data for Road transport was updated. In the Energy sector, the coal and diesel consumption data in the Road transport, Manufacturing industries and construction, other sectors and Non-specified emissions from energy production categories were updated due to updated Department of Mineral Resources and Energy (DMRE) energy balance data.

Due to the reporting of company emissions data for the recently introduced National Greenhouse Gas Emission Reporting Regulations (NGERs), updated company emission data was incorporated into the IPPU sector where available. These included updated production data (particularly for the years from 2014) for cement production, lime production, glass production, nitric acid production, iron and steel production, ferroalloys production and lead production. Additional improvements included the application of the hydrated lime emission factor, corrected emission factors for the iron and steel industry, and an update in the lubricant and paraffin wax production data due to updates in the energy balance data.

The main improvements and updates in the AFOLU sector were:

(i) Livestock:
   a. Updated cattle herd compositions.
   b. Updated manure management.
   c. Included country specific nitrogen (N)-excretion rates.

(ii) Land:
   a. Included 20-year default transition period.
   b. Updated burnt area data.
   c. Included annual burnt area data instead of 5-year averages.
   d. Updated biomass, dead organic matter (DOM) and soil organic carbon (SOC) data.
   e. Improved plantation data.
   f. Updated wood removal data.

(iii) Aggregated and non-CO_2 emissions on land:
   a. Updated biomass burning factors (burnt area, emission factors, fuel loads, etc).
   b. Updated burnt area to the MODIS collection 6 data.
   c. Applied annual burnt area data instead of 5-year averages.
   d. Improved crop residue calculations.
   e. Included N^2O losses from land use change.

Further improvements in the AFOLU sector are discussed in section 2.8.3.4.

In the Waste sector, the solid waste disposal data was improved by incorporating updated country specific population data, waste generation rates and percentage of waste going to solid waste disposal sites into the First Order Decay (FOD) model for the years 1950 to 1999. Further details of improvements are provided in the sectoral analysis section of this chapter, as well as in the 2017 National Inventory Report (NIR2017). In addition, this submission contains a full uncertainty analysis with all sectors being included.

2.2.2. Enhanced Capacity of the DFFE Inventory Team

Since the last Biennial Update Report (BUR), the DFFE has increased the capacity of the Inventory team by taking on an Inventory coordinator as well as a specialist in each of the sectors. The Inventory coordinator will coordinate the preparation of the Inventory and will also be in charge of maintaining the National GHG Inventory Management System (NGHGIS). The sector specialists will take the lead in the preparation of the emission estimates for each of the sectors. The team was not fully involved in the preparation of the 2017 Inventory since new team members were only brought on board in 2019 but will be involved in the 2019 Inventory.

Gondwana Environmental Solutions International, the consulting company involved in developing the NGHGIS (in collaboration with Aether), compiling the AFOLU sector emission estimates and compiling the overall Inventory, have provided training for the new Inventory team on Inventory preparation, sector compilation files, Quality Assurance (QA) and QC and the NGHGIS. The capacity building will enable the DFFE to manage and complete the Inventory compilation of future Inventories.

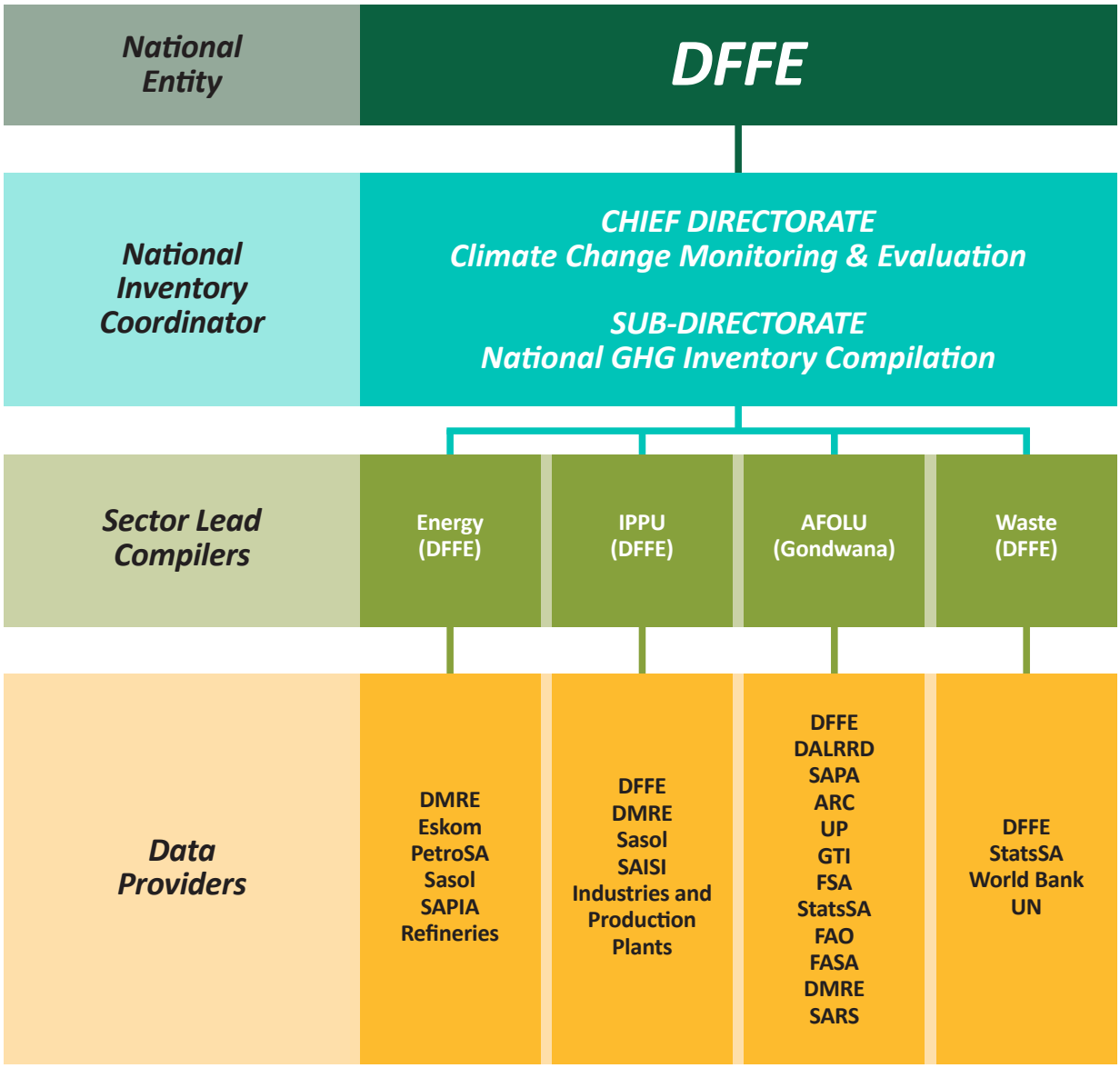
2.2.3. National GHG Emissions Reporting Regulations

Many companies in South Africa have been reporting their GHG emissions voluntarily for a number of years, primarily through the CDP (formerly the Carbon Disclosure Project), while at the same time national government has been reporting South Africa's emissions as part of National Communications to the United Nations Framework Convention on Climate Change (UNFCCC). While corporate reporting and national reporting have developed independently of each other, they have the potential to complement each other and enable decision-makers to understand national and sector trends, as well as to inform mitigation activities (Singh et al., 2014). The South African Government, through the National Environmental Management: Air Quality Act (Act No. 39 of 2004): National GHG Emission Reporting Regulations (NGERs) (DEA, 2017), has introduced mandatory reporting which implies that some emitters that are meeting set capacity, production or usage thresholds will be required to report their emissions to the government. The purpose of the NGERs is to introduce 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 United Framework Convention on Climate Change (UNFCCC) and instrument treaties to which it is bound; and (c) to inform the formulation and implementation of legislation and policy. Companies will submit emissions data to the South African GHG Emissions Reporting System (SAGERS) (discussed in chapter 6, section 6.3.3.1) which is a component of the National Atmospheric Emissions Inventory System (NAEIS).

2.3. INSTITUTIONAL CONTEXT

The preparation of the Inventory is a multi-organisation effort led by the Department of Forestry, Fisheries and the Environment (DFFE), previously the Department of Environment, Forestry and Fisheries (DEFF). South Africa uses a hybrid (centralised/distributed) approach to programme management for the Inventory compilation. 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 responsible for the coordination and management of all climate change-related information, including mitigation, adaptation, monitoring and evaluation, and Inventories. Although the DFFE takes a lead role in the compilation, implementation and reporting of the Inventories, other relevant agencies and ministries play supportive roles in terms of data provision across relevant sectors. The AFOLU sector Inventory was compiled by external consultants (Gondwana Environmental Solutions International (Gondwana)) who were appointed formally through a contract. All other sector estimates were compiled by the DFFE.

Figure 2.1:
OVERVIEW OF THE INSTITUTIONAL ARRANGEMENTS FOR THE COMPILATION OF THE NATIONAL GHG INVENTORY.



2.4. GLOBAL WARMING POTENTIALS

In this inventory, the Second Assessment Report (SAR) (IPCC, 1996) Global Warming Potentials (GWPs) were applied. This is consistent with the previous Inventory for 2015 (DEA, 2019b) and is compliant with UNFCCC Reporting Requirements.

2.5. QUALITY CONTROL AND ASSURANCE PROCEDURES

A Quality Control (QC) and quality assurance (QA) plan was developed for the Inventory (DEA, 2019b) highlighting the various stages of the QC process, the activities to be completed and the responsibilities.

2.5.1. Quality Control

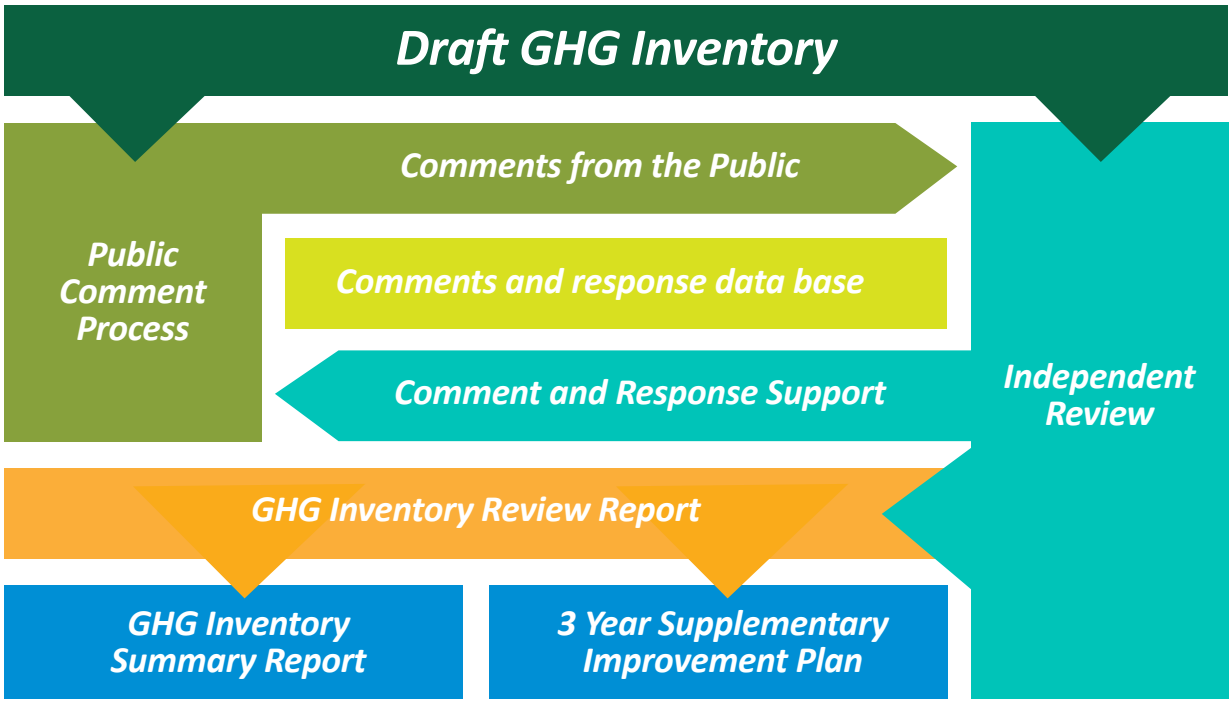
The QC procedures are performed by the experts during Inventory calculation and compilation. QC measures are aimed at the attainment of the quality objectives. The QC procedures comply with the IPCC Good Practice Guidance and the 2006 IPCC Guidelines. General Inventory QC checks include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies, and documentation and archiving of Inventory data and QC 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 are 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. The quality control checks performed in the 2017 Inventory are provided in Table 1.2 in the NIR2017.

2.5.2. Quality Assurance

QA, as defined in the IPCC Good Practice Guidance, comprises a ***"planned system of review procedures conducted by personnel not directly involved in the Inventory compilation and development process."*** The QA process includes both expert review and a general public review as shown in Figure 2.2. 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. The expert and public reviews of the draft document offer a broader range of researchers and practitioners in government, industry and academia, as well as the general public, the opportunity to contribute to the final document. The comments received during these processes are reviewed and, as appropriate, incorporated into the National Inventory Report (NIR) or reflected in the Inventory estimates.

Figure 2.2:
THE INDEPENDENT REVIEW PROCESS FOR THE 2000 – 2017 INVENTORY.



2.5.3. Verification

Emission and activity data are verified by comparing them with other available data compiled independently of the National GHG Inventory Management System (NGHGIS). These include measurement and research projects and programmes initiated to support the NGHGIS, or for other purposes, but producing information relevant to the Inventory preparation. The specific verification activities are described in detail in the relevant category sections in the following chapters.

2.6. DATA STORAGE & ARCHIVING

South Africa recently developed the NGHGIS to manage and simplify its climate change obligations to the UNFCCC process. This system aims to ensure a) the sustainability of the Inventory preparation in the country, b) consistency of reported emissions and c) the standard/quality of results. The NGHGIS ensures that the country prepares and manages data collection and analysis, as well as all relevant information related to climate change in the most consistent, transparent and accurate manner for both internal and external reporting.

The NGHGIS includes:

(i) The formalisation of a Single National Entity (the DFFE) responsible for the preparation, planning, management, review, implementation, and improvement of the Inventory.
(ii) Legal and collaborative arrangements between the Single National Entity and the institutions that are custodians of key source data.
(iii) A process and plan for implementing QA and QC procedures.
(iv) A process to ensure that the national inventory meets the standard inventory data quality indicators of accuracy, transparency, completeness, consistency, and comparability.
(v) A process for continual improvement of the Inventory.

The NGHGIS has been useful in the compilation of the 2015 and the 2017 Inventory respectively in keeping records of the following; stakeholders lists with their contact details, list of input datasets which are linked to the stakeholder list, QA/QC plan and checks, QA/QC logs which provide details of all QA/QC activities, all method statements, calculations and supporting files, key references, key categories and all NIRs.

Other data collected to support the compilation of the Inventory can be stored on the government's departmental Electronic Data Management System. South Africa also developed South African GHG Emissions Reporting System (SAGERS) which will be used in collecting and storing industry emission data.

2.7. SUMMARY OF 2017 NATIONAL GHG INVENTORY

South Africa's emissions are estimated using the 2006 IPCC Guidelines for National GHG Inventories. The Inventory covers sources of greenhouse gas emissions, and removals by sinks, resulting from human (anthropogenic) activities for the major greenhouse gases: CO_2, CH_4, N_2O, PFCs, and hydrofluorocarbons HFCs. The indirect greenhouse gases, carbon monoxide (CO), and oxides of nitrogen (NOx), are also included for biomass burning. Emission estimates are based on the sectoral approach and, as per the guidelines, the gases are reported under four sectors: Energy; Industrial Processes and Product Use (IPPU); Agriculture, Forestry and Other Land Use (AFOLU) and Waste. SF_6 emissions have not yet been included due to a lack of data, however the DFFE are in discussions with the main electricity producer (Eskom) to obtain historical SF_6 data so that it can be included in the next Inventory. Furthermore, a threshold has been set for SF_6 in the new NGERs so that companies will start reporting SF_6 data.

2.7.1. National GHG Inventory Emissions for 2017

Emissions are to be reported using the IPCC 1996 Guideline table format, however, since South Africa utilises the IPCC 2006 Guidelines, methodologies populating the 1996 summary table leads to many inconsistencies and errors. The emissions are therefore reported using the similar 2006 IPCC Guideline reporting formats, and to be transparent about the relationship between the IPCC 1996 and 2006 categories, a comparison between the two is shown in Table 2.1.

National emissions of CO_2, CH_4 and N_2O and GHG pre-cursors for 2017 are provided in Table 2.2. Emissions of GHG precursor gases (NOx, CO and NMVOCs) are only estimated from Biomass burning. GWPs from the IPCC Second Assessment Report (SAR) (IPCC, 1996) GWPs were used. The AFOLU sector has emissions and removals, with the removals occurring in the Land and Harvested Wood Products categories. Together these two categories form what is termed the FOLU (Forestry and Other Land Use) component of the Inventory. Net emissions (or emissions including FOLU) include emissions and sinks from all sectors, while gross emissions exclude the removals from the FOLU categories.

Table 2.1:

RELATIONSHIP BETWEEN THE IPCC 1996 AND 2006 GUIDELINE CATEGORIES.

IPCC 1996 CATEGORY	IPCC 2006 CATEGORY
1 - ENERGY	**1 - ENERGY**
1.A - Fuel Combustion Activities	**1.A - Fuel Combustion Activities**
1.A.1 - Energy Industries	1.A.1 - Energy Industries
1.A.2 - Manufacturing Industries and Construction	1.A.2 - Manufacturing Industries and Construction
1.A.3 - Transport	1.A.3 - Transport
1.A.4 - Other Sectors	1.A.4 - Other Sectors
1.A.5 – Other	1.A.5 - Non-Specified
1.B - Fugitive Emissions from Fuels	**1.B - Fugitive Emissions from Fuels**
1.B.1 - Solid Fuels	1.B.1 - Solid Fuels
1.B.2 - Oil and Natural Gas	1.B.2 - Oil and Natural Gas
IE	1.B.3- Other emissions from Energy Production
IE	**1.C - Carbon Dioxide Transport and Storage**
IE	1.C.1 - Transport of CO_2
IE	1.C.2 - Injection and Storage
IE	1.C.3 - Other
2 - INDUSTRIAL PROCESSES AND PRODUCT USE	**2 - INDUSTRIAL PROCESSES AND PRODUCT USE**
2.A - Mineral Industry	**2.A - Mineral Industry**
2.B - Chemical Industry	**2.B - Chemical Industry**
2.C - Metal production	**2.C - Metal Industry**
IE - 1A, 2A5, 2A6, 3	**2.D - Non-Energy Products from Fuels and Solvent Use**
IE - 2F6	**2.E - Electronics Industry**
2.F - Consumption of Halocarbons and Sulphur Hexafluoride	**2.F - Product Uses as Substitutes for Ozone Depleting Substances**
IE - 2F6, 3D	**2.G - Other Product Manufacture and Use**
IE - 2D1, 2D2, 2G	**2.H - Other**
3 - SOLVENT AND OTHER PRODUCT USE	**3 - AGRICULTURE, FORESTRY, AND OTHER LAND USE**
4 - AGRICULTURE	**3.A - Livestock**
4.A - Enteric Fermentation	3.A.1 - Enteric Fermentation
4.B - Manure Management	3.A.2 - Manure Management
5 - LULUCF	**3.B - Land**
5.A - Changes in Forest and Other Woody Biomass Stocks;	3.B.1 - Forest Land
5.B - Forest and Grassland Conversion;	3.B.2 - Cropland
5.C - Abandonment of Management Soils;	3.B.3- Grassland
5.D - CO_2 Emissions and Removals from Soil;	3.B.4 - Wetlands
5.E - Other	3.B.5 - Settlements
	3.B.6 - Other Land
4.E - Prescribed Burning of Savannas;	**3.C - Aggregate sources and non-CO_2 emissions sources on land**
4.F - Field Burning of Agricultural Residues	3.C.1 - Emissions from Biomass Burning
4.D - Agricultural Soils	3.C.2 - Liming
4.D - Agricultural Soils	3.C.3 - Urea Application
4.D - Agricultural Soils	3.C.4 - Direct N_2O Emissions from Managed Soils
4.D - Agricultural Soils	3.C.5 - Indirect N_2O Emissions from Managed Soils
4.D - Agricultural Soils	3.C.6 - Indirect N_2O Emissions from Manure Management
4.C - Rice Cultivation	3.C.7 - Rice Cultivations
4.G - Other	3.C.8 - Other (please specify)
	3.D - Other
	3.D.1 - Harvested Wood Products
	3.D.2 - Other (please specify)
6 - WASTE	**4 - WASTE**
6.A - Solid Waste Disposal on Land	**4.A - Solid Waste Disposal**
IE - 6A3	**4.B - Biological Treatment of Solid Waste**
4.C - Waste incineration	**4.C - Incineration and Open Burning of Waste**
4.D - Wastewater Treatment and Discharge	**4.D - Wastewater Treatment and Discharge**
4.E - Other	**4.E - Other**
	5 - OTHER
	5.A - Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH_3
	5.B - Other
	MEMO ITEMS
	International bunkers
	International Aviation
	International Water-Borne Transport
	Multilateral Operations

Table 2.2:

NATIONAL GHG INVENTORY OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR 2017, INCLUDING GHG PRECURSORS.

IPCC 2006 CATEGORY	EMISSIONS AND REMOVALS#								
	Net CO_2	CH_4 (Gg)[a]	N_2O	HFCs (Gg CO_2e)[b]	PFCs	NOx	CO (Gg)[a]	NMVOC	Total GHGs (Gg CO_2e)
EMISSIONS (INCL. FOLU)	**402 095.3**	**2 398.4**	**82.0**	**4 014.5**	**113.1**	**22.3**	**528.8**	**31.1**	**482 016.3**
EMISSIONS (EXCL. FOLU)	**433 406.2**	**2 366.7**	**82.0**	**4 014.5**	**113.1**	**22.3**	**528.8**	**31.1**	**512 660.6**
1 - ENERGY	**403 971.0**	**196.4**	**8.4**	**-**	**-**	**-**	**-**	**-**	**410 685.3**
1.A - Fuel Combustion Activities	**377 563.2**	**18.6**	**8.4**	**-**	**-**	**NE**	**NE**	**NE**	**380 542.1**
1.A.1 - Energy Industries	248 093.6	2.7	3.8	-	-	NE	NE	NE	249 333.7
1.A.2 - Manufacturing Industries and Construction	28 645.3	0.5	0.4	-	-	NE	NE	NE	28 765.5
1.A.3 - Transport	53 597.6	12.0	2.7	-	-	NE	NE	NE	54 694.5
1.A.4 - Other Sectors	37 547.3	3.2	1.3	-	-	NE	NE	NE	38 022.3
1.A.5 - Non-Specified	9 679.4	0.1	0.1	-	-	NE	NE	NE	9 726.1
1.B - Fugitive Emissions from Fuels	**26 407.8**	**177.9**	**NE**	**-**	**-**	**NE**	**NE**	**NE**	**30 143.1**
1.B.1 - Solid Fuels	19.5	73.9	NE	-	-	NE	NE	NE	1 571.0
1.B.2 - Oil and Natural Gas	641.8	NE	NE	-	-	NE	NE	NE	641.8
1.B.3 - Other Emissions from Energy Production	25 746.5	104.0	NE	-	-	NE	NE	NE	27 930.4
1.C - Carbon Dioxide Transport and Storage	**NE**	**-**	**-**	**-**	**-**	**NE**	**NE**	**NE**	**0.0**
1.C.1 - Transport of CO_2	NE	-	-	-	-	NE	NE	NE	0.0
1.C.2 - Injection and Storage	NE	-	-	-	-	NE	NE	NE	0.0
1.C.3 - Other	NA	-	-	-	-	NE	NE	NE	0.0
2 - INDUSTRIAL PROCESSES AND PRODUCT USE	27 496.0	8.0	0.9	4 014.5	113.1	-	-	-	32 084.6
2.A - Mineral Industry	**6 257.3**	**NE**	**NE**	**-**	**-**	**NE**	**NE**	**NE**	**6 257.3**
2.B - Chemical Industry	**433.6**	**8.0**	**0.9**	**-**	**-**	**NE**	**NE**	**NE**	**893.4**
2.C - Metal Industry	**20 274.5**	**0.1**	**NE**	**NE**	**113.1**	**NE**	**NE**	**NE**	**20 388.7**
2.D - Non-Energy Products from Fuels and Solvent Use	**530.6**	**NE**	**NE**	**-**	**-**	**NE**	**NE**	**NE**	**530.6**
2.E - Electronics Industry	**NE**	**-**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0.0**
2.F - Product Uses as Substitutes for Ozone Depleting Substances	**NE**	**-**	**-**	**4 014.5**	**NE**	**NE**	**NE**	**NE**	**4 014.5**
2.G - Other Product Manufacture and Use	**-**	**-**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0.0**
2.H - Other	**NA**	**NA**	**NA**	**-**	**-**	**NE**	**NE**	**NE**	**0.0**
3 - AGRICULTURE, FORESTRY, AND OTHER LAND USE	-29 409.2	1 224.4	70.0	-	-	22.3	528.8	31.1	17 997.5
3.A - Livestock	**-**	**1 172.8**	**5.3**	**-**	**-**	**-**	**-**	**-**	**26 272.3**
3.A.1 - Enteric Fermentation	-	1 137.3	-	-	-	-	-	-	23 883.7
3.A.2 - Manure Management	-	35.4	5.3	-	-	-	-	-	2 388.6
3.B - Land	**-30 534.0**	**31.7**	**IE**	**-**	**-**	**IE**	**IE**	**IE**	**-29 867.4**
3.B.1 - Forest Land	-29 616.9	IE	IE	-	-	IE	IE	IE	-29 616.9
3.B.2 - Cropland	1 580.8	IE	IE	-	-	IE	IE	IE	1 580.8
3.B.3 - Grassland	-15 613.8	IE	IE	-	-	IE	IE	IE	-15 613.8
3.B.4 - Wetlands	NE	31.7	IE	-	-	IE	IE	IE	666.6
3.B.5 - Settlements	-397.0	IE	IE	-	-	IE	IE	IE	-397.0
3.B.6 - Other Land	13 512.9	IE	IE	-	-	IE	IE	IE	13 512.9
3.C - Aggregate Sources and non-CO_2 Emissions Sources on Land	**1 901.7**	**19.9**	**64.7**	**-**	**-**	**22.3**	**528.8**	**31.1**	**22 369.5**
3.C.1 - Emissions from Biomass Burning	IE	19.9	1.3	-	-	22.3	528.8	31.1	827.5
3.C.2 - Liming	1 222.1	-	-	-	-	-	-	-	1 222.1
3.C.3 - Urea application	679.6	-	-	-	-	-	-	-	679.6
3.C.4 - Direct N_2O Emissions from Managed Soils	55.0	-	-	-	-	-	-	-	17 049.1
3.C.5 - Indirect N_2O Emissions from Managed Soils	6.9	-	-	-	-	-	-	-	2 126.3
3.C.6 - Indirect N_2O Emissions from Manure Management	1.5	-	-	-	-	-	-	-	464.9
3.C.7 - Rice Cultivations	-	NO	NO	-	-	-	-	-	0.0
3.C.8 - Other (please specify)	NO	NO	NO	-	-	-	-	-	0.0
3.D - Other	**-776.9**	**NA**	**NA**	**-**	**-**	**-**	**-**	**-**	**-776.9**
3.D.1 - Harvested Wood Products	-776.9	-	-	-	-	-	-	-	-776.9
3.D.2 - Other (please specify)	NO	NO	NO	-	-	-	-	-	0.0
4 - WASTE	37.5	969.5	2.7	-	-	-	-	-	21 249.0
4.A - Solid Waste Disposal	**-**	**827.0**	**NE**	**-**	**-**	**NE**	**NE**	**NE**	**17 366.0**
4.B - Biological Treatment of Solid Waste	**-**	**NE**	**NE**	**-**	**-**	**NE**	**NE**	**NE**	**-**
4.C - Incineration and Open Burning of Waste	**37.5**	**11.5**	**0.3**	**-**	**-**	**NE**	**NE**	**NE**	**360.2**
4.D - Wastewater Treatment and Discharge	**-**	**131.1**	**2.5**	**-**	**-**	**NE**	**NE**	**NE**	**3 522.8**
4.E - Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**-**
5 - OTHER	-	-	-	-	-	-	-	-	-
5.A - Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH_3	**-**	**-**	**NE**	**-**	**-**	**NE**	**NE**	**NE**	**-**
5.B - Other	**-**	**-**	**NO**	**-**	**-**	**NO**	**NO**	**NO**	**-**
MEMO ITEMS									
International Bunkers	6 603.6	0.4	0.1	NA	NA	NA	NA	NA	6 633.5
International Aviation	4 929.1	0.2	0.0	NA	NA	NA	NA	NA	4 942.1
International Water-borne Transport	1 674.4	0.1	0.0	NA	NA	NA	NA	NA	1 691.5
Multilateral Operations	NA	NA	NA	NA	NA	NA	NA	NA	-

NE = Not estimated; NO = Not occurring; IE = Included elsewhere; NA = Not applicable.

a The emissions in Gg CO_2e for CH_4 and N_2O per category are available in the Appendix 2.A of the NIR2017.

b The emissions of PFC and HFCs are reported in Gg in Table 2.7.

2.7.2. Changes in Emissions Since BUR3

Emissions (excl. FOLU) declined by 2.8% since the last Inventory submission (for 2015) (Table 2.3). The decrease was due to a 0.8%, 22.0%, and 6.1% decline in the Energy, IPPU, and AFOLU sectors, respectively, over the 2015 to 2017 period. It should be noted that the decline in the IPPU sector may not be a true decline in emissions as there are some inconsistencies in the time-series for several categories (see section 2.7.10 for further details).

Emissions (incl. FOLU) decreased by 4.4% since the last inventory submission (Table 2.3). The reduction in the emissions relative to the growth in emissions (excl. FOLU) was due to a decline in the AFOLU emissions and this was due to a 32.5% increase in removals from the Land sector. The Energy sector was the largest contributor to South Africa's total emissions (incl. FOLU) in 2017, comprising 85.2% of total net emissions. This was followed by the AFOLU (excl. FOLU) sector (10.1%) and the IPPU sector (6.7%).

Table 2.3:

CHANGES IN SOUTH AFRICA'S TOTAL EMISSIONS (INCLUDING AND EXCLUDING FOLU) BETWEEN 2000, 2015 & 2017.

	Emissions (Gg CO_2e)			Change between 2000 & 2017		Change between 2015 & 2017	
	2000	2015	2017	Gg CO_2e	%	Gg CO_2e	%
EMISSIONS (EXCL. FOLU)	448 874.2	527 301.0	512 660.6	63 786.4	14.2	-14 640.4	-2.8
EMISSIONS (INCL. FOLU)	436 733.5	504 157.9	482 016.3	45 282.8	10.4	-22 141.5	-4.4

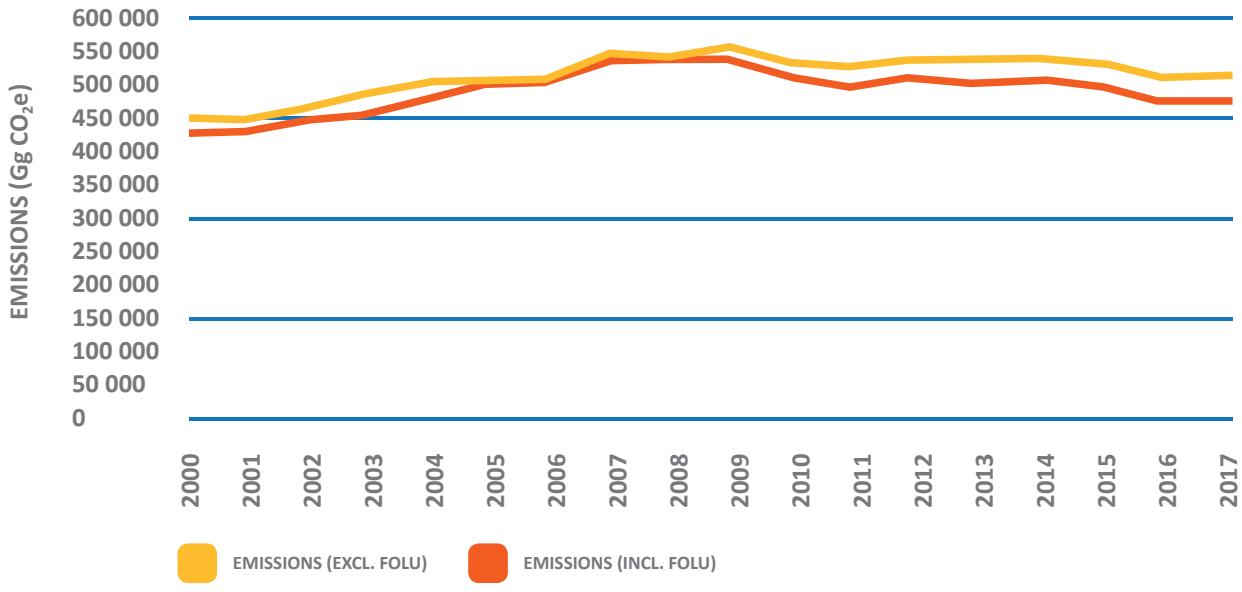
2.7.3. Trends in Total Aggregated Emissions Since 2000

South Africa's GHG emissions excluding FOLU were 448 874 Gg CO_2e in 2000 and these increased by 14.2% by 2017 (Table 2.4). Emissions (excl. FOLU) in 2017 were estimated at 512 661 Gg CO_2e. Emissions increased gradually between 2000 and 2009 at which stage emissions started to stabilise (Figure 2.3, Figure 2.4). Emissions declined in 2011 but increased again reaching 528 816 Gg CO_2e in 2013 (Table 2.4). Emissions declined in 2016 and 2017.

The annual change data shows that the number of years with a decrease in emissions have risen since 2009, and the number of years with consecutive decreases have also increased. The annual average growth rate was 2.0% between 2000 and 2009, however between 2009 and 2017 there was an average annual contraction of 0.5%. This shows that the emissions are stabilising and even moving towards a declining trend.

South Africa's GHG emissions (incl. FOLU) were 436 734 Gg CO_2e in 2000 and these increased by 10.4% (45 282 Gg CO_2e) by 2017. Emissions (incl. FOLU) in 2017 were estimated at 482 016 Gg CO_2e. The emissions (incl. FOLU) followed the same trend as the emissions (excl. FOLU) with slightly lower emissions between 2010 and 2017 (Figure 2.3, Figure 2.4). This was due to the increased Land sink during this period. Emissions, therefore, increased gradually between 2000 and 2009 after which there was a decline to 2017. Between 2000 and 2017 the average annual growth was 0.6%, however the annual average growth rate between 2000 and 2009 was 2.3% and between 2009 and 2017 there was an average annual decline of 1.0%. The Energy sector was the main contributor to the increase.

Figure 2.3:
NATIONAL AGGREGATED GHG EMISSIONS (EXCLUDING AND INCLUDING FOLU), 2000 - 2017.



2.7.4. Emission Trends by Sector

Figure 2.4, Figure 2.5 shows the trend in emissions (excl. FOLU) from the four sectors in South Africa between 2000 and 2017.

2.7.4.1. Energy

The Energy sector is the largest contributor to South Africa's total emissions (excl. FOLU), contributing 80.1% towards these emissions in 2017 which is up from a 77.8% contribution in 2000. Energy sector emissions increased from 349 100 Gg CO_2e in 2000 to 410 685 Gg CO_2e in 2017. The main contributor to the more robust Energy emissions is increased demand for liquid fuels in road transportation, manufacturing industries and construction, civil aviation, and the residential and commercial sectors. This increased demand for fuels is largely driven by population growth and an expanding economy.

Fuel combustion activities contribute an average of 92.2% to the total energy emission between 2000 and 2017. Energy industries contribute an average of 65.2% to the Fuel combustion activity emissions, and an average of 63.8% to the total energy emissions between 2000 and 2017. Transport and Other sectors contributed 54 695 Gg CO_2e (13.3%) and 38 022 Gg CO_2e (9.3%) to the total energy emissions in 2017, and these are up from 41 063 Gg CO_2e and 26 123 Gg CO_2e in 2000, respectively.

2.7.4.2. IPPU

The IPPU sector contributed an average of 7.0% to the total emissions (excl. FOLU) between 2000 and 2017. In 2017 the IPPU contribution was 32 085 Gg CO_2e. Emissions increased between 2000 and 2007 when it reached a peak of 42 512 Gg CO_2e. This was followed by a decline to 35 468 Gg CO_2e in 2010, which was a function of the economy experiencing a recession in 2008/09. Emissions increased slightly in 2011 and then stabilised until 2016. In 2017, emissions declined to 2000 levels, however this decline is partly due to a change in data source (between 2015 and 2017) for several categories (see details in section 2.7.10) and therefore may not be a true reflection of actual emissions. Data will be sought in the next inventory to improve this time-series inconsistency.

The main drivers in the IPPU sector are the metal industries, particularly Iron and steel production and Ferroalloy production which contributed 24.1% and 35.3% respectively to the total IPPU emissions in 2017. In addition, the HFC and PFC emissions should be monitored closely since HFC emissions have increased from 842 Gg CO_2e in 2005 to 4 015 Gg CO_2e in 2017. The increase in PFC emissions from 2011 was due to the addition of new categories (Foam blowing agents, Fire protection and Aerosols), but only 1.8% of the increase was accounted for by the new emissions categories.

2.7.4.3. AFOLU

The AFOLU sector (excl. FOLU) contributed an average of 10.3% to total emissions (excl. FOLU) between 2000 and 2017, declining from 11.9% in 2000 to 9.5% in 2017. The main driver of change in the AFOLU emissions (excl. FOLU) is the decrease in the livestock population. Livestock have input into the enteric fermentation, manure management, as well as direct and indirect N_2O emissions.

The AFOLU sector produced 48 642 Gg CO_2e (excl. FOLU) in 2017, while the emissions including FOLU were 17 998 Gg CO_2e. This change is due to the increasing Land sink, which strengthened between 2009 and 2017. The largest contributor was the Forest land category, which has increased over time due to increasing forest land area and a decline in wood removals. Emissions and removals from Grasslands remained constant, with Land converted to grasslands contributing the largest proportion to this category. Other lands provide a constant source of emissions as carbon is lost when land is converted to Other

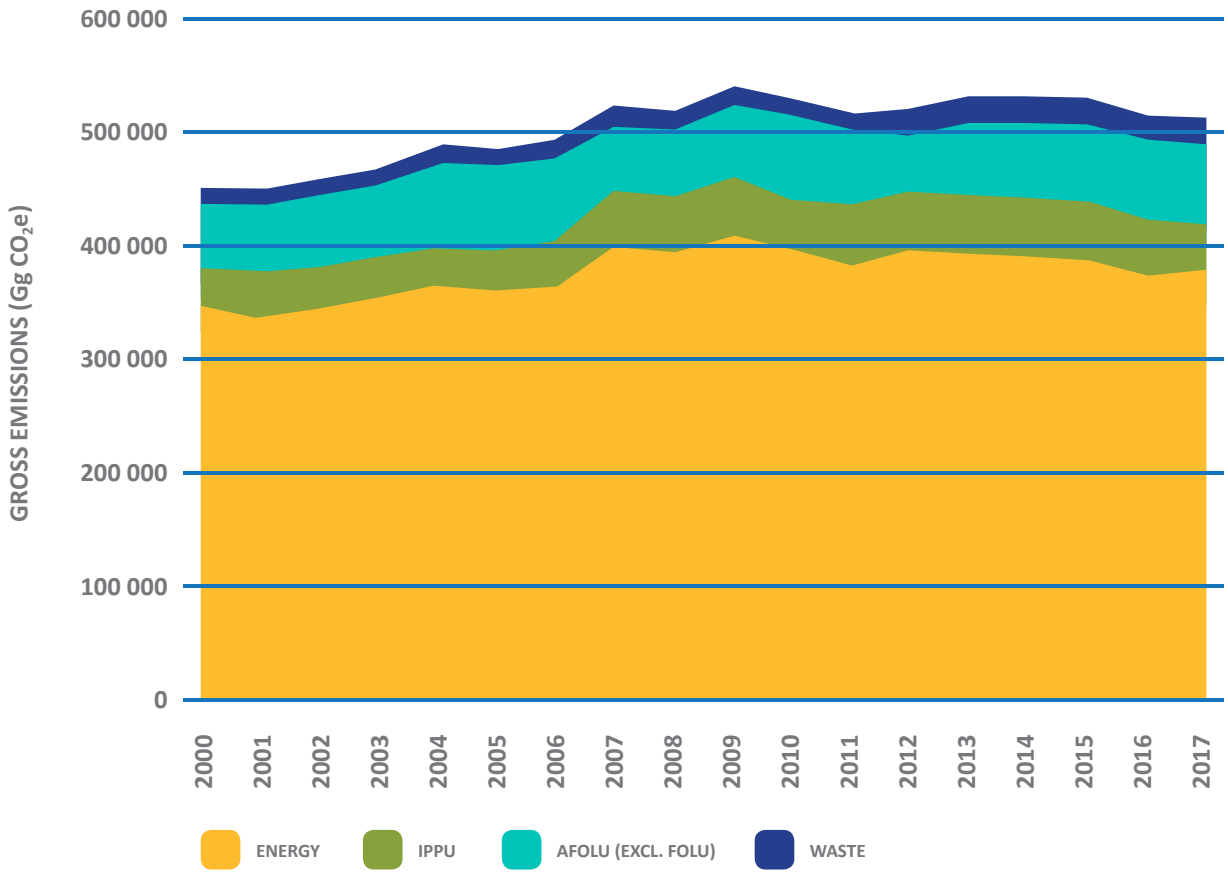
lands. The source from Other lands (16 044 Gg CO_2) is almost equal to the sink from Grasslands (15 614 Gg CO_2 in 2017).

Aggregated and non-CO_2 emissions on land contributed 46.0% to the AFOLU (excl. FOLU) emissions in 2017, and the largest contributor to this category (76.2%) is Direct N_2O from managed soils. Nitrogen inputs from urine and dung deposits contribute 62.6% to direct N_2O, followed by 12.7% from inorganic N inputs and 10.7% from organic N inputs.

2.7.4.4. Waste

The Waste sector emissions have increased from 13 558 Gg CO_2e in 2000 to 21 249 Gg CO_2e in 2017. The Waste sector contribution to overall emissions (excl. FOLU) has slowly increased from 3.0% in 2000 to 3.7% in 2017 (Figure 2.6). The emissions in this sector are driven mainly by population growth.

Figure 2.4:
SECTORAL CONTRIBUTION TO THE TREND IN THE EMISSIONS (EXCL. FOLU) FOR SOUTH AFRICA, 2000 - 2017.

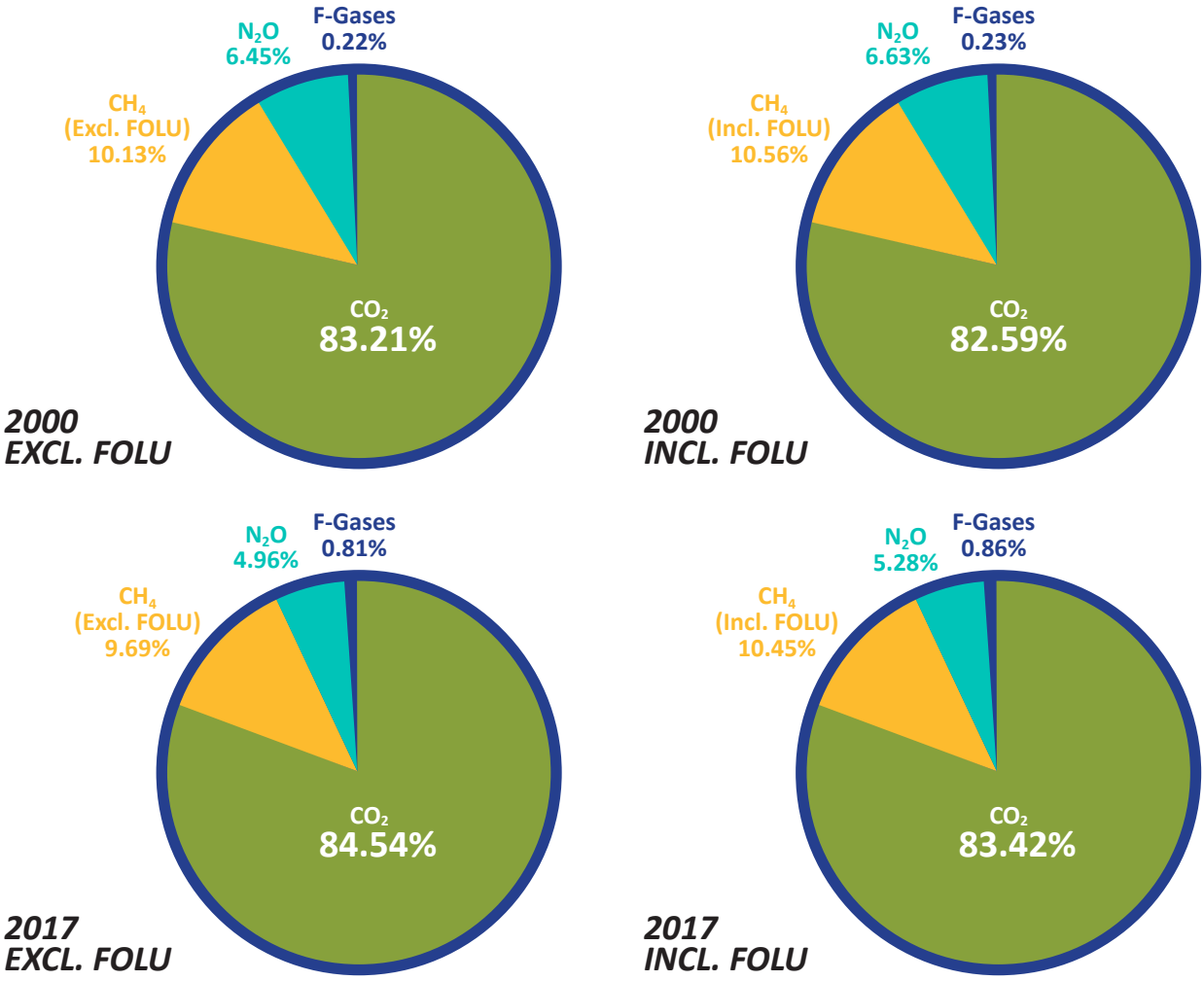


2.7.5. Emission Trends by Gas

CO_2 gas is the largest contributor to South Africa's emissions (Figure 2.5, Figure 2.7). This is followed by CH_4 and then N_2O. The contribution from CH_4 and N_2O generally declined from 2000 to 2017, while the contribution from CO_2 and F-gases increased. However, the contribution by F-gas is still below 1.0%.

Figure 2.5:

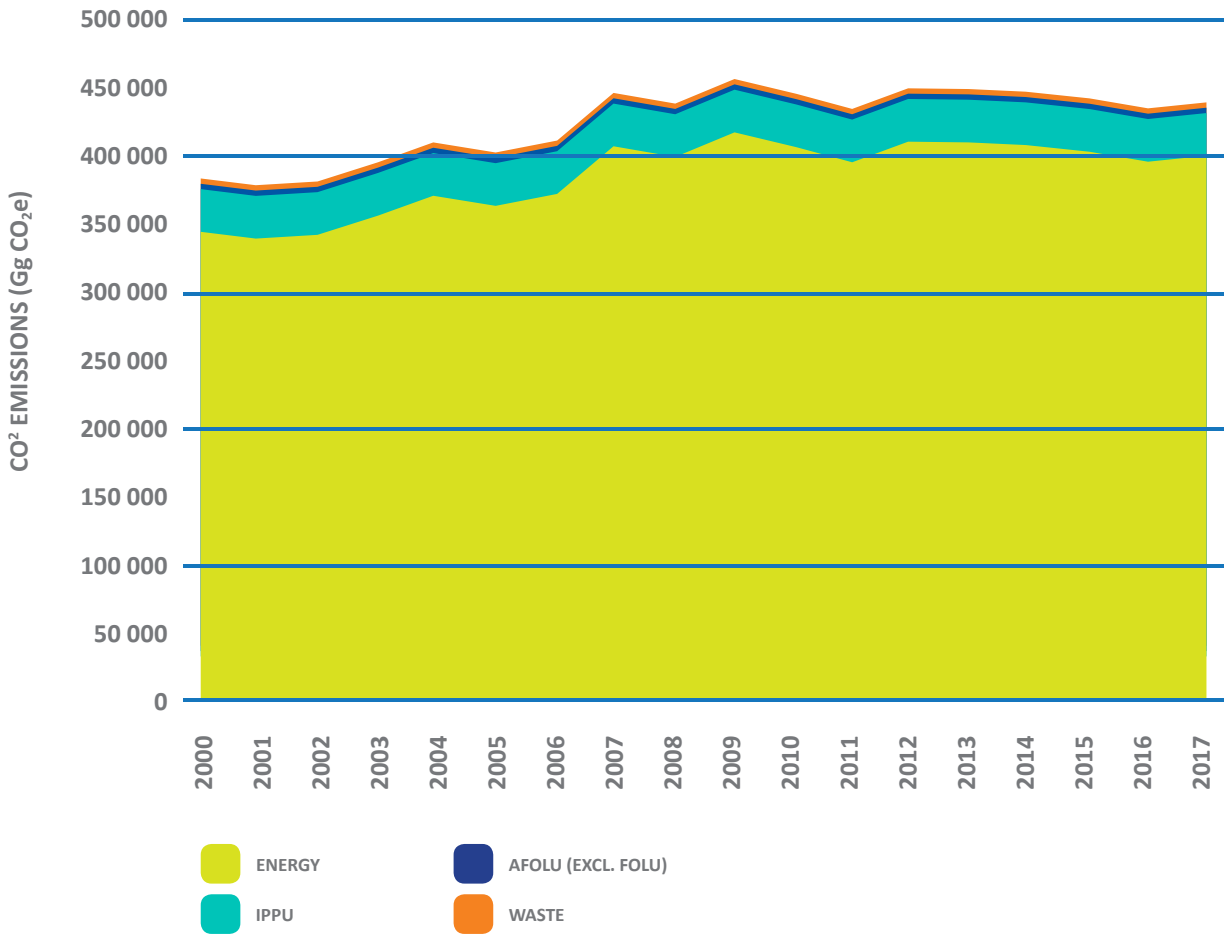
PERCENTAGE CONTRIBUTIONS FROM EACH OF THE GASES TO SOUTH AFRICA'S EMISSIONS (EXCLUDING FOLU (LEFT) AND INCL. FOLU (RIGHT)) BETWEEN 2000 & 2017.



2.7.5.1. Carbon dioxide

The CO_2 emissions totalled 433 406 Gg CO_2 (excl. FOLU) and 402 095 Gg CO_2 (incl. FOLU) in 2017). Since CO_2 is the largest contributor to national emissions, the CO_2 emission trend follows that of the overall emission trend. The Energy sector is by far the largest contributor to CO_2 emissions in South Africa (Figure 2.6), contributing an average of 91.7% between 2000 and 2017, and 93.2% in 2017. The categories 1A1 Energy industries (61.4%), 1A3 Transport (13.3%) and 1A4 Other sectors (9.3%) were the major contributors to the Energy CO_2 emissions in 2017. The IPPU sector contributed an average of 8.0% between 2000 and 2017, while the AFOLU sector (excl. FOLU) contributed an average of 0.3%.

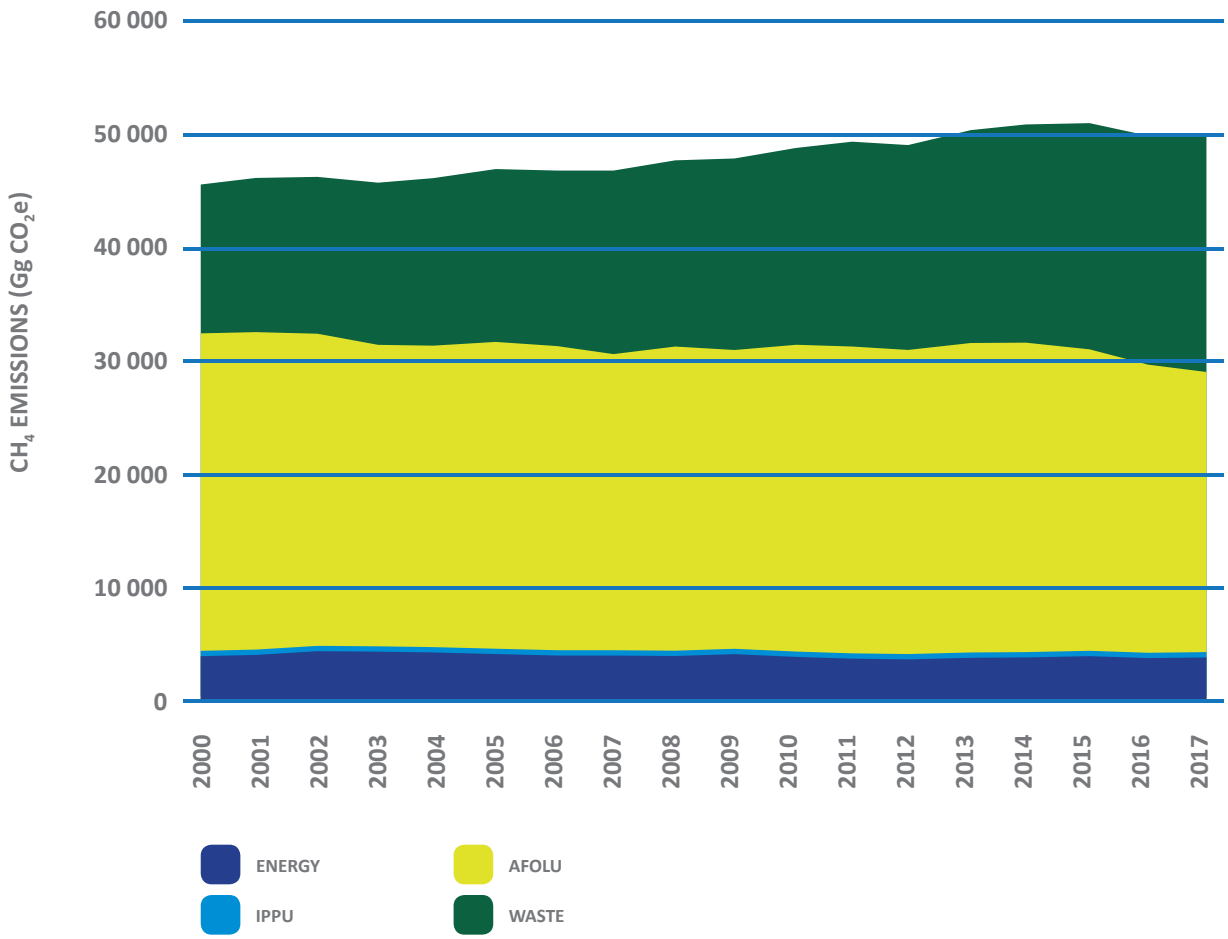
Figure 2.6:
TREND AND SECTORAL CONTRIBUTION TO CO_2 EMISSIONS (EXCLUDING FOLU), 2000 - 2017.



2.7.5.2. Methane

National CH_4 emissions increased from 45 452 Gg CO_2e (2 164 Gg CH_4) in 2000 to 49 700 Gg CO_2e (2 367 Gg CH_4) in 2017. In the Land sector, wetlands contributed an additional 667 Gg CO_2e (31.7 Gg CH_4) to the total CH_4, pushing the total CH_4 (incl. FOLU) to 50 367 Gg CO_2e. The AFOLU livestock category and Waste sectors were the major contributors (Figure 2.7), providing 50.4% and 41.0%, respectively, to the total CH_4 emissions in 2017. The contribution from livestock declined by 11.8% (due to a decline in livestock populations), while the contribution from the Waste sector increased by 12.7% over the period 2000 to 2017.

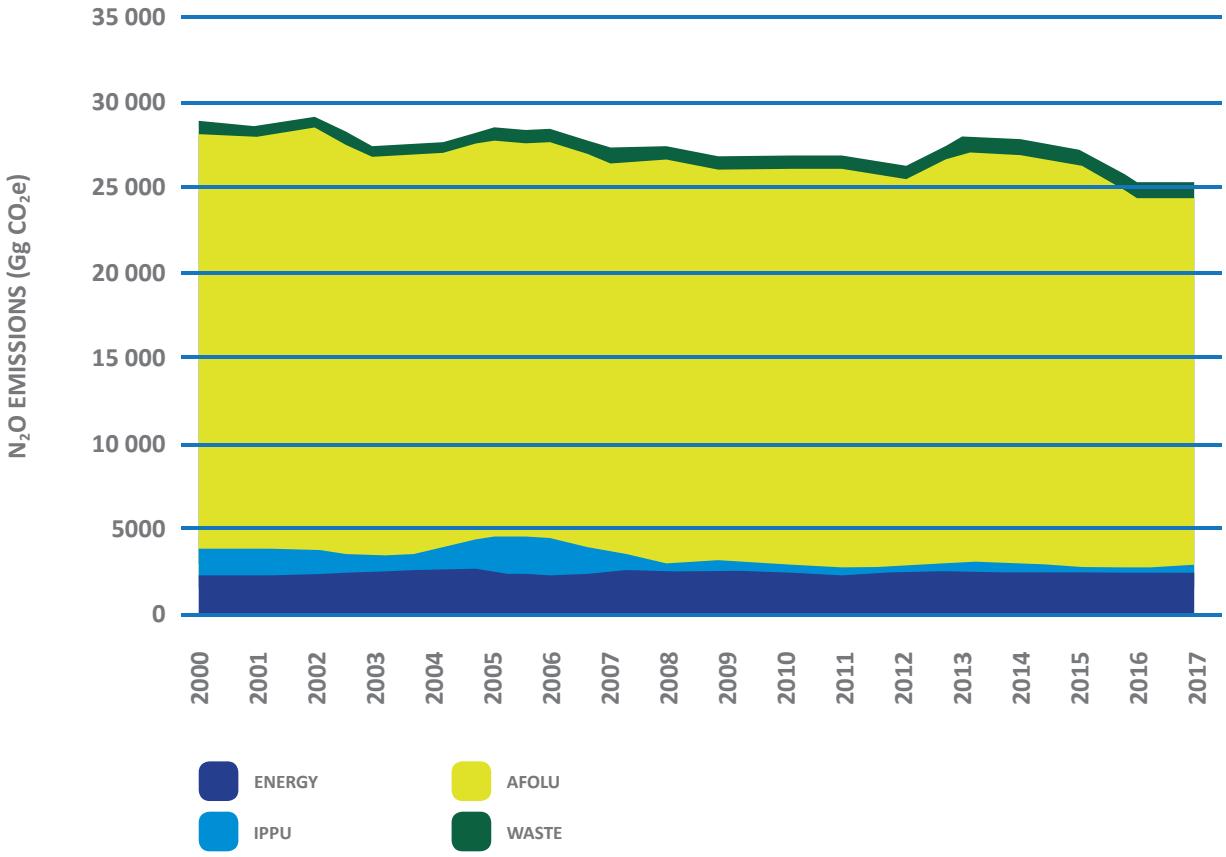
Figure 2.7:
TREND AND SECTORAL CONTRIBUTION TO CH_4 EMISSIONS (INCLUDING FOLU), 2000 - 2017.



2.7.5.3. Nitrous oxide

The emissions declined by 12.1% over the 2000 to 2017 period from 28 942 Gg CO_2e (93 Gg N_2O) to 25 427 Gg CO_2e (82 Gg N_2O) (Table 2.6). The main contributors are the AFOLU (85.3%) and Energy (10.2%) sectors (Figure 2.8, Figure 2.10). The categories 3C Aggregated and non-CO_2 sources on land (which includes emissions from managed soils and biomass burning) and 1A Fuel combustion activities are the main contributors to N_2O. Livestock manure, urine and dung inputs to managed soils provided the largest N_2O contribution in the AFOLU sector, therefore, the trend follows a similar pattern to the livestock population. N_2O emissions from IPPU declined by 82.2% between 2000 and 2017. This is attributed to declines in N_2O emissions from Nitric Acid production. The Nitric Acid industry implemented Clean Development Mechanism (CDM) projects through the adoption of the latest N_2O emission reduction technologies.

Figure 2.8:
TREND AND SECTORAL CONTRIBUTION TO N_2O EMISSIONS (INCLUDING FOLU), 2000 - 2017.



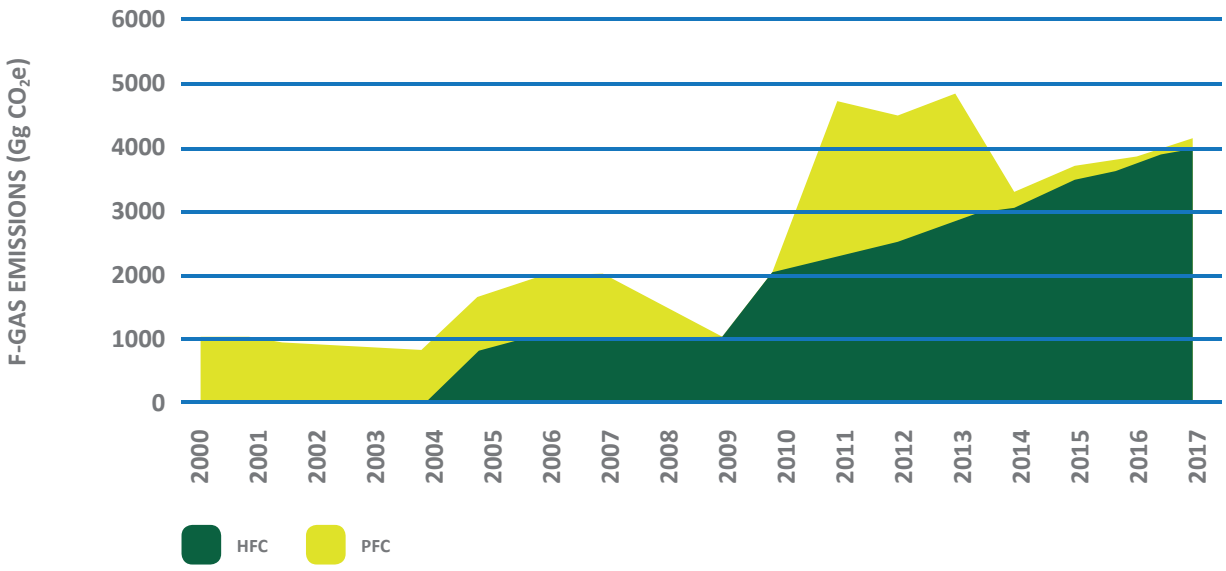
2.7.5.4. F-gases

Estimates of HFC and PFC emissions were only estimated for the IPPU sector in South Africa. F-gas emission estimates varied annually (Figure 2.9) and contributed 0.8% to overall emissions in 2017. Emissions increase from 2011 due to the addition of HFC emissions from air conditioning, foam blowing agents, fire protection and aerosols (Figure 2.9). There is no data prior to 2005 so this time-series is not consistent with the rest of the reported emissions data. The elevated F-gas emissions are, therefore, not necessarily due to an increase in emissions but rather due to the incorporation of new categories.

PFC emissions were estimated at 983 Gg CO_2e in 2000. This increased to 1 979 Gg CO_2e in 2012, then declined to 113 Gg CO_2e in 2017. PFCs are produced during the production of aluminium. The Aluminium production data was updated for the years 2014 onwards and the updated data was an order of magnitude lower than the previous years. This is causing the decline in the PFC emissions. This inconsistency in the time-series will be investigated further in the 2019 inventory. There is 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 recession that occurred during 2008/09. Increases in 2011 and 2012 were due to increased emissions from aluminium plants due to inefficient operations. The industry was used to assist with the rotational electricity load shedding in the country at the time, which necessitated switching on and off at short notice leading to large emissions of C_2F_4 and CF_4. CF_4 emissions contribute the most to the PFC emissions.

HFCs increased from 842 Gg CO_2e in 2005 to 4 015 Gg CO_2e in 2017, and the largest contributor is HFC-134a (see Table 2.4 in the NIR2017 for further details on the various HFCs).

Figure 2.9:
TREND AND SECTORAL CONTRIBUTION TO F-GAS EMISSIONS (INCLUDING FOLU), 2000 - 2017.



2.7.6. Trends in Indirect GHG Emissions

The trends in emissions of CO, NOx and NMVOCs are shown in Table 2.4. These emissions were estimated for biomass burning only. Emissions of these indirect gases from other categories have not yet been estimated due to a lack of data but have been included on the improvement list for future inventories.

Table 2.4:

TRENDS IN INDIRECT GHG EMISSIONS BETWEEN 2000 AND 2017.

	NOx	CO (Gg)	NMVOC
2000	68.1	1 479.4	70.1
2001	80.0	1 710.6	83.5
2002	79.1	1 722.5	82.8
2003	59.6	1 338.1	66.6
2004	54.3	1 178.6	57.1
2005	86.8	1 895.5	89.1
2006	76.7	1 672.3	75.9
2007	70.2	1 596.3	82.7
2008	69.1	1 507.8	75.9
2009	65.6	1 436.8	70.1
2010	65.6	1 462.9	73.6
2011	64.8	1 442.8	73.1
2012	56.3	1 295.2	71.7
2013	57.3	1 254.4	63.6
2014	59.3	1 331.1	69.6
2015	42.5	957.8	51.9
2016	23.4	562.5	33.9
2017	22.3	528.8	31.1

2.7.7. Key Categories

The key categories were 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 or net level of emissions and those that are within the top 95% of the categories that contribute to the change between 2000 and 2017, or the trend of emissions. This includes both source and sink categories. The level assessment was conducted on the current year (2017) only, while the trend assessment utilised the base year (2000) and 2017. In the next inventory, a level assessment will be completed for both the base year and the current year. Identifying key categories will allow resources to be allocated to the appropriate activities to improve those specific subcategory emissions in future submissions. The full key category analysis (level and trend, including and excluding FOLU) are provided in Appendix 1.A of the NIR2017.

In this inventory a ranking system was added to allow the key categories to be ranked in order of prioritisation based on the findings from both the level and trend assessment. The ranking system works by allocating a score based on how high categories rank in the current year level assessment and the trend assessment. The top-ranking category gets a score of 1 and the second a score of 2, etc. The ranking score from both approaches are then added together to get the overall score for each category. The categories are then ranked from lowest score to highest, with draws in score resolved by the most recent year level assessment. This ranking approach was only applied to the assessments including Land Use, Land-Use Change, and Forestry (LULUCF). The key categories identified in 2017, along with their ranking, are summarised in Table 2.6.

Table 2.5:

KEY CATEGORIES FOR SOUTH AFRICA FOR 2017 (INCLUDING FOLU) AND THEIR RANKING.

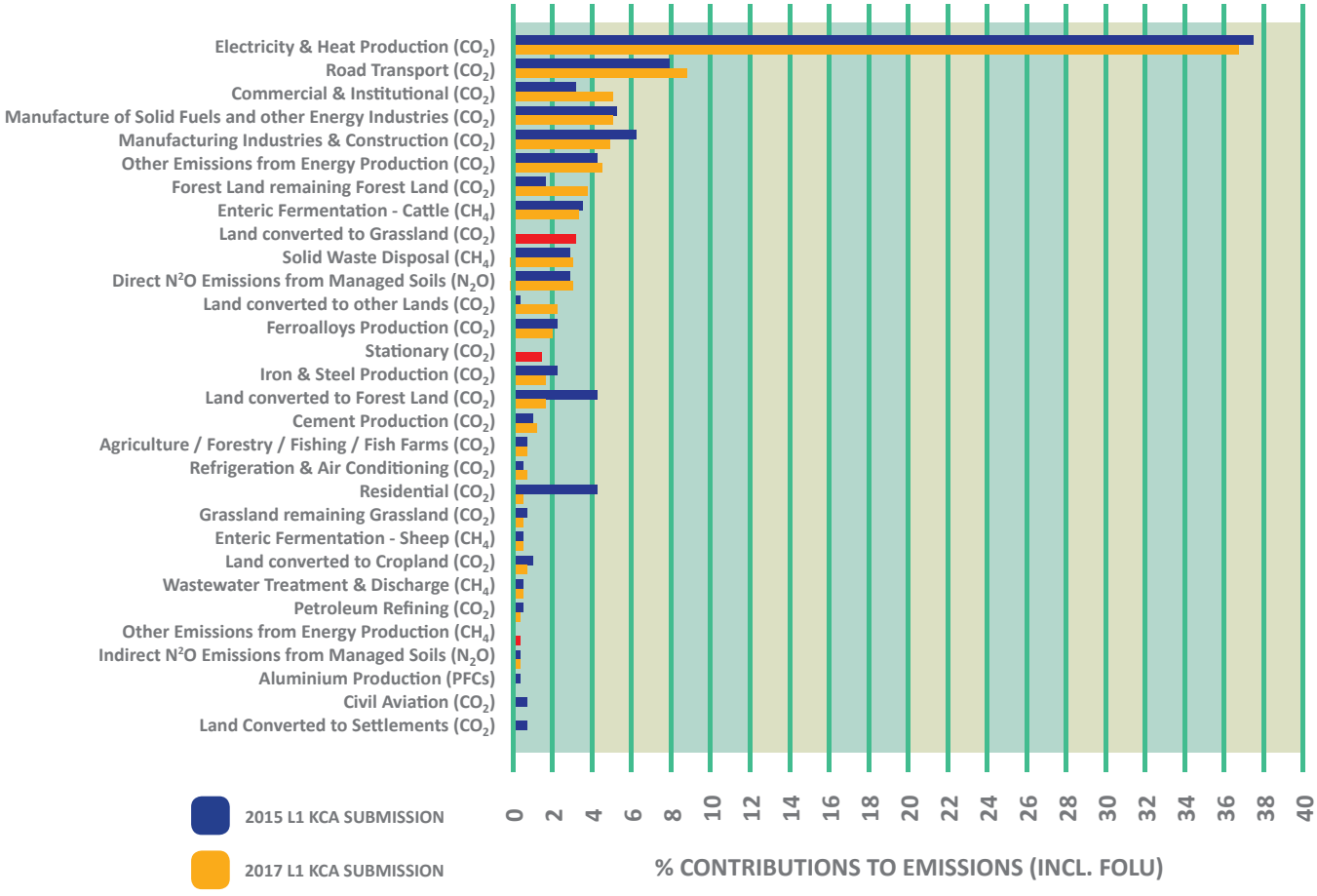
Rank	IPCC Category Code	IPCC Category	GHG	Key Category Identification
1	1A3b	Road Transport (Liquid fuel)	CO_2	L1, T1
2	1A1a	Electricity and Heat Production (Solid fuel)	CO_2	L1, T1
3	1A4a	Commercial/Institutional (Solid fuel)	CO_2	L1, T1
4	3B1a	Forest land remaining forest land	CO_2	L1, T1
5	1A1c	Manufacture of Solid Fuels and Other Energy Industries (Liquid fuel)	CO_2	L1, T1
6	1B3	Other Emissions from Energy Production	CO_2	L1, T1
7	4A	Solid Waste Disposal	CH_2	L1, T1
8	3A1a	Enteric fermentation - cattle	CH_2	L1, T1
9	2C1	Iron and Steel Production	CO_2	L1, T1
10	1A5a	Stationary (Solid fuel)	CO_2	L1, T1
11	3C4	Direct N_2O emissions from managed soils	N_2O	L1, T1
12	3B3b	Land converted to grassland	CO_2	L1, T1
13	1A2	Manufacturing Industries and Construction (Solid fuel)	CO_2	L1, T1
14	2C2	Ferroalloys Production	CO_2	L1, T1
15	2F1	Refrigeration and Air Conditioning	HFCs	L1, T1
16	3B6b	Land converted to other lands	CO_2	L1, T1
17	1A2	Manufacturing Industries and Construction (Liquid fuel)	CO_2	L1, T1
18	1A4c	Agriculture/Forestry/Fishing/Fish Farms (Liquid fuel)	CO_2	L1, T1
19	3B1b	Land converted to forest land	CO_2	L1, T1
20	1A2	Manufacturing Industries and Construction (Gas)	CO_2	L1, T1
21	2A1	Cement Production	CO_2	L1, T1
22	1A4b	Residential (Solid fuel)	CO_2	T1
23	3A1c	Enteric fermentation- sheep	CH_4	L1, T1
24	1A4b	Residential (Liquid fuel)	CO_2	L1, T1
25	3B3a	Grassland remaining grassland	CO_2	L1, T1
26	1A1a	Electricity and Heat Production	CO_2	T1
27	1A3a	Civil Aviation (Liquid)	CO_2	T1
28	4D1	Wastewater Treatment and Discharge	CH_4	L1, T1
29	3C5	Indirect N_2O emissions from managed soils	N_2O	L1, T1
30	3C2	Liming	CO_2	T1
31	1B3	Other Emissions from Energy Production	CH_4	L1, T1
32	1A1b	Petroleum Refining (Liquid)	CO_2	T1
33	3B2b	Land converted to cropland	CO_2	L1
34	1A1b	Petroleum Refining (Gas)	CO_2	L1
35	3D1	Harvested wood products	CO_2	L1, T1
36	2B3	Nitric acid production	N_2O	T1
37	2A2	Lime Production	CO_2	T1
38	1A4a	Commercial/Institutional (Liquid fuel)	CO_2	L1
39	3B5a	Settlements remaining settlements	CO_2	T1
41	3C1c	Biomass burning in grasslands	N_2O	T1
42	3C1c	Biomass burning in grasslands	CH_4	T1
43	2C3	Aluminium Production	PFCs	T1
44	2B6	Titanium dioxide production	CO_2	T1

2.7.7.1. Key category changes since BUR3

In this inventory a disaggregation by fuel type (solid, liquid, gas) in the energy sector was included, which was not done in the previous inventory. This difference made direct comparison with the 2015 submission difficult, however a comparison was done by adding the percentage contribution for solid, liquid and gaseous fuels for each category that appeared on the 2017 level assessment (including FOLU) key category list (Figure 2.10). Three new key categories were identified, namely, Land converted to grassland, Stationary (Solid fuels, CO_2), and Coal mining and handling (CH_4). Updates in the Land sector changed the allocation between the Forest land remaining forest land and the Land converted to forest land categories, leading to a change in their contribution. There was also a change in contribution from the Residential category due to updated activity data.

Figure 2.10:

COMPARISON OF LEVEL ASSESSMENT KEY CATEGORIES AND THEIR CONTRIBUTION TO EMISSIONS (INCL. FOLU) IN THE CURRENT AND PREVIOUS 2015 SUBMISSION. NEW KEY CATEGORIES IN 2017 ARE SHOWN IN RED.



2.7.8. Uncertainty Analysis

South Africa has conducted uncertainty analysis across the sectors of Energy, IPPU, AFOLU and Waste. Progress has been made since the last submission, as previously the uncertainty was only included for the Energy and IPPU sectors.

Emission estimate uncertainties are typically low for CO_2 from energy consumption as well as from some industrial process emissions. Uncertainty surrounding estimates of emissions are higher for AFOLU and synthetic gases. Uncertainty ranges for the various sectors are largely consistent with typical uncertainty ranges expected for each sector (IPCC, 2014). Uncertainties are based largely on IPCC default values, but there are several categories, particularly in the AFOLU sector, which have obtained uncertainty estimates from country specific studies and expert opinion. The methods and assumptions for uncertainty estimates in the various Energy, IPPU, AFOLU and Waste sector sub-categories are provided in chapters 3, 4, 5 and 6, respectively, of the NIR2017.

The IPCC good practice tier 1 (Approach 1) method was used to determine the overall aggregated uncertainty on South Africa's inventory estimate for 2017. The analysis (details provided in Appendix 1.B of the NIR2017) shows that the overall uncertainty on the 2017 estimate is 10.2%, while the uncertainty in the emission trend is estimated at 7.1%. If FOLU is excluded, then the overall uncertainty is reduced to 9.4% with the uncertainty in trend being 6.7%.

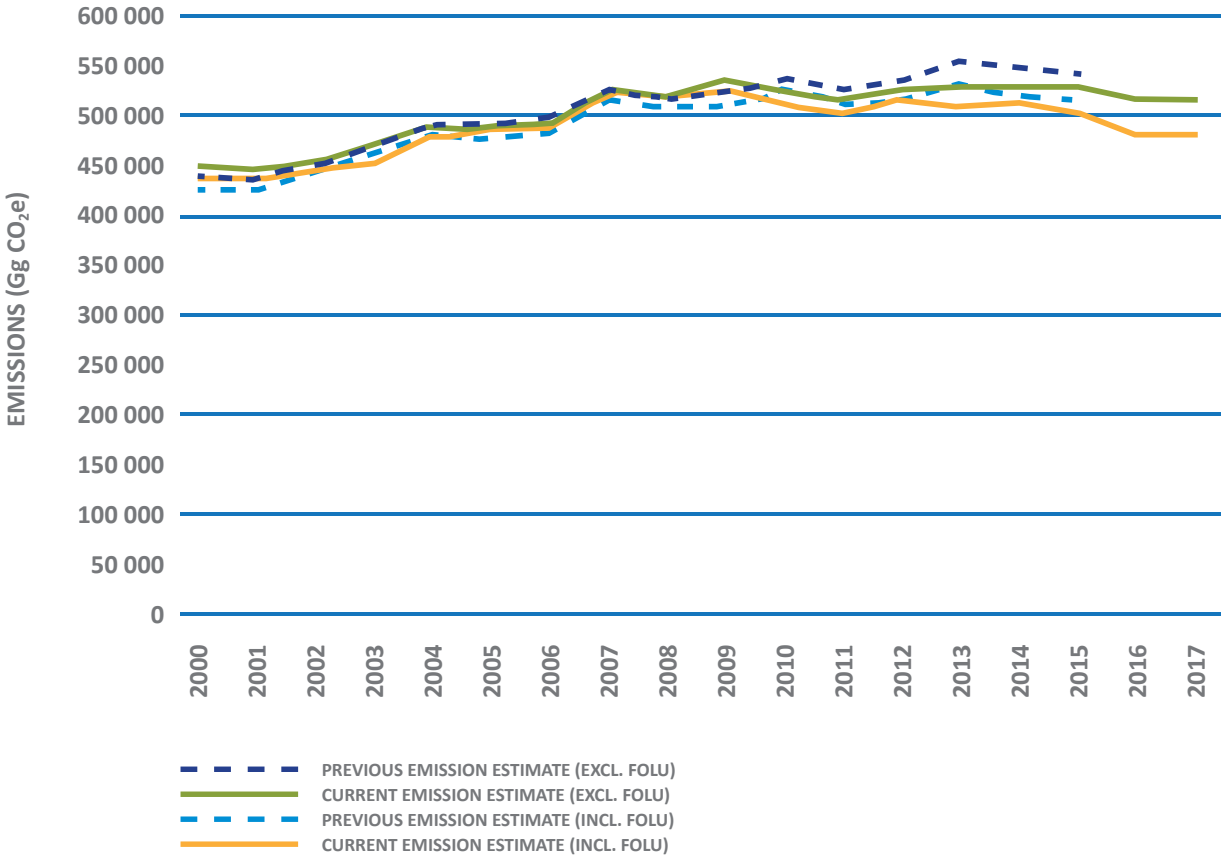
Even though this inventory has made some progress on the uncertainty analysis since the last submission, further improvements are required. In this Inventory IPCC default uncertainty estimates were applied throughout much of the Energy and IPPU sectors due to a lack of data, but in the next submission more country specific uncertainty data will be sought for inclusion.

2.7.9. Recalculations and their Impact

Due to updates and improvements discussed in section 2.2.1.1., recalculations were undertaken. Recalculations due to improvements led to a 2.5% and 1.6% decrease in emission estimates excluding and including FOLU, respectively, for 2015 (Figure 2.11). Recalculated estimates were 3.7% and 1.7% less than previous estimates for the Energy and IPPU sectors, while the estimates for AFOLU (excl. FOLU), AFOLU (incl. FOLU) and Waste sector estimates were 4.6%, 36.1% and 4.2% higher, respectively, than the previous submission for 2015. The percentage change did, however, vary across the time-series (see Table 1.6 of the NIR2017).

South Africa has conducted uncertainty analysis across the sectors of Energy, IPPU, AFOLU and Waste.

Figure 2.11:
IMPACT OF 2017 RECALCULATIONS ON THE EMISSION ESTIMATES.



There was a 3.1% and 2.5% decline in the overall CO_2 emission estimates excluding and including FOLU, respectively (see Table 1.7 of NIR2017). This was due to recalculations in all sectors except Waste, with changes in Energy and AFOLU dominating. After recalculations, the 2015 CH_4 emissions were estimated to be 1.2% higher. The main contributor was a 1.5% increase from the Energy sector recalculations, which was offset by a decline in the estimates for the other sectors. Recalculated N_2O emissions were 11.8% higher in this submission, mainly due to a 14.1% increase in AFOLU sector estimates, and a decline in the N_2O from the Energy sector. F-gas recalculations led to a lowering of emission estimates between 2013 and 2015 compared to the previous submission. In 2015 there was a 34.7% difference, and this is mainly due to updated Aluminium production data.

2.7.10. Time-Series Consistency

The time-series is consistent for the Energy, AFOLU and Waste sectors. In the previous Inventory there was an inconsistency with the lime data in the AFOLU sector, but IPCC splicing techniques were used in this Inventory to correct for this. There are several categories in the IPPU sector which have inconsistent time-series and the details of these are provided in Table 2.6.

Table 2.6:
TIME-SERIES INCONSISTENCIES IN THE IPPU SECTOR.

Category	Time-series Inconsistency	Reason for Inconsistency	Actions to be taken
2B5 Carbide production	2014 - 2017 are inconsistent with previous years	Updated plant specific production data obtained through SAGERS for recent years. Reporting in SAGERS only started in 2014.	Production plants will be approached to obtain historical data to improve time-series consistency. Alternatively, the application of IPCC splicing techniques will be investigated.
2B6 Titanium dioxide production	2014 - 2017 are inconsistent with previous years	Updated plant specific emission data obtained through SAGERS for recent years. Reporting in SAGERS only started in 2014.	
2B8 Carbon black production	2016 - 2017 are inconsistent with previous years	Updated plant specific production data obtained through SAGERS for recent years. Data reported only starts in 2016. Data from SAGERS has added acetylene black process and there is no data for previous years on this.	
2C1 Iron and steel production	2017 data is inconsistent with previous years	Updated plant specific production data obtained through SAGERS for recent years. In 2017 data was reported for sinter production (which was not previously reported) and there was a change in allocation of production data between pig iron, direct reduced iron and sinter.	
2F1 Refrigeration and air conditioning	No data prior to 2005	Lack of data for years prior to 2005	Currently there are no actions in place to obtain data for earlier years. The application of IPCC splicing techniques will be investigated over the next two inventory cycles.
2F2 Foam blowing agents	No data prior to 2011	A specific project was undertaken to obtain this data and data was only collected from 2011.	
2F3 Fire protection			
2F4 Aerosols			

2.7.11. Completeness

The Inventory for the period 2000–2017 is not complete, mainly due to a lack of data. Table 2.7 identifies the sources in the 2006 IPCC Guidelines which were not included in this inventory and the reason for their omission is discussed further in the appropriate chapters. It is also noted that precursor gases and SF_6 have not yet been included in the inventory.

Table 2.7:
ACTIVITIES IN THE 2017 INVENTORY WHICH ARE NOT ESTIMATED (NE), INCLUDED ELSEWHERE (IE) OR NOT OCCURING (NO).

NE, IE or NO	IPPC category	Activity	Comments
NE	1B2	CO_2 and CH_4 fugitive emissions from oil and natural gas operations	Emissions from this source category will be included in the next inventory submission.
	1B1b	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams	New research work on sources of emissions from this category will be used to report emissions in the next inventory submission.
	1B1ai2	CH_4 emissions from abandoned mines	New research work on sources of emissions from this category will be used to report emissions in the next inventory submission.
	1C1	CO_2 transport	Insufficient data to include.
	1C2	Injection and storage	Insufficient data to include.
	2A4	Other process use of carbonates	Emissions from this source category will be included in the next inventory submission.
	2C1	N_2O emissions from iron and steel production	This will be considered in the next inventory.
	2C2	N_2O emissions from ferroalloy production	This will be considered in the next inventory.
	2D2	CH_4 and N_2O emissions from paraffin wax use	Insufficient data to include.
	2E	Electronics industry	A study needs to be undertaken to understand emissions from this source category.
	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.
	3B	CO_2 from organic soils	Insufficient data on the distribution and extent of organic soils. Project was completed by DFFE to identify and map organic soils. This data will be considered in the next inventory.
	3B	CO_2 from changes in dead wood for all land categories	Estimates are provided for litter, but not for dead wood due to insufficient data.
	3B4	CO_2 emissions from wetlands	Insufficient data and wetland area not considered to be significant. A recent study initiated by DFFE could provide further data which will be considered in the next inventory.
	3C4	N_2O from organic soils	Insufficient data on the distribution and extent of organic soils. Project was completed by DFFE to identify and map organic soils. This data will be considered in the next inventory.
	4B	CH_4, N_2O emissions from biological treatment of waste	Insufficient data to include, but will be considered for inclusion in next inventory.

Table 2.7:

ACTIVITIES IN THE 2017 INVENTORY WHICH ARE NOT ESTIMATED (NE), INCLUDED ELSEWHERE (IE) OR NOT OCCURING (NO).

NE, IE or NO	IPPC category	Activity	Comments
NE	4C1	CO_2, CH_4 and N_2O from waste incineration	Insufficient data to include
	2	SF_6 emissions in the IPPU sector	Insufficient data. It is planned to include these by the 2021 inventory.
	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	CO_2 emissions	Insufficient data. It is planned to include these by the 2021 inventory.
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.
	3B	Precursor emissions from controlled burning	Emissions from controlled burning are not separated from biomass burning and so are included under Biomass burning (3C1)
	3C1	CO_2 emissions from biomass burning	These are not included under biomass burning, but rather under disturbance losses in the Land sector (3B).
	4 D1	Domestic wastewater treatment and discharge emissions	Reported under the total for Wastewater treatment and discharge
	4D2	Industrial wastewater treatment and discharge emissions	Reported under the total for Wastewater treatment and discharge
NO	2B7	CO_2, CH_4 and N_2O emissions from Soda Ash Production	
	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	
	3C7	Rice cultivation	

2.7.12. Planned Improvements

The main challenges in the compilation of the Inventory are the availability of accurate activity data and resources. The DFFE has recently increased the number of personnel in the Inventory team (see section 2.2.2) to assist with the resource issue. Previously, the small Inventory team was not able to adequately incorporate improvements while also completing the Inventory within the limited time available. Therefore, a larger number of personnel should allow the completion of more improvement activities within an inventory cycle. In addition, the enhanced capacity should assist in improving the QA/QC process, as there are additional people to complete the checks and to follow the gaps and needs through to the improvement plan.

In terms of data, the DFFE has undertaken a project to modify the NAEIS to meet the requirements of the NGERs (DEA, 2017a). The SAGERS portal has been developed as part of the project, it will serve as a tool for the implementation of the online registration and reporting by industry in fulfilment of the mandatory NGERs. The system enables the country to enhance the data collection process and obtain company specific data, thereby reducing the reliance on publicly available data. This means an improvement in the quality of the Inventories, consistent with the requisite principles of completeness, consistency, accuracy, comparability and transparency credentials. The key benefits of the portal to South Africa include the institutionalisation of the preparation of the Inventory.

Institutionalising the GHG preparations has several additional advantages, with the most important being sustainability. Previously, data was collected on a voluntary, ad hoc basis and relied on the relationships between the Inventory team member and the company individual. Institutionalising the data collection process provides a formal and more regular means of obtaining data, and this process is also independent of individual relationships. Data collection will not be hindered by loss of information due to staff turnover. In addition, institutionalising the data collection system speeds up the data collection process, as the inventory team members do not need to go to individual companies to obtain activity data, but rather go to a central point to collect all data. This will, therefore, create more time for QA/QC and improvements.

In this Inventory cycle, the full time-series back to 1990 was estimated for the AFOLU sector, however the results of this are not shown since the other sectors still only have data from 2000. The Inventory team is planning on extending the time-series for all sectors over the next few years and it is planned that in the 1st BTR, the time-series will be starting from 1990 and going to 2021.

There is still a need to include SF_6 emissions, as well as other gases such as SOx, NOx and NMVOC. The DFFE is in discussions with Eskom to obtain SF_6 data and a threshold has been set for SF_6 in the new NGERs so companies will start reporting SF_6 data. SF_6 emissions are, therefore, expected to be included by the 2021 inventory.

Table 2.8 presents a list of activities in the Inventory improvement plan. Further details on sector specific improvements are discussed in the sectoral analysis section (section 2.8) below.

Table 2.8:
LIST OF IMPROVEMENTS FOR SOUTH AFRICA'S INVENTORY.

Sector	Improvement	Prioity	Reason	Status	Completion Timeframe	Barriers & Constraints
Cross Cutting	Improve uncertainty data for all sectors but incorporating more country specific uncertainty values.	Medium	Accuracy	Proposed	Ongoing as there is continued improvement.	Lack of uncertainty data is a contraint on this activity. As data becomes available it will be incorporated, but there are no specific planned projects for this activity at this stage.
	Improve transparency in reporting by including more detailed description of methodologies and activity data, particularly in the Energy and IPPU sectors.	High	Transparency	Planned	5th BUR (2019 Inventory)	Lack of resources and time have hindered the completion of this activity. The enhanced Inventory team should assist in completing this task.
	Incorporate data from SAGERS into Inventory (data reported due to NGERs).	High	Accuarcy	Planned	5th BUR (2019 Inventory)	The NGERs had to be implemented and SAGERS for reporting had to be developed. These are now in place and reporting has started.
	Extend time-series back to 1990 for the Energy, IPPU and Waste sectors.	Medium	Completeness	Planned	1st BTR (2021 Inventory)	Lack of data for years prior to 2000, particularly for categories where data is highly variable (such as HFCs and PFCs), have constrained the completion of this task. A study is planned to extend/extrapolate the data back to1990 for the three IPCC sectors. IPCC splicing techniques will be considered during this study.
	Set up memorandums of understanding with key data providers, e.g., DMRE, Eskom, SAPIA.	High	Transparency	Not completed	No timeline provided due to difficulties of setting up MoUs.	This has proved to be difficult. MoUs are still under discussion, however a regulatory process and the National Greenhouse Gas Improvement Programme (GHGIP) are being implemented as an alternative data gathering process.
	Improve QA/QC processes by addressing all issues in external review.	High	Completeness	In progress	5th BUR (2019 Inventory)	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. External reviewers should also use QC procedures suggested in the QA/QC plan for commenting on the calculation files so as to assist with the speed of the process.

Sector	Improvement	Prioity	Reason	Status	Completion Timeframe	Barriers & Constraints
Cross Cutting	Enhance the improvement plan by incorporating all review activities not addressed in the current Inventory.	High	Transparency	In Progress	5th BUR (2019 Inventory)	Challenges around inclusion of further improvements into the improvement plan are limited resources and process management. The DFFE Inventory team has increased in size, including an Inventory co-ordinator, which should assist in addressing this issue.
	Incorporate NOx, CO, NMVOC, and SOx emissions.	High	Completeness	Proposed	5th BUR (2019 Inventory)	These emissions will first be implemented in the Transport sector especially the Road transport sector. A studywhich looked at vehicle kilometres travelled by vehicle technology is being concluded in April 2020 and will enable the estimation of these emissions from the Energy Sector. Data for the Energy sector will be included in the 2019 Inventory, followed by both other sectors in the 2021 Inventory.
Energy	Incorporate all updated information from the recent fuel consumption study.	High	Key category; Accuracy	In progress	5th BUR (2019 Inventory)	Completion of the fuel consumption study is a barrier to completing this task, however, it should be completed in 2020 (see Table 2.9 on GHGIP). The results of the study will be incorporated to produce an enhanced Inventory. Sections that have been completed have already begun to be incorporated into the Inventory.
	CO_2 and CH_4 fugitive emissions from oil and natural gas operations.	Medium	Completeness	Planned	5th BUR (2019 Inventory)	Emissions from this source category will be added in the next Inventory as information will be obtained through the NGERs.
	CO_2, CH_4 and N_2O from spontaneous combustion of coal seams.	Low	Completeness	Planned	1st BTR (2021 Inventory)	New research will allow this category to be included in the 2021 Inventory.
	CH_4 emissions from abandoned mines.	Low	Completeness	Planned	1st BTR (2021 Inventory)	New research outputs will enable this activity to be included in the 2021 Inventory.

Table 2.8:
LIST OF IMPROVEMENTS FOR SOUTH AFRICA'S INVENTORY.

Sector	Improvement	Prioity	Reason	Status	Completion Timeframe	Barriers & Constraints
Energy	Fugitive emissions from coke production to be reported separately from 2C process emissions.	Low	Transparency	Planned	5th BUR (2019 Inventory)	Progress on this has been slow but reporting through the NGERs will allow this activity to be incorporated in the next Inventory.
	Improve understanding of difference between reference and sectoral approach.	Medium	Key category; Accuracy	Planned	5th BUR (2019 Inventory)	The fuel consumption study that will be concluded in April 2020, will be used to estimate emissions for the sectoral approach and the data from supply side such as Eskom, Sasol and SAPIA will be used to estimate emissions using the reference approach. Inclusion of this study will assist the Inventory team in understanding the differences between the reference and sectoral approaches.
	Incorporate emissions from biogas.	Low	Completeness	Proposed	Date for incorporation not set as it is only a proposed improvement.	This would require a study and so should be recommended as a project under the GHGIP.
	CO_2 transport and storage.	Low	Completeness	Proposed		Further data required.
	CO_2, CH_4 and N_2O emissions from combined heat and power (CHP) combustion systems.	Medium	Completeness	Proposed		Data is required.
	Develop emission factors, carbon content of fuels and net calorific values of liquid fuels.	High	Key category; Accuracy	Planned	1st BTR (2021 Inventory)	Resources and funding are required to complete this study so it will be incorporated into the GHGIP (see section 2.7.12.1). This study is planned to start in 2020.
	Development of Tier 3 methods for coal-to-liquid, gas-to-chemicals and gas-to-liquid.		Accuracy	Proposed	Date for incorporation not set as it is only a proposed improvement.	
	Improve explanation of large changes in trends.		Transparency	Planned	5th BUR (2019 Inventory)	This aspect will be incorporated in the next Inventory and BUR.

Sector	Improvement	Prioity	Reason	Status	Completion Timeframe	Barriers & Constraints
IPPU	Calculate CH_4 emissions from Iron and steel production.	High	Key category; Accuracy	Planned	5th BUR (2019 Inventory)	Data is available for this activity so it will be incorporated in the next Inventory.
	Estimate emissions from other process use of carbates (OPUC) category using currently available data.	Medium	Completeness	Planned	5th BUR (2019 Inventory)	Emissions from this category can be calculated from existing data, so this will be included in the next Inventory.
	Development of country specific emission factor for the ferroalloy industry.	Medium	Key category; Accuracy	Proposed	1st BTR (2021 Inventory)	Resources and funding are required to complete this study so it will be incorporated into the GHGIP (see section 2.7.12.1).
	Development of Tier 3 methodologies for aluminium production.	Medium	Key category; Accuracy	Proposed	Date for incorporation not set as it is only a proposed improve-ment.	
	Include emissions from electronics industry.	Medium	Completeness	Planned	1st BTR (2021 Inventory)	A study needs to be undertaken to understand emissions from this source so it should be highlighted as a project for the GHGIP (see section 2.7.12.1).
	Incorporate SF_6 emissions.	Medium	Completeness	In Progress	5th BUR (2019 Inventory)	Lack of data has been a challenge.
AFOLU	Incorporate all back-ground data and equations for the tier 2 calculations of enteric fermentation.	High	Key category; Accuracy; Transparency	Planned	1st BTR (2021 Inventory)	Lack of time and resources have been barriers to incorporating this infor-mation. With the increase in Inventory team members this should now be possible.
	Incorporate 2018 National Land Cover (NLC) map and update land use change data for 2015–2018.	High	Key category; Accuracy;	Planned	5th BUR (2019 Inventory)	National Land Cover maps were not available at the time of preparing the 2017 Inventory but this has now been completed (see Table 2.9)
	Incorporate organic soils study to include emissions from organic soils.	Medium	Completeness	Planned	5th BUR (2019 Inventory)	Time has been the main barrier for this activity as for the 2015 Inventory the soil map was not complete, and in the 2017 Inventory there was insufficient time to complete all the mapping integration and land cover overlays. Some of this work has now been done as part of the NTCSA.

Table 2.8:
LIST OF IMPROVEMENTS FOR SOUTH AFRICA'S INVENTORY.

Sector	Improvement	Prioity	Reason	Status	Completion Timeframe	Barriers & Constraints
AFOLU	Include deadwood in the DOM pool for all land categories.	Low	Completeness	Planned	1st BTR (2021 Inventory)	The recently updated NTCSA included dead wood estimates, so this data will be considered in the next Inventory. However, a literature search for forest lands during the current Inventory revealed that there is insufficient data to support the inclusion of deadwood, therefore, more research may be required, and deadwood would then only be included in the 2021 Inventory.
	Incorporate updated NTCSA data to improve estimates, particularly for soils.	High	Key category; Accuracy	Planned	5th BUR (2019 Inventory)	NTCSA update has just been completed, so data will begin to be incorporated.
	Complete an assessment of crop types and areas and investigate discrepancies between crop statistics and NLC data.	Medium	Consistency; Comparability	Planned	1st BTR (2021 Inventory)	Variability in crop classifications from the various data sources have made this challenging. Funding will be required to complete a proper assessment of croplands so this project can be included in the GHGIP (see section 2.7.12.1).
	Include CO_2 estimates for wetlands.	Low	Completeness	Proposed	1st BTR (2021 Inventory)	Lack of data has been the barrier to including this activity and it has been a low priority due to the small area of wetlands. Data from NTCSA will be considered, and other data explored, so that estimates can be included by the 2021 Inventory.
	Update HWP with country specific data.	Low	Accuracy	Planned	5th BUR (2019 Inventory)	Time constraints and priority level are the reasons for this not being completed yet.

Sector	Improvement	Prioity	Reason	Status	Completion Timeframe	Barriers & Constraints
Waste	Data collection on quantities of waste disposed of into managed and unmanaged landfills.		Key category; Accuracy	In Progress	5th BUR (2019 Inventory)	Project is underway so data will be included in 2019 Inventory.
	Improve methane correction factor and rate constants.			Proposed	5th BUR (2019 Inventory)	This would require a study so will be recommended as a project under the GHGIP.
	Include economic data for different population groups.			In Progress	5th BUR (2019 Inventory)	Study was completed in March 2020 so data will be included in next Inventory.
	Include information on population distribution in rural and urban areas as a function of income.			In Progress	5th BUR (2019 Inventory)	Study was completed in March 2020 so data will be included in next Inventory.
	Include HWP in solid waste.	Medium	Key category; Completeness	Proposed	Will be considered for inclusion in the 5th BUR	Data may be insufficient, in which case further data collection will be suggested. data.
	Obtain data on waste streams and the bucket system.		Accuracy	In Progress	5th BUR (2019 Inventory)	Study was completed in March 2020 so data will be included in next Inventory.
	CH_4, N_2O emissions from biological treatment of waste.	Medium	Completeness			
	CO_2, CH_4 and N_2O from waste incineration.	High				

2.7.12.1. GHG Improvement Programme

As part of the ongoing initiative to improve the GHG Inventory, South Africa is implementing GHGIP, which comprises a series of sector-specific projects that are targeting improvements in activity data, country-specific methodologies and emission factors used in the most significant sectors. Table 2.9 and Table 2.10 summarise some of the projects that are under implementation as part of the GHGIP.

The DFFE has also identified the following private sectors for engagement on the GHGIP:

(i) Ferroalloys industry – development of country specific emission factors.
(ii) Cement industry – development of country specific emission factors.
(iii) CTL-GTCs and GTLs – development of T3 methodologies.
(iv) Aluminium production – development of T3 methodologies.
(v) Petrochemical industry – development of emission factors, carbon content of fuels, and net calorific values of liquid fuels.

Table 2.9:
DFFE DRIVEN GHGIP PROJECTS.

Sector	Baseline	Nature of Methodological Improvement	Partner	Completion Date
Transport sector [implications for other sectors]	Using IPCC default emission factors	Development of country-specific CO_2	DOT	December 2020
Coal-to-liquids (CTL)	Allocation of emissions not transparent	Improved allocation of emissions, material balance approach	Sasol	December 2019
Ferro-alloy production	Using a combination of IPCC default factors and assumptions based on material flows	Shift towards an IPCC Tier 2 approach	Xstrata, Ferro-Alloy Producers' Association	December 2020

Table 2.10:
DONOR FUNDED GHGIP PROJECTS UNDER IMPLEMENTATION.

Project	Partner	Objective	Outcome	Timelines	Status
Development of a formal Inventory System	Norwegian Embassy	Helping South Africa develop its national system	Inventories are documented and managed centrally	2015-2020	Completed
Land-cover Mapping	The UK Department for International Development	To develop a land-use map for one time step 2017/18	Land-use change matrix developed for 36 IPCC land-use classes to detect changes	2019-2020	Completed
Waste-sector Data Improvement Project	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)	To improve waste-sector GHG emissions estimates and address data gaps	To improve waste-sector GHG emissions estimates and address data gaps	2019-2020	In Progress
2nd Energy Sector Fuel Consumption Study & VKT Study	GIZ	Improved energy activity data on fuel consumption for solid, liquid and gaseous fuels	Improved energy activity data on fuel consumption for solid, liquid and gaseous fuels	2019-2020	In Progress

2.8. SECTORAL ANALYSIS

2.8.1. Energy

South Africa's GDP is the 30th highest in the world, but in primary energy consumption South Africa is ranked 17th in the world. South Africa's energy intensity is high mainly because the economy is 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 for the production of a significant proportion of the liquid fuels consumed in the country. The Energy sector is critical to the South African economy because it accounts for a total of 15% of the GDP.

The Energy sector in South Africa is highly dependent on coal as the primary energy resource. The largest source of energy sector emissions in South Africa is the combustion of fossil fuels. Emissions from combustion include CO_2, N_2O, CH_4 and H_2O. A large quantity of liquid fuels is imported in the form of crude oil. Renewable energy sources include biomass and natural processes that can be used as energy sources. Biomass is used commercially in industry to produce heat and in households for cooking and heating.

In terms of energy demand, South Africa is divided into six sectors: Industry, Agriculture, Commerce, Residential, Transport and Other. The Industrial sector (which includes mining, iron and steel, chemicals, non-ferrous metals, non-metallic minerals, pulp and paper, food and tobacco, and other) is the largest user of energy in South Africa. The primary energy supply in South Africa is dominated by coal (59%), followed by crude oil (16%), renewable resources and waste (20%), natural gas (3%) and nuclear energy (2%) (DoE, 2017).

The energy sector includes:

(i) Exploration and exploitation of primary energy sources.
(ii) Conversion of primary energy sources into more useable energy forms in refineries and power plants.
(iii) Distribution of fuels.
(iv) Final use of fuels in stationary and mobile applications.

The categories included in the Energy sector for South Africa are Fuel combustion activities (1A), including international bunkers, Fugitive emissions from fuels (1B) and Carbon dioxide transport and storage (1C).

2.8.1.1. Trends

Total emissions from the Energy sector for 2017 were estimated to be 410 685 Gg CO_2e (Table 2.11). Fuel combustion activities (1A) was the main contributor, accounting for 92.7% of emissions from the Energy sector. Fugitive emissions from fuels (1B) contributed the rest, since emissions from Carbon dioxide transport and storage (1C) were not estimated. Overall, Energy industries were the main contributors, accounting for 60.7% of emissions from the Energy sector. This was followed by Transport (13.3%) and Manufacturing industries and construction (7.0%). The Residential and Commercial sectors are both heavily reliant on electricity for meeting energy needs.

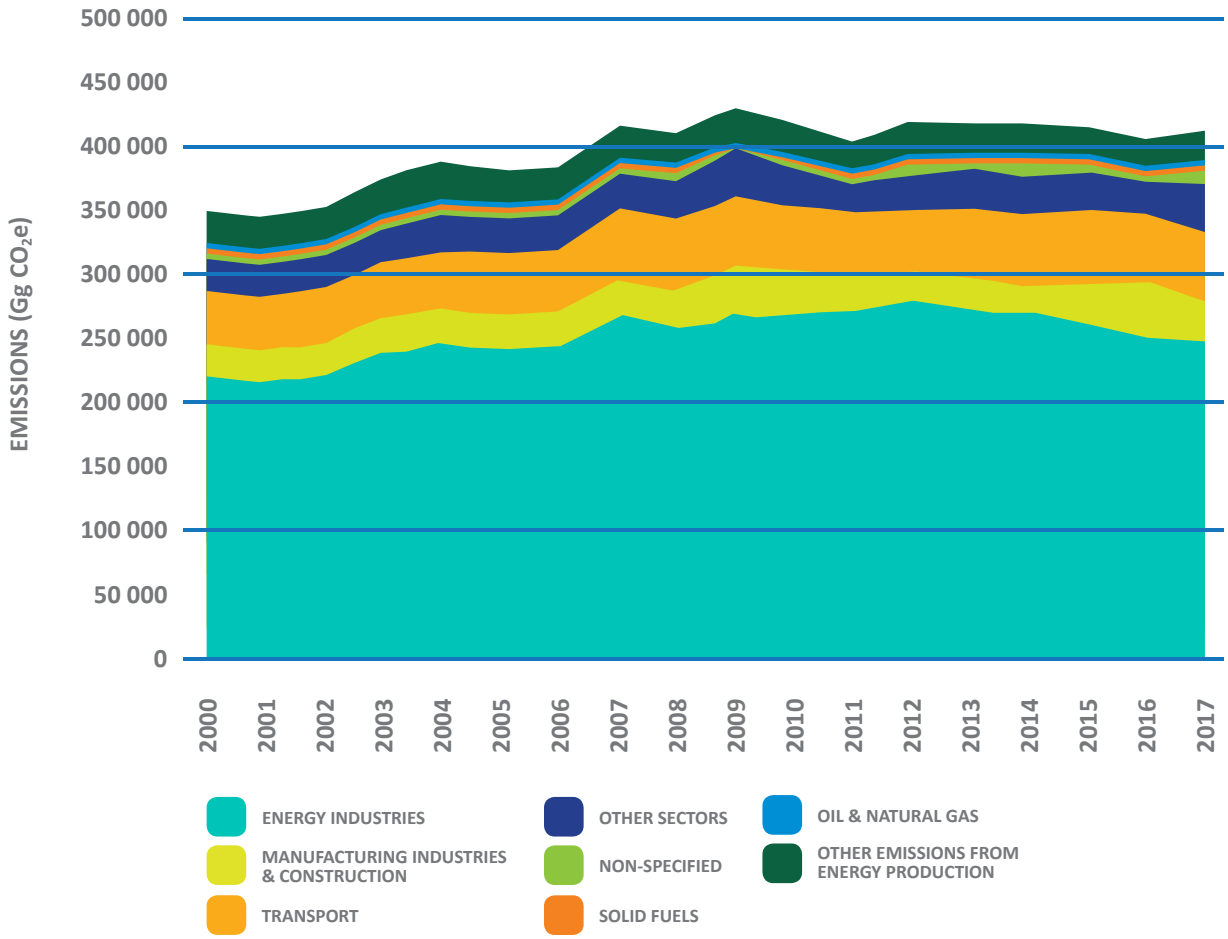
Table 2.11:
EMISSIONS FROM THE ENERGY SECTOR IN 2017 BY GAS AND SUB-CATEGORY.

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	403 971.0	196.4	4 125.0	8.4	2 589.3	410 685.3
1A Fuel Combustion Activities	377 563.2	18.6	389.7	8.4	2 589.3	380 542.1
1B Fugitive Emissions from Fuels	26 407.8	177.9	3 735.3	0.0	0.0	30 143.1
1C Carbon Dioxide Transport & Storage	NE	NE	NE	NE	NE	NE

Energy sector emissions increased by 17.6% (61 585 Gg CO_2e) between 2000 and 2017 (Figure 2.12). Emissions peaked in 2009, and thereafter the emissions have plateaued. The plateauing might be a result of increasing penetration of electricity generated from renewable energy resources (wind, solar photovoltaics (PV) and concentrated solar power (CSP)). In 2013, a penetration level of 0.03% (0.01 TWh) of wind and solar energy resources was introduced into the national electricity system. By 2016 and 2017, the penetration levels of these renewable resources had increased to 3% (6.9 TWh) and 4% (10.8 TWh), respectively.

The emissions from Fuel combustion activities grew by 64 099 Gg CO_2e (20.3%) over the 2000 to 2017 period, while the Fugitive emissions from fuels declined by 2 513 Gg CO_2e (7.7%). The main driver of the increase was the 13.0% (28 747 Gg CO_2e) increase in Energy industries. In addition, there was a 33.2% (13 632 Gg CO_2e) increase in Transport sector emissions due to increased road transport emissions. The emissions from the Other sectors (1A4) subcategory grew by an average of 3.8% per annum with the largest contributor in 2017 being the Commercial/Industrial sector (79.5%). Increased use of subbituminous coal was the main reason for the increase in emissions in this sector 2017. On the other hand, the sub-bituminous coal used in the Residential sector declined, leading to reduced emissions from this sector, particularly between 2013 and 2017. The sectoral summary sheet for Energy, provided in Appendix 3.A of the NIR2017, can be referred to for further details.

Figure 2.12:
EMISSION TRENDS FOR THE SUB-CATEGORIES IN THE ENERGY SECTOR, 2000–2017.



2.8.1.2. Methods and data

GHG emissions from the Energy sector were estimated using a detailed sectoral or bottom-up approach. Most of the emission estimates in the sectoral approach for the Energy sector are calculated using IPCC Tier 1 and 2 methods as shown in Table 2.12.

Table 2.12:

SUMMARY OF METHODS AND EMISSION FACTORS FOR THE AFOLU SECTOR AND AN ASSESSMENT OF THE COMPLETENESS OF THE AFOLU SECTOR EMISSIONS.

GHG Source & Sink Category 1A FUEL COMBUSTION ACTIVITIES	CO_2		CH_4		N_2O		DETAILS
	Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor	
1 ENERGY INDUSTRIES							
a. Main activity electricity and heat production	T1, T2	DF, CS	T1	DF	T1	DF	CS CO_2 EF for subbituminous coal (Technical Guidelines: DEA, 2017b)
b. Petroleum refining	T1	DF	T1	DF	T1	DF	
c. Manufacture of solid fuels and other energy industries	T3	CS	T3	CS	T3	CS	No activity data; emissions supplied by Sasol and PetroSA- based on Mass Balance Approach.
2 MANUFACTURING INDUSTRIES AND CONSTRUCTION	**T1, T2**	**DF, CS**	**T1**	**DF**	**T1**	**DF**	**CS CO_2 EF for sub-bituminous coal (Technical Guidelines: DEA, 2017b)**
3 TRANSPORT							
a. Civil aviation	T1	DF	T1	DF	T1	DF	CS CH_4 EF for gas/diesel oil.
b. Road transportation	T1	DF	T1	DF	T1	DF	
c. Railways	T1	DF	T1, T2	DF, CS	T1	DF	
d. Water-borne navigation	T1	DF	T1	DF	T1	DF	
e. Other transportation	NO		NO		NO		
4 OTHER SECTORS							
a. Commercial / Institutional	T1, T2	DF, CS	T1	DF	T1	DF	CS CO_2 EF for sub-bituminous coal (Technical Guidelines: DEA, 2017b).
b. Residential	T1, T3	DF, CS	T1	DF	T1	DF	
c. Agriculture / Forestry / Fishing / Fish farms	T1, T4	DF, CS	T1	DF	T1	DF	
5 NON-SPECIFIED							
a. Stationary	T1, T2	DF, CS	T1	DF	T1	DF	CS CO_2 EF for sub-bituminous coal (Technical Guidelines: DEA, 2017b).
b. Residential	IE		IE		IE		The fuels associated with this category are assumed to be included elsewhere in the energy balance.

T1- T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not Applicable

Table 2.12:

SUMMARY OF METHODS AND EMISSION FACTORS FOR THE AFOLU SECTOR AND AN ASSESSMENT OF THE COMPLETENESS OF THE AFOLU SECTOR EMISSIONS.

GHG Source & Sink Category 1B FUGITIVE EMISSIONS FROM FUELS	CO_2		CH_4		N_2O		DETAILS
	Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor	
1 SOLID FUELS							
a. Coal mining and handling	T2	CS	T2	CS	NO		CS CO_2 and CH_4 EFs based on the study by Coaltech SA.
b. Uncontrolled combustion and burning coal dumps	NE		NE		NO		
c. Solid fuel transformation	NE		NE		NO		Fugitive emissions from coal-to-liquids is included under 1B3. Emissions from coke production are included under 2C.
2 OIL AND NATURAL GAS							
a. Oil	T3	CS	T3	CS	NO		Based on measurements- PetroSA.
b. Natural gas	NE		NE				
3 OTHER EMISSIONS FROM ENERGY PRODUCTION	**T3**	**CS**	**T1, T3**	**DF, CS**	**NE**		**Industry specific CO_2 and CH_4 emissions supplied by Sasol and PetroSA - based on Mass Balance Approach. Charcoal CH_4 used approach T1.**

T1- T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not Applicable

Table 2.12:

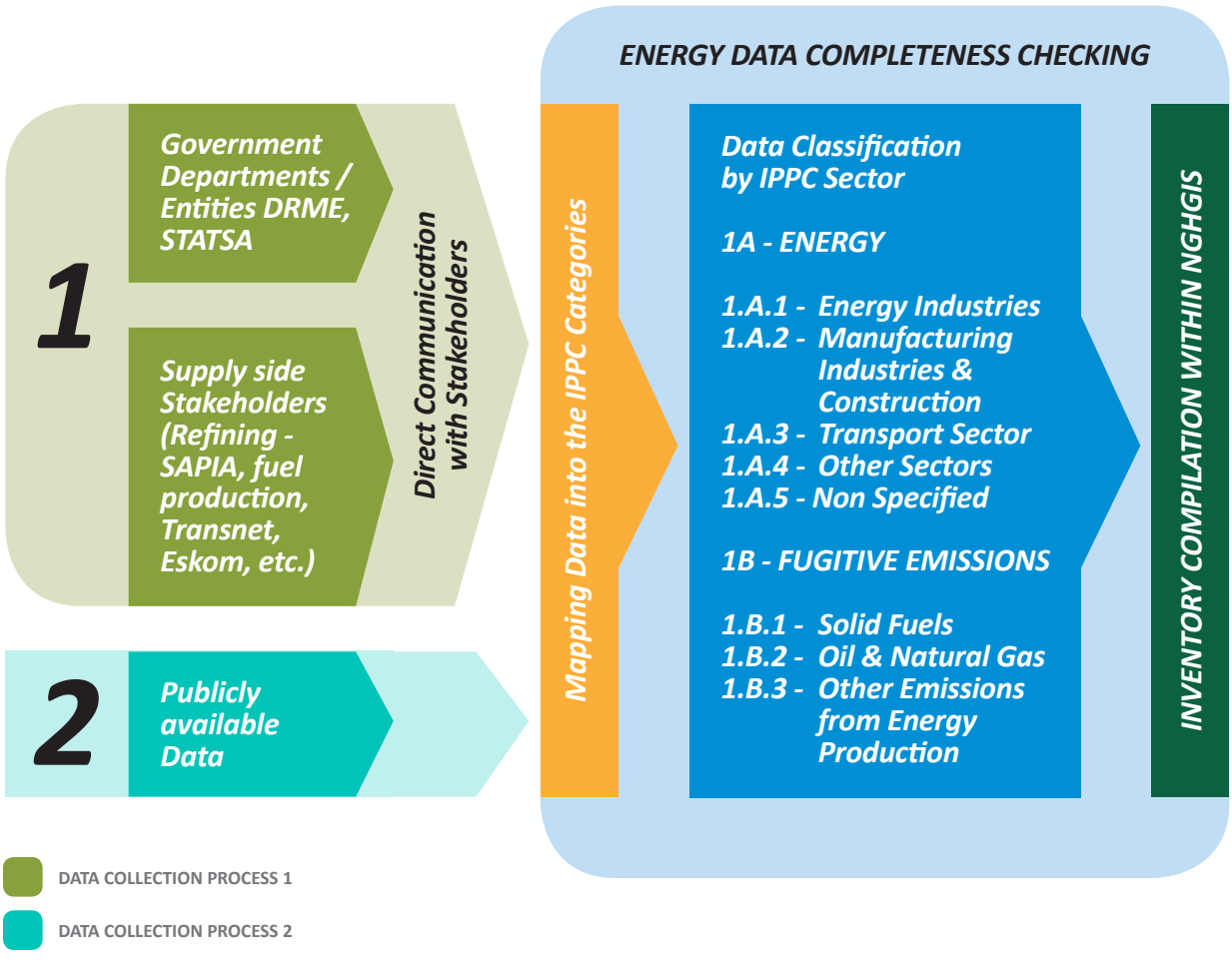
SUMMARY OF METHODS AND EMISSION FACTORS FOR THE AFOLU SECTOR AND AN ASSESSMENT OF THE COMPLETENESS OF THE AFOLU SECTOR EMISSIONS.

GHG Source & Sink Category 1C CARBON DIOXIDE TRANSPORT AND STORAGE	CO_2		CH_4		N_2O		DETAILS
	Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor	
1 TRANSPORT OF CO^2							
a. Pipelines	NE		NE		NE		
b. Ships	NE		NE		NE		
c. Other	NE		NE		NE		
2 INJECTION AND STORAGE							
a. Injection	NE		NE		NE		
b. Storage	NE		NE		NE		
3 OTHER	**NE**		**NE**		**NE**		

T1- T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not Applicable

All activity and emission factor data sources for the Energy sector are provided in Table 3.7 and 3.22 of the NIR2017. Data was collected through two instruments. The first process involved receiving data through direct interaction between the DFFE and stakeholders that supplied the department with the data. These key department and stakeholders are government departments such as the DMRE, public entities such as Eskom (electricity production), Transnet and associations such as South African Petroleum Industry Association (SAPIA). The second process involved collecting data that was publicly available. The datasets from all these data collection processes are run through a data completeness checking system to check whether all the sectors within the economy are covered (Figure 2.13). Incomplete categories are then identified and highlighted for future data collection efforts.

Figure 2.13:
DATA COLLECTION PROCESS FOR THE 2017 ENERGY SECTOR INVENTORY.



2.8.1.3. Reference and sectoral approach comparison

As a way of verifying CO_2 emissions from fuel combustion for the time series 2000–2017, South Africa also applied the top-down IPCC Reference Approach to the Inventory. The Reference Approach was applied on the basis of relatively easily available energy supply statistics and as a way of maintaining good practice as per IPCC Reporting Guidelines. Significant differences between the reference and sectoral approaches may indicate possible problems with the activity data, net calorific values, carbon content, excluded carbon calculation etc.

The reference approach outputs were compared to the sectoral emissions for the period 2000 to 2017 and the CO_2 emissions were always higher using the reference approach (see section 3.2.2 of the NIR2017). The difference in CO_2 emissions using the reference and sectoral approach was 14.2%, 20.4% and 17.3% for the years 2015, 2016 and 2017, respectively. The largest differences were seen in the solid fuels, where consumption is consistently higher with the reference approach (see Appendix 3.B of the NIR20017). Allocation of solid fuels between energy use, non-energy use as well as use for synthetic fuels production remains one of the key drivers of the differences observed between the two datasets. There is a much smaller difference between the two approaches for liquid fuels, with some years having higher consumption with the reference approach and other years higher with the sectoral approach (see Appendix 3.B of NIR2017). As with solid fuels, there is a large discrepancy in consumption between the two approaches, with consumption being consistently high with the reference approach (see Appendix 3.B of NIR2017).

There are a number of possible reasons for the discrepancy between the two approaches:

(i) Missing information on stock changes that may occur at the final consumer level. The relevance of consumer stocks depends on the method used for the Sectoral Approach.
(ii) High distribution losses for gas will cause the Reference Approach to be higher than the Sectoral Approach,
(iii) Unrecorded consumption of gas or other fuels may lead to an underestimation of the Sectoral Approach.
(iv) The treatment of transfers and reclassifications of energy products may cause a difference in the Sectoral Approach estimation since different net calorific values and emission factors may be used depending on how the fuel is classified.
(v) Net Calorific Values (NCV) used in the sectoral approach differs from those used in the reference approach. In power generation, NCV values in the sectoral approach vary over the 2000-2016 time series based on the information provided by industry.
(vi) Activity data on Liquid fuels in the sectoral approach particularly for energy industries is sourced directly from the companies involved and has been reconciled with other publicly available datasets.
(vii) Inconsistencies on the sources of activity data within the time series and in some cases the application of extrapolation.
(viii) The misallocation of the quantities of fuels used for conversion into derived products (other than power or heat) or quantities combusted in the energy sector.
(ix) Simplifications in the Reference Approach. There are small quantities of carbon which should be included in the Reference Approach because their emissions fall under fuel combustion. These quantities have been excluded where the flows are small or not represented by a major statistic available within energy data.

The data and methodologies are currently being evaluated to determine if there are any further improvements that can be made to resolve some of the above-mentioned issues. In addition, further explanation for the discrepancies will be included.

2.8.1.4. Recalculations

Recalculated emission estimates for the Energy sector were on average 0.7% lower than previous estimates for the Energy sector between 2000 and 2009, and 4.2% lower from 2010 onwards (see Figure 3.3 of NIR2017).

Fuel combustion activity recalculations were necessary due to an update of the DMRE energy balance data. Recalculated values were on average 4.2% lower than the previous submission for this category. Improvements were made to the consumption data in the Road transport, Manufacturing industries and construction, Other sectors and Non-specified emissions from energy production categories. The main fuels that necessitated recalculation in these sectors are sub-bituminous coal and gas/diesel oil. A significant amount of diesel was allocated to 1A5a in the energy balance. Given that in the previous Inventories, this category did not have any diesel allocated to it, this led to an increase in diesel consumption in the energy industries. Emissions in this category increased from 1 204 Gg CO_2e in the previous submission to 5 782 Gg CO_2e in 2015 in the current submission. This was counteracted by an average decrease of 19.6% in the Manufacturing industries and construction category and a 38.7% decline in Other sector emissions compared to the previous inventory.

In addition to the updated energy balance data, a recent parc model study (DFFE, 2020) was completed for the transport sector which provided consumption data based on vehicle kilometres travelled (VKT).

Fugitive emissions from fuels were 2.4% lower than estimates in the 2015 Inventory. Solid fuel emissions were lower due to updated coal production data and in the Other emissions from energy production category the charcoal consumption data was corrected.

2.8.1.5. Planned improvements

Improvements planned for the next Inventory are:

(i) There will be three instruments through which the data will be collected for the Inventory in future. The first process will involve enhancement of the current direct communication between stakeholders and the DFFE, with memorandums of understanding being drafted to formalise the data collection process between significant industry players and government departments. For example, memorandums of understanding will be finalised for government departments such as the DMRE, public entities such as Eskom and associations such as SAPIA.

(ii) The other improvement will be the data that will be generated through SAGERS. SAGERS was developed to improve the compilation of Inventories by assisting the DFFE and Category A data providers to abide by the NGERs (DEA, 2017a) (see section 6.3.3.1). SAGERS will not only improve GHG reporting for the Energy sector but will also improve the IPPU sector emission estimates which relied heavily on publicly available data. In the next Inventory, data gathered through the NGERs and SAGERS will be incorporated.

(iii) A fuel consumption study is currently underway. This study aims primarily to disaggregate the use of combustion fuels, including liquid fuels, solid fuels, biomass-based fuels and gaseous fuel data according to the demand-side sectors and sub-sectors of the South African economy for each year in the period 2013–2018 and projections to 2035. Effectively, this project will not only update the work done in the Phase I fuel disaggregation study conducted by GIZ in 2015 but will also expand on its scope. The long-term forecasting will be based on final demand figures.

and event scenarios that are expected (might occur) in the next 15 years. This study is generating energy consumption data from all the demand sectors in South Africa and goes further to estimating vehicle kilometres travelled in the Transport sector. The Inventory will be updated with information from this study as it becomes available.

(iv) Fugitive emissions from coke production are currently accounted for under category 2C as part of process emissions, however, it is planned that by the 2019 Inventory these will be separated from process emissions and reported separately.

(v) Re-evaluate reference versus sectoral data and methodology and include any improvements into the next inventory. In addition, provide further explanations for the differences.

(vi) Country-specific uncertainty data will be sought and incorporated when available. This will be an ongoing improvement over the next few inventory cycles.

(vii) Time-series will be extended back to 1990 over the next few years, but this will likely only be available in the 1st BTR.

2.8.2. IPPU

The IPPU sector includes non-energy related emissions from industrial processing plants. The main emission sources are releases from industrial processes that chemically or physically transform raw material, e.g., ammonia products manufactured from fossil fuels. GHG emissions released during these processes are CO_2, CH_4, N_2O, HFCs and PFCs. Also included in the IPPU sector are emissions used in products such as refrigerators, foams and aerosol cans.

HFCs and perfluorocarbons PFCs are used in a large number of products and in refrigeration and air conditioning equipment. PFCs are also emitted as a result of anode effects in aluminium smelting. Therefore, the IPPU sector includes estimates of PFCs from aluminium production, and HFCs from refrigeration and air conditioning.

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 largest source of emissions in the IPPU sector in South Africa is the production of iron and steel.

The performance of the economy is the key driver for trends in the IPPU sector. South Africa is a relatively small, open economy and economic activity therefore typically correlates with global economic trends. 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 enormously across almost all categories in the IPPU sector.

2.8.2.1. Trends

In 2017 the IPPU sector produced 32 085 Gg CO_2e (Table 2.13), which is 6.3% of South Africa's emissions (excl. FOLU). The largest source category is the Metal industry category, which contributes 63.5% to the total IPPU sector emissions. Iron and steel production and Ferroalloys production are the biggest CO_2 contributors to the Metal industry subsector, producing 7 725 Gg CO_2e and 11 330 Gg CO_2e, respectively. The Mineral industry and the Product uses as substitute ozone depleting substances (ODS) subsectors contribute 19.5% and 12.5%, respectively, to the IPPU sector emissions, with all the emissions from the Product uses as substitute ODS being HFCs. Ferroalloy production, carbon black production and ammonia production produce a small amount (168 Gg CO_2e) of CH_4, while chemical industries are estimated to produce 293 Gg CO_2e of N_2O.

Table 2.13:
EMISSIONS FROM THE ENERGY SECTOR IN 2017 BY GAS AND SUB-CATEGORY.

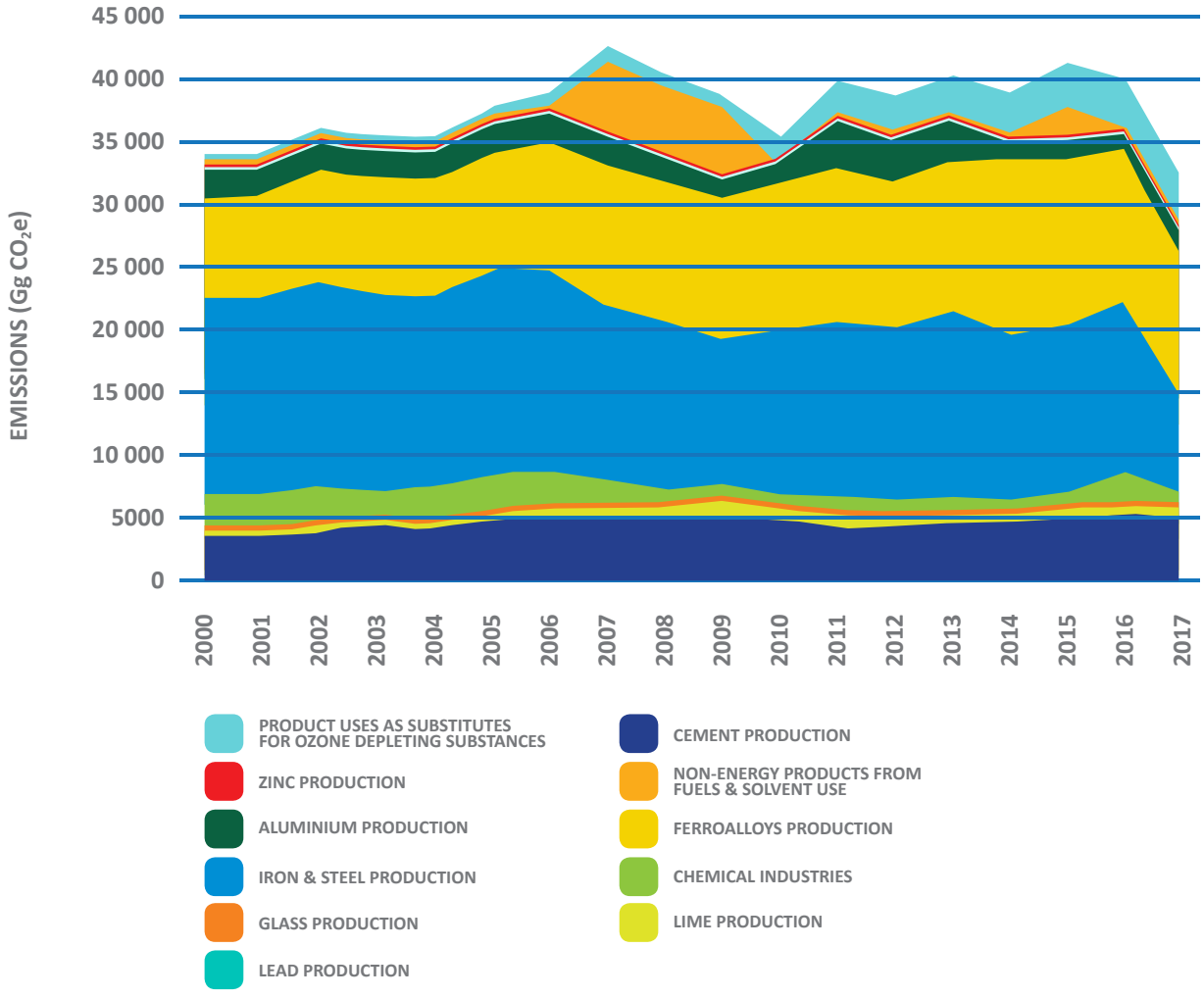
GHG Source Categories	CO_2	CH_4		N_2O		HFCs	PFCs	Total
	Gg CO_2e	Gg	Gg CO_2e	Gg	Gg CO_2e	Gg CO_2e	Gg CO_2e	Gg CO_2e
2. IPPU	27 496.0	8.0	168.4	0.9	292.6	4 014.5	113.1	32 084.6
2A Mineral Industry	6 257.3	NE	NE	NE	NE	NE	NE	6 257.3
2B Chemical Industry	433.6	7.9	167.3	0.9	292.6	NE	NE	893.4
2C Metal Industry	20 274.5	0.1	1.1				113.1	20 388.7
2D Non-energy Products from Fuels & Solvents	530.6							530.6
2E Electronic Industry	NE					NE	NE	
2F Product uses as Substitute ODS						4 014.5	NE	4 014.5
2G Other Product Manufacture & use	NE	NE	NE	NE	NE	NE	NE	NE
2H Other	NE	NE	NE	NE	NE	NE	NE	NE

IPPU emissions increased by 28.9% between 2000 and 2007, after which there was a 16.6% decline to 2010 (Figure 2.14). This decrease was mainly due to the global economic recession and the electricity crisis that occurred in South Africa during that period. In 2011, emissions increased again as the economy was beginning to recover from the global recession. Emissions stabilised between 2011 and 2016. Between 2016 and 2017 there was a 22.3% decline in emissions, mostly due to a 42.8% decline in pig iron production in the Iron and steel production sub-category. In recent years, companies have been reporting data through the SAGERS system due to the NGER and this data is starting to be included in the inventory. In 2017, the Iron and steel industries showed a change in allocation of production data, with a much-reduced production from pig iron and direct reduced iron, but production data for sinter, which was not previously reported, was included. The emission factor for sinter is much lower than for pig iron and direct reduced iron and hence the reduction in emissions in 2017.

Estimated emissions from the IPPU sector are 903 Gg CO_2e (2.7%) lower than the emissions in 2000. This was mainly due to the 20.5% decrease in the metal industry emissions and the 67.8% decrease in the chemical industry emissions (Figure 2.14).

In the metal industry, Ferroalloy production increased by 3 247 Gg CO_2e while Iron and steel production emissions declined by 7 609 Gg CO_2e. IPPU emissions showed a decrease of 22.1% (9 088 Gg CO_2e) between 2015 and 2017. The main contributors to this decrease were the Iron and steel production and Ferroalloy production categories which decreased by 42.1% (5 609 Gg CO_2e) and 14.6% (1 942 Gg CO_2e) respectively, over this period. The Mineral industry emissions increased by 2.3% (138 Gg CO_2e) between 2015 and 2017, and the Metal industry showed an overall decrease of 27.2% (7 616 Gg CO_2e). Again, this reduction may not be a true reduction in emissions but is partly due to a change in the activity data source during this time. The IPPU sectoral summary sheet in Appendix 4.a of the NIR2017 provides further detail.

Figure 2.14:
TRENDS IN THE IPPU SUB-CATEGORIES BETWEEN 2000 AND 2017.



2.8.2.2. Methods and data

Activity data in the IPPU sector are derived from a variety of sources (see Tables 4.11, 4.15, 4.21 and 4.25 of the NIR2017) with South Africa using a combination of Tier 1, Tier 2 and Tier 3 methods (Table 2.14). Many of the organisations in the chemical industries determine their own emissions and provide these emission estimates to the DFFE. In most cases the activity data and emission factors used are not supplied due to confidentiality issues. In this category, emissions are generally determined by a Tier 3 mass balance analysis unless otherwise stated. In the IPPU sectoral summary table (Appendix 4.A of the NIR2017) the emissions for the individual chemical industry sub-categories are not provided as these values are confidential (and are listed as such in the summary table). Instead, the emissions are aggregated and reported at the Chemical industries category level.

For Refrigeration and air conditioning applications, the IPCC guidelines (IPCC, 2006) propose either an emissions factor approach at the sub-application level (Tier 2a) or a mass balance approach at the sub-application level (Tier 2b) to calculate emissions. In the HFC Emissions Database, the emissions factor approach (Tier 2a) is primarily applied, with the mass balance approach applied for uncertainty purposes/checking. There was insufficient data to follow this approach for Commercial Refrigeration and Industrial Processes, thus a hybrid approach was applied for these sub-applications, which were combined into one application.

2.8.2.3. Recalculations

Recalculations were performed for the entire time-series. The emission estimates for the IPPU sector are lower than the previous estimates for the years 2000 to 2006 and 2010 onwards, whereas estimates were higher between 2007 and 2009 (see Figure 4.2 of NIR2017). These changes were due to the following recalculations:

- Mineral Industry showed a 0.6% reduction in emissions due to:
  - o updated Cement production activity data.
  - o the application of the hydrated lime emission factor.

- Chemical Industry had an emission estimate that was 17.3% below the previous submission for 2014 and a 7.0% higher estimate for 2015 relative to the last submission and this was due to:
  - o updated Carbide production activity data for 2014 onwards.
  - o updated Titanium dioxide production activity data.
  - o updated Carbon black production activity data for 2015.

- Metal Industry showed a 2.7% to 4.4% lower emission estimate between 2000 and 2013, with a 10.4% and 9.5% reduction in the estimates for 2014 and 2015 respectively, due to:
  - o a correction in the direct reduced iron and sinter emission factors for Iron and steel production.
  - o an update to the emission factor for emissions from the Corex process (included under the Other category for Steel and iron production).
  - o updated activity data for ferrosilicon 65% Si production for 2015 onwards.
  - o updated activity data for Aluminium production for 2014 onwards.
  - o updated activity data for Lead and Zinc production for 2013 onwards.

- Non-energy products from fuels and solvent use showed a much higher emission estimate (by an average of 5 418 Gg CO_2e) between 2007 and 2009, and an average of 458 Gg CO_2e between 2011 and 2014 compared to previous submission due to:
  - o improved energy balance activity data for lubricants and paraffin wax.

The specific details of the recalculations for the various sub-categories are provided in section 4.1.4 of the NIR2017.

Table 2.14:
SUMMARY OF METHODS AND EMISSION FACTORS FOR THE IPPU SECTOR.

GHG Source and Sink Category		CO_2		CH_4		N_2O		HFCs		PFCs	
		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	T1	DF	NO		NO		NO		NO	
2	Lime Production	T1	DF	NO		NO		NO		NO	
3	Glass Production	T1	DF	NO		NO		NO		NO	
4	Other process uses of carbonates	NE		NO		NO		NO		NO	
B	CHEMISTRY										
1	Ammonia Production	T3	CS	T3	CS						
2	Nitric Acid Production	NO		NO		T3	CS	NO		NO	
3	Adipic Acid Production	NO		NE		NE		NO		NO	
4	Caprolactam, Glyoxal & Glyoxylic Acid Production	NO		NE		NE		NO		NO	
5	Carbide Production	T3	CS	NE		NE		NO		NO	
6	Titanium Dioxide Production	T2	CS	NE		NE		NO		NO	
7	Soda Ash Production	NO		NE		NE		NO		NO	
8	Petrochemical & Carbon Black Production	T1	DF	NE		NE		NO		NO	
9	Fluorochemical Production			NE		NE		NO		NO	
C	METAL INDUSTRY										
1	Iron and Steel Production	T1, T2	DF, CS	NE		NE		NO		NO	
2	Ferroalloy Production	T1, T3	DF, CS	T1, T3	DF, CS	NE		NO		NO	
3	Aluminium Production	T1	DF	NE		NE		NO		T3	CS
4	Magnesium Production	NO		NE		NE		NO		NO	
5	Lead Production	T1	DF	NE		NE		NO		NO	
6	Zinc Production	T1	DF	NE		NE		NO		NO	
D	NON-ENERGY PRODUCTS FROM FUELS AND SOLVENTS										
1	Lubricant use	T1	DF	NE		NE		NO		NO	
2	Paraffin Wax use	T1	DF	NE		NE		NO		NO	
3	Solvent use	NE		NE		NE		NO		NO	
E	ELECTRONICS INDUSTRY										
1	Integrated circuit or semiconductor	NE		NE		NE		NO		NO	
2	TFT flat panel display	NE		NE		NE		NO		NO	
3	Photovoltaics	NE		NE		NE		NO		NO	
4	Heat Transfer Fluid	NE		NE		NE		NO		NO	
F	PRODUCT USES AS SUBSTITUTE ODS										
1	Refrigeration and Air Conditioning	NO		NO		NO		T1	DF	NE	
2	Foam Blowing Agents	NO		NO		NO		T1	DF	NE	
3	Fire Protection	NO		NO		NO		T1	DF	NE	
4	Aerosols	NO		NO		NO		T1	DF	NE	
5	Solvents	NO		NO		NO		NE		NE	
G	OTHER PRODUCT MANUFACTURE AND USE										
1	Electrical Equipment	NE		NE		NE		NO		NO	
2	SF6 and PFCs from other Product uses	NE		NA		NA		NE		NE	
3	N2O from Product uses	NO		NE		NE		NO		NO	
H	OTHER										
1	Pulp & Paper Industry	NE		NE		NE		NE		NE	
2	Food & Beverage Industry	NE		NE		NE		NE		NE	

T1-T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not applicable

2.8.2.4. Planned improvements

Planned improvements for the IPPU sector include:

- Incorporation of further data from SAGERS. Due to the recent introduction of the NGERs, companies have started reporting data and emissions through SAGERS. In this Inventory some of the initial data collected through SAGERS was incorporated and this will continue to be incorporated in the next Inventory. In the next Inventory, updated and improved information from this reporting will be included.

- The introduction of SAGERS data, which is only reported from 2015, has introduced some inconsistencies into the time-series. In the next Inventory these inconsistencies will be investigated, and historical data will be sought from companies to address this issue. If data cannot be sourced, then the various IPCC splicing techniques will be considered to ensure the time-series is consistent.

- Country-specific uncertainty data will start to be incorporated in the next Inventory and this activity will continue through to the 1st BTR.

It is planned that by the 1st BTR the time-series will be starting from 1990 and extending to 2021.

2.8.3. AFOLU

The AFOLU sector includes GHG emissions and removals from agriculture as well as land use and forestry. Based on the IPCC 2006 Guidelines, the main categories that were included in the emission estimates for the AFOLU sector are Livestock (3A), Land (3B), Aggregated and non-CO_2 sources on land (3C) and Other (3D). Rice cultivation (3C7), Other (3C8) and Other (3D2) were not included as they do not occur in South Africa.

Emissions from fuel combustion in this sector were not included here as these fall under the agriculture, forestry and fisheries subsector in the Energy sector. The Land category included land remaining in the same land use as well as land converted to another land use. This category included a Tier 1 (Formulation B) approach to the mineral soil carbon pool, while organic soils were not reported on as the area of organic soils in South Africa was estimated to be insignificant. The DFFE has recently completed a project on organic and humic soils (DEA, 2019a), but this data became available late in the Inventory preparation process, and so it was not possible to include it in the Inventory. This data set will be assessed in the next Inventory and incorporated if found to be relevant and useable.

Emissions from ruminants in privately owned game parks was included in the previous Inventory, however, due to discussions during the UNFCCC in-country review, these were excluded from this Inventory as they are considered not to be managed. Similarly, for Buffalo emissions, these were excluded as they are considered not to be managed. In addition, in the previous Inventory (NIR2015) the dairy cattle included all dairy cattle (both lactating and non-lactating cattle); however, in this Inventory only lactating cows and heifers are included under Dairy cattle. The emissions from non-lactating dairy cattle are included under the Other cattle sub-category. Further details are provided in the relevant sections below.

In this Inventory the time-series back to 1990 was established for the AFOLU sector. Data is, however, only shown for 2000 to 2017 to ensure consistency in time-series with emissions form the other sectors that only have emission estimates from 2000 onwards. The full time-series can be used in future inventories when the time-series for other sectors is completed. The full extended time series is expected to be reported in the 1st BTR.

2.8.3.1. Trends

The AFOLU sector (including FOLU) in South Africa was a source of 17 997 Gg CO_2e in 2017 (Table 2.15). In 2017 CH_4 emissions contributed the most (52.8%) to the AFOLU (excl. FOLU) emissions, with N_2O contributing 44.6%. Enteric fermentation contributed 95.8% of the CH_4 emissions. Direct N_2O emissions from managed soils was the largest contributor (78.6%) to the N_2O emissions in this sector. Indirect emissions of NOx, CO and NMVOCs were estimated for biomass burning only.

Table 2.15:
EMISSIONS FROM THE ENERGY SECTOR IN 2017 BY GAS AND SUB-CATEGORY.

Greenhouse Gas Source Categories	CO_2 Gg CO_2e	CH_4 Gg CO_2e	N_2O Gg CO_2e	NOx Gg CO_2e	CO Gg CO_2e	NMVOCs Gg CO_2e	Total Gg CO_2e
3. AFOLU (Incl. FOLU)	-29 409.2	1 224.4	70.0	528.8	21.4	31.1	17 997.5
3. AFOLU (excl. FOLU)	1 901.7	1 192.7	70.0	528.8	21.4	31.1	48 641.8
3A Livestock	NA	1 172.8	5.3	NA	NA	NA	26 272.2
3B Land	-30 534.0	31.7	NE	NA	NA	NA	-29 867.4
3C Aggregated and non-CO_2	1 901.7	19.9	64.7	528.8	31.1	31.1	22 369.5
3D Other	-776.9	NA	NA	NA	NA	NA	-776.9

*Totals may not sum exactly due to rounding off.

The AFOLU (excl. FOLU) emissions declined by 8.6% (4 587 Gg CO_2e) between 2000 and 2017, while net emissions from AFOLU (incl. FOLU) declined by 56.2% (23 091 Gg CO_2e) over the same period (Figure 2.16). This large decline is due to a 18 017 Gg CO_2 increase in the Land sink over this period. There were, however, fluctuations in the Land sink throughout the 17-year period.

Total GHG emissions from Livestock declined (see Table 5.3 of NIR2017) due mainly to the decreasing cattle, sheep and goat populations. The other cattle population has declined by 5.4% since 2000, leading to a decline in other cattle emissions which is the largest contributor to Enteric fermentation. Livestock contributed 54.0% to the total AFOLU (excl. FOLU) emissions.

The Land component is estimated to be an overall sink with the Forest land category being the main contributor to this sink (see Table 5.33 of the NIR2017). The increasing sink is due to increasing forest land area and a decline in wood removals. There was a peak in burnt area in 2008, and then a fairly steep decline between 2014 and 2017, leading to reduction in disturbance losses. Furthermore, there was a decline in wood removals by households for lighting and cooking purposes, probably due to increased electrification, which also contributed to the reduced removals.

The Grasslands sink remained fairly constant over the 17-year period with a reduction in the sink between 2010 and 2012. This was due to an increase in fire disturbance losses from low shrublands (which are included within the Grassland category) during these years. Land converted to grasslands contributed the largest portion to the Grassland category. Croplands were a source of CO_2 due to the conversion to croplands. The sink remained fairly constant (between 1 500 Gg CO_2 and 1 80 Gg CO_2) over the time-series. Croplands remaining croplands were a sink, while Land converted to croplands produced emissions of 2 756 Gg CO_2e in 2017. The majority of the emissions were from the conversion of forest land to cropland.

Other lands provide a constant source of emissions (13 513 Gg CO_2) as carbon is lost when land is converted to Other lands. Since it is assumed there is no vegetation on Other lands and no changes in soil carbon, there are no emissions or removals from the Other lands remaining other land category. In Land converted to other land only changes due to initial biomass loss and soil carbon losses are relevant.

Emissions from Aggregated and non-CO_2 emission sources declined by 9.2% between 2000 and 2017. The fluctuations in this category are driven mainly by changes in Liming and Direct N_2O from managed soils. Aggregated and non-CO_2 emissions on land contributed 46.0% to the AFOLU (excl. FOLU) emissions in 2017.

HWP estimates indicate that this subsector is a small sink of CO_2 and this sink increased from 290 Gg CO_2e in 2000 to 776 Gg CO_2e in 2017, however, there were annual fluctuations (Table 2.23).

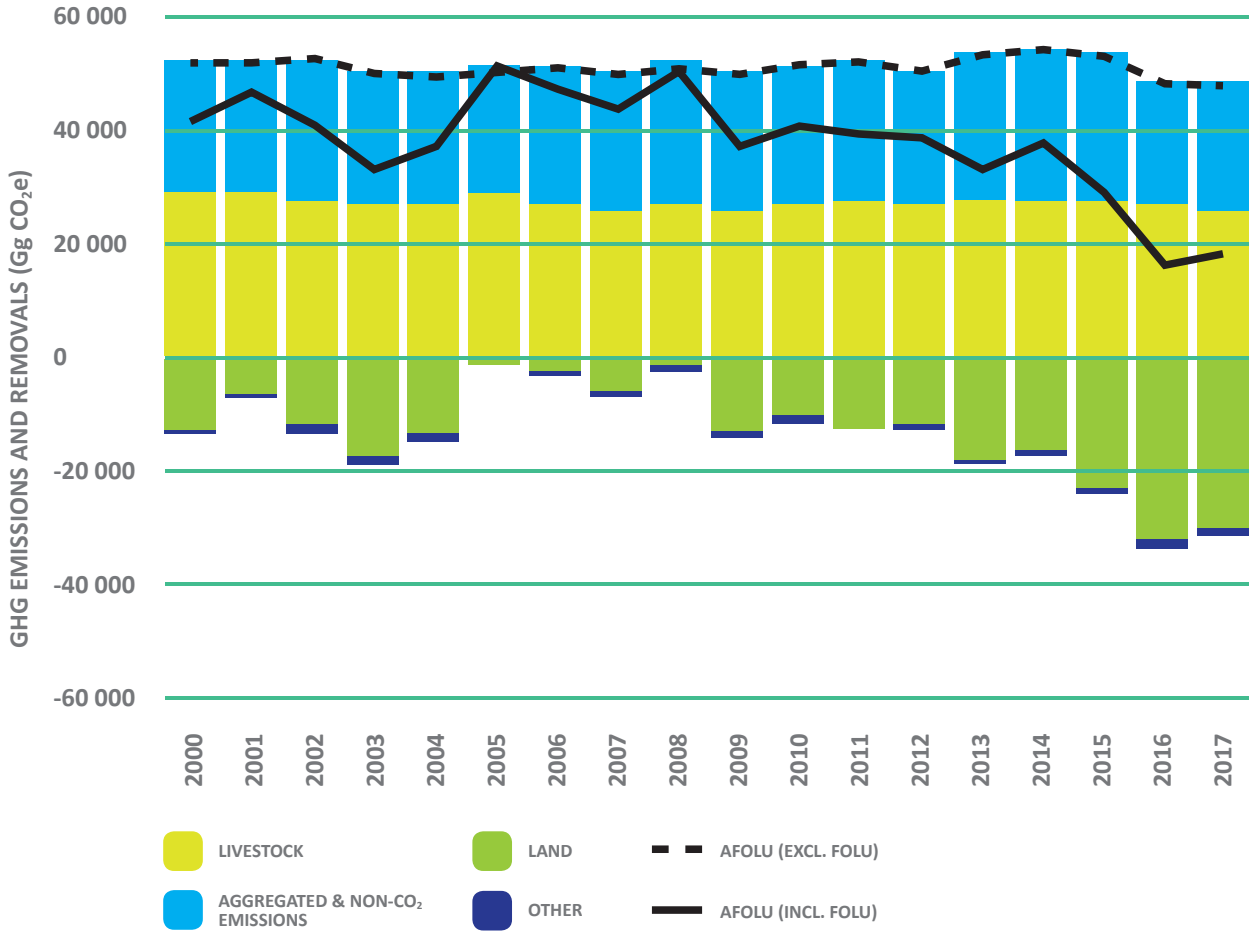
There was a 6.0% (3 163 Gg CO_2e) decrease in the AFOLU (excl. FOLU) emissions since 2015. This can be attributed to a slight decline in livestock population during this period. The AFOLU (incl. FOLU) emissions declined by 37.2% (10 664 Gg CO_2e) over the same period due to a large increase in the Land sink. Aggregated and non-CO_2 emissions on land decreased by 1 412 Gg CO_2e (5.3%), while the HWP sink increased by 169 Gg CO_2e since 2015.

The AFOLU and LULUCF sectoral summary sheets are provided in Appendix 5.A of the NIR2017. The LULUCF summary table (Table 5A.2 of the NIR2017) provides similar information to that required in Table 3A.2.1A of the IPCC Good Practice Guidance for LULUCF, however to be fully compliant with BUR requirements an additional LULUCF summary table is provided in Annex A of this report. This table was not included in the NIR2017, but will be included in the next inventory along with the summary table 3A.2.2A from the IPCC Good Practice Guidance for LULUCF.

2.8.3.2. Land representation

The South African National Land-Cover Dataset 1990 (GTI, 2015) and 2013-14 (GTI, 2014) developed by GeoTerraImage (GTI), were used for this study to determine long-term changes in land cover and their associated impacts. Land-use changes were mapped using an Approach 2 method as described in the 2006 IPCC Guidelines. Land was stratified by soil and climate and the 20-year transition period was included. The various corrections and assumptions are discussed in detail in section 5.4.2 of the NIR2017. The land classes used in the 2017 Inventory are provided in Table 2.16 and a detailed description of the 35 land cover classes provided in the LC maps are given in GTI (2014; 2015).

Figure 2.15:
EMISSION TRENDS FOR SOUTH AFRICA'S AFOLU SECTOR, 2000–2017.



2.8.3.3. Methods and data

The AFOLU sector uses a mix of T1 and T2 methods as indicated in Table 2.17. For Enteric fermentation and Manure management, country specific emission factors are taken from Du Toit et al. (2013a-c) and Moeletsi et al. (2015). The National Terrestial Carbon Sinks Assessment (DEA, 2015) provided some of the input carbon stock data for the land subcategory, with soil management data for croplands being provided by Tongwane et al. (2016). Details of sources of activity data are provided in Table 5.5 of the NIR2017.

Table 2.16:
LAND CLASSIFICATION FOR THE 2017 INVENTORY.

35 Class Categories	17 Class Categories	IPCC Category 2017 Submission
Indigenous forests	Indigenous forests	Forest land
Forest: Fynbos		
Plantations/woodlots	Plantations/woodlots	
Thicket/dense bush	Thicket/dense bush	
Thicket: Fynbos		
Thicket: Nama-Karoo		
Thicket: Succulent Karoo		
Woodland/open bush	Woodland/open bush	
Open bush: Fynbos		
Open bush: Nama-Karoo		
Open bush: Succulent Karoo		
Grasslands	Grasslands	Grassland
Grasslands: Fynbos		
Grasslands: Nama-Karoo		
Grasslands: Succulent Karoo		
Low shrubland	Low shrubland	
Low shrubland: Fynbos		
Low shrubland: Nama-Karoo		
Low shrubland: Succulent Karoo		
Degraded	Degraded	
Bare ground	Bare ground	Other land
Bare ground: Fynbos		
Bare ground: Nama-Karoo		
Bare ground: Succulent Karoo		
Cultivated commercial annual: non-pivot	Cultivated commercial annual: non-pivot	Cropland
Cultivated commercial annual: pivot	Cultivated commercial annual: pivot	
Cultivated commercial permanent orchards	Cultivated commercial permanent orchards	
Cultivated commercial permanent vines	Cultivated commercial permanent vines	
Cultivated subsistence crops	Cultivated subsistence crops	
Settlements	Settlements	Settlements
Mines	Mines	
Waterbodies	Waterbodies	Wetlands
Wetlands	Wetlands	

Table 2.17:
SUMMARY OF METHODS AND EMISSION FACTORS FOR THE AFOLU SECTOR AND AN ASSESSMENT OF THE COMPLETENESS OF THE AFOLU SECTOR EMISSIONS.

GHG Source & Sink Category 3A LIVESTOCK	CO_2		CH_4		N_2O		DETAILS
	Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor	
1 ENTERIC FERMENTATION							
a.i. Dairy cattle	NA		T2	CS	NA		CS EF for CH_4 and N_2O from Du Toit et al. (2013a- c) were applied for all indicated livestock. Buffalo and wild game are not considered to be managed, therefore, not included in the emission estimates.
a.ii. Other cattle	NA		T2	CS	NA		
b. Buffalo	NA		NO		NA		
c. Sheep	NA		T2	CS	NA		
d. Goats	NA		T2	CS	NA		
e. Camels	NA		NO	NO	NA		
f. Horses	NA		T1	DF	NA		
g. Mules and asses	NA		T1	DF	NA		
h. Swine	NA		T2	CS	NA		
j. Other	NA		NO		NO		
2 MANURE MANAGEMENT							
a.i. Dairy cattle	**NA**		**T2**	**CS**	**T2**	**DF**	CS EF for CH_4 and N_2O from Du Toit et al. (2013a) were applied.
a.ii. Other cattle	**NA**		**T2**	**CS**	**T2**	**DF**	
b. Buffalo	**NA**		**NO**		**NO**		Buffalo are not considered to be managed, therefore, not included in emission estimates.
c. Sheep	**NA**		**T2**	**CS**	**NO**		CS EF for CH_4 from Du Toit et al. (2013b) were applied.
d. Goats	**NA**		**T2**	**CS**	**NO**		
e. Camels	**NA**		**NO**		**NO**		
f. Horses	**NA**		**T1**	**DF**	**NO**		
g. Mules and asses	**NA**		**T1**	**DF**	**NO**		
h. Swine	**NA**		**T2**	**CS**	**T2**	**DF**	CS EF for CH_4 from Du Toit et al. (2013b- c) were applied.
i. Poultry	**NA**		**T2**	**CS**	**T2**	**DF**	
j. Other	**NA**		**NO**		**NO**		Wild game not considered to be managed, therefore, excluded from emission estimates.

T1- T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not Applicable

Table 2.17:

SUMMARY OF METHODS AND EMISSION FACTORS FOR THE AFOLU SECTOR AND AN ASSESSMENT OF THE COMPLETENESS OF THE AFOLU SECTOR EMISSIONS.

GHG Source & Sink Category 3B LAND	CO_2		CH_4		N_2O		DETAILS
	Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor	
1 FOREST LAND							
a. Forest land remaining forest land	Biomass: T2	Biomass: CS	NE		NE		CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE		NE		CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T1	Soil: DF	NE		NE		Mineral soils (MS) only, organic soils (OS) NE.
b. Land converted to forest land	Biomass: T2	Biomass: CS	NE		NE		CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE		NE		CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T1	Soil: DF	NE		NE		MS only, OS NE.
2 CROPLAND							
a. Cropland remaining cropland	Biomass: T2	Biomass: CS	NE		NE		CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE		NE		CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T1	Soil: DF	NE		NE		MS only, OS NE.
b. Land converted to cropland	Biomass: T2	Biomass: CS	NE		NE		CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE		NE		CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T2	Soil: DF, CS	NE		NE		CS stock change factors were applied.

T1- T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not Applicable

GHG Source & Sink Category 3B LAND	CO_2		CH_4		N_2O		DETAILS
	Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor	
3 GRASSLAND							
a. Grassland remaining grassland	Biomass: T2	Biomass: CS	NE	NE			CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE	NE			CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T1	Soil: DF	NE	NE			MS only, OS NE.
b. Land converted to grassland	Biomass: T2	Biomass: CS	NE	NE			CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE	NE			CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T1	Soil: DF	NE	NE			MS only, OS NE.
4 WETLAND							
a. Wetland remaining wetland	NE		T1	DF	NE		
b. Land converted to wetland	NE		NE		NE		
5 SETTLEMENTS							
a. Settlements remaining settlements	Biomass: T2	Biomass: CS	NE		NE		CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE		NE		CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T1	Soil: DF	NE		NE		MS only, OS NE.
b. Land converted to settlements	Biomass: T2	Biomass: CS	NE		NE		CS activity data and EF are applied (see data sources table).
	DOM: T2	DOM: CS	NE		NE		CS DOM stocks are utilised from NTCSA (DEA, 2014).
	Soil: T1	Soil: DF	NE		NE		MS only, OS NE.
6 OTHER LAND							
a. Other land remaining other land	Biomass: NE		NE		NE		
	Soil: T1	Soil: DF	NE		NE		
b. Land converted to other land	Biomass: T2	Biomass: CS	NE		NE		CS activity data and EF are applied (see data sources table).
	Soil: T1	Soil: DF	NE		NE		MS only, OS NE.

T1- T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not Applicable

Table 2.17:

SUMMARY OF METHODS AND EMISSION FACTORS FOR THE AFOLU SECTOR AND AN ASSESSMENT OF THE COMPLETENESS OF THE AFOLU SECTOR EMISSIONS.

GHG Source & Sink Category 3C AGGREGATED SOURCES & NON-CO_2 EMISSIONS ON LAND	CO_2		CH_4		N_2O		DETAILS
	Method Applied	Emission Factor	Method Applied	Emission Factor	Method Applied	Emission Factor	
1 BIOMASS BURNING	T2	DF, CS	T2	DF, CS	T2	DF, CS	CS Mb, Cf and EF for savannas and croplands were applied (DEAT, 2009; DAFF, 2010).
2 LIMING	T1	DF	NA		NA		
3 UREA APPLICATION	T1	DF	NA		NA		
4 DIRECT EMISSIONS FROM MANAGED SOILS							
Synthetic fertilisers	NA		NA		T1	DF	
Animal waste added to soils	NA		NA		T1, T2	DF	CS manure management data was applied (Du Toit et al., 2013a- d; Moeletsi et al., 2015).
Other organic fertilisers	NA		NA		T1	DF	
Urine and dung deposited by grazing livestock	NA		NA		T1, T2	DF	
Crop residues	NA		NA		T1	DF	
5 INDIRECT EMISSIONS FROM MANAGED SOILS							
Atmospheric deposition	NA		NA		T1	DF	
Nitrogen leaching and runoff	NA		NA		T1	DF	
6 INDIRECT EMISSIONS FROM MANURE MANAGEMENT							
Volatilisation	NA		NA		T1	DF	
Nitrogen leaching and runoff	NA		NA		T1	DF	
7 RICE CULTIVATION	NO		NO		NO		
3D OTHER							
1 HARVESTED WOOD PRODUCTS	T2	DF	NA		NA		
2 OTHER	NO		NA		NA		

T1- T3 = Tier method 1, 2 or 3; DF = IPCC default emission factor; CS = Country specific emission factor; NE = Not estimated; NO = Not occurring; NA = Not Applicable

2.8.3.4. Recalculations

The AFOLU sector is under continual improvement which leads to recalculations. As in the previous 2015 Inventory, significant changes have been made to this sector. The improvements and their contribution to total change in the 2015 estimates are provided in Table 2.18.

Table 2.18:
AFOLU IMPROVEMENTS AND THEIR CONTRIBUTION TO THE TOTAL CHANGE COMPARED TO THE PREVIOUS SUBMISSION (2015).

Sub-category	Improvement / Update	Change Gg CO_2e	Change in category emissions (%)
Enteric Fermentation	Changed ratio of dairy cows to heifers; Adjusted herd composition for cattle; Removed game emissions.	-325.6	-4.3
Manure Management (CH_4)	Adjusted herd composition for cattle; Updated manure management data.	70.1	0.9
Manure Management (N_2O)	Adjusted herd composition for cattle; Updated manure management data; Used country specific N excretion rates for poultry and swine.	589.8	7.8
Forest Land	Area adjustment for 20-year transition; Updated biomass, litter and soil ref data; Updated wood removal data; Used annual burnt area data instead of 5-year averages.	10 875.6	143.1
Cropland	Area adjustment for 20-year transition; Updated biomass, litter and soil ref data; Updated stock change factors; Improved disturbance data.	-1 975.8	-26.0
Grassland	Area adjustment for 20-year transition; Degraded land class area incorporated; Updated biomass, litter and soil ref data; Improved disturbance data.	-12 280.8	-161.6
Wetland	Updated CH_4 emission factor.	31.6	0.4
Settlements	Area adjustment for 20-year transition; Updated biomass, litter and soil ref data; Improved disturbance data.	-3 151.5	-41.5
Other Lands	Area adjustment for 20-year transition; Removal of degraded class area; Included Tier 1 assumption that soil carbon becomes zero after 20 years.	11 142.2	146.6
Biomass Burning	Updated land areas with 20-year transition; Removed assumption that forests and thickets don't burn; Improved burnt area data; Used annual burnt area instead of 5-year average; Updated fuel load and combustion factor data.	-84.2	-1.1
Liming	Used new lime consumption data source.	323.1	4.3
Direct N_2O from managed soils	Adjusted herd composition data for cattle; Updated manure management data; Improved crop residue calculations; Updated inorganic N data; Excluded sewage sludge N input due to double counting; Included FSOM* N_2O emissions.	2 461.1	32.4
Indirect N_2O from managed soils	Adjusted herd composition data for cattle; Updated manure management data; Improved crop residue calculations.	49.9	0.7
Indirect N_2O from manure management	Adjusted herd composition for cattle; Updated manure management data; Country specific N excretion rates for poultry, swine, horses, mules and asses.	-175.9	-2.3
Harvested Wood Products	Updated import and export data from FAOStat.	51.8	0.7
TOTAL CHANGE (INCL. FOLU)		**7 601.3**	**100.0**

*FSOM = amount of N in mineral soils that is mineralised, in association with loss of soil carbon from soil organic matter as a result of changes to land use or management.

The recalculations led to a 1.3% lower emission estimate for Livestock compared to the previous Inventory, while the recalculations to the Aggregated and non-CO_2 emissions on land led to a 12.1% higher estimate than in the previous submission. The Land category recalculations produced a sink estimate that was 17.1% lower than the previous 2015 estimate (see Figure 5.2 in the NIR2017). Recalculations for HWP produced a 7.8% decrease in the sink estimate for 2015, but like the Land category, there were annual fluctuations. Overall, the recalculations for the AFOLU sector excluding FOLU showed a 4.6% increase in emission estimates for 2015, while the AFOLU sector including FOLU were 36.1% higher than in the previous submission for the year 2015.

2.8.3.5. Planned improvements

There are several needs and improvements which are required to improve the estimates in the AFOLU sector. For the Livestock category it is planned that over the next two Inventory cycles the background data and calculations of the Enteric fermentation emission factors will be incorporated into the calculation files. Initially the cattle data will be included (since this is a key category), followed by the other livestock. This will enable adjustments to the various components of the calculations to be made as new data becomes available. For the Land category the planned improvements are:

(i) Incorporate the recently released 2018 land cover/land use data and update land changes for 2015 to 2019. In addition, a more detailed assessment of the assumptions and land change areas will be conducted.
(ii) In the next Inventory any relevant data for organic soils will be incorporated from the study completed by the DFFE.
(iii) Incorporate CO_2 emissions and removals from wetlands. The methodology in the new 2013 wetland supplement (IPCC, 2014) and 2006 refinement will be considered. The 2013 supplement was considered for the CH_4 emission estimates in this Inventory but the emission factor of 235kg ha^{-1} yr^{-1} for mineral soils in temperate climates is very much higher than the previous emission factor of 16.06 kg ha^{-1} yr^{-1}. This new emission factor is in line with a study done in South Africa (Otter et al., 2000), however, there was insufficient time to do a proper assessment of the new guidelines and do a validation of the higher emission outputs for wetlands for this submission.
(iv) Carbon stock data for all land types will be updated with information from the Terrestrial Carbon Sinks Assessment update that is currently underway, including an update of soil stock change factors.
(v) Undertake an assessment of crop area estimates and crop type classifications to obtain improved crop area estimates for all crop types.
(vi) Update HWP to incorporate country-specific information.
(vii) Include a more detailed uncertainty analysis for land.
(viii) Include the full time-series from 1990–2021 in the 1st BTR.

2.8.4. Waste

Among the sectors that contribute to the increasing quantities of GHGs into the atmosphere is the Waste sector. This section highlights the GHG emissions into the atmosphere from managed landfills, open burning of waste and wastewater treatment systems in South Africa, estimated using the IPCC 2006 Guidelines.

The waste sector in the national Inventory of South Africa comprises three sources:

(i) 4A Solid waste disposal.
(ii) 4C Incineration and open burning of waste (only open burning of waste is estimated).
(iii) 4D Wastewater treatment and discharge.

For completeness in this sector, emissions from Incineration and Biological treatment of organic waste still need to be addressed.

2.8.4.1. Trends

In 2017 the Waste sector produced 21 249 Gg CO_2e or 3.8% of South Africa's GHG emissions (excl. FOLU). The largest source category was Solid waste disposal which contributed 81.7% towards the total sector emissions (Table 2.19). This was followed by Wastewater treatment and discharge which contributed 16.6%.

Waste sector emissions have increased by 56.7% from the 13 558 Gg CO_2e in 2000. Emissions increased steadily between 2000 and 2017 (Figure 2.16). Solid waste disposal was the main contributor (average of 80.2%) to these emissions. Emissions from Solid waste disposal increased by 64.8% (6 832 Gg CO_2e) since 2000 (10 534 Gg CO_2e), while emissions from Incineration and open burning of waste and Wastewater treatment and discharge each increased by 28.4% over this period.

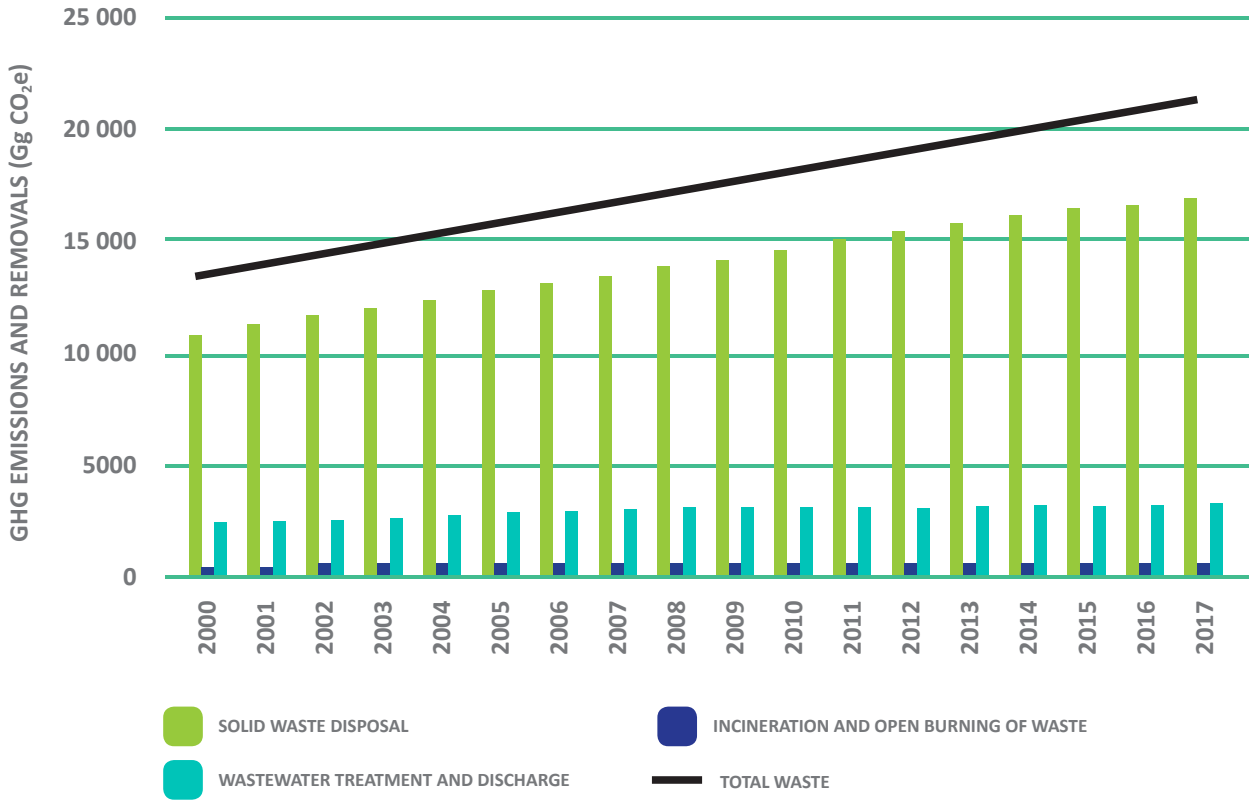
The contribution from the Waste sector to the national emissions (excl. FOLU) increased from 3.0% in 2000 to 3.8% in 2017.

The Waste sectoral summary sheet in Appendix 6.A of the NIR2017 provides further details.

Table 2.19:
SUMMARY OF THE ESTIMATED EMISSIONS FROM THE WASTE SECTOR IN 2017.

Greenhouse Gas Source Categories	CO_2 Gg CO_2e	CH_4 Gg CH_4	N_2O Gg N_2O	Total Waste Sector Gg CO_2e
4. WASTE	37.5	20 359.9	851.6	21 249.0
4A Solid Waste Disposal	NA	17 366.0	NA	17 366.0
4B Biological Treatment of Solid Waste	NE	NE	NE	NE
4C Incineration and Open Burning of Waste	33.5	240.7	82	360.2
4D Wastewater Treatment and Discharge	NA	2 753.3	769.6	3 522.8

Figure 2.16:
TREND IN EMISSIONS FROM WASTE SECTOR, 2000 - 2017.



2.8.4.2. Methods and data

The emissions for the Waste sector were derived by either using available data or estimates based on accessible surrogate data sourced from the scientific literature. Table 2.20 shows the methods and emission factors applied in this sector. For the waste sector, among the chief limitations of quantifying the GHG emissions from different waste streams was the lack of a periodically updated national inventory data on: the quantities of organic waste deposited in well-managed landfills; the annual recovery of methane from landfills; quantities generated from anaerobically decomposed organic matter from wastewater treated; and per capita annual protein consumption in South Africa.

The methodology for calculating GHG emissions from solid waste is consistent with the IPCC tier 1 First Order Decay (FOD) Model (IPCC, 2006).

Input data includes population data (StatsSA, 2015), waste generation rates, GDP, annual waste generation, population growth rates, emission rates, half-lives of bulk waste stream (default value for the half-life is 14 years), rate constants, methane correction factor (MCF), degradable carbon fraction (DCF), as well as other factors described in the IPPC Guidelines, Volume 5, Chapter (IPPC, 2006). Data sources are provided in Table 6.5 of the NIR2017. Notably, due to a lack of published specific-activity data for many of these parameters in South Africa, the default values suggested in the IPCC Guidelines were applied. A Tier 1 approach, with default IPCC 2006 emission factors, was applied in the calculation of CO_2, CH_4 and N_2O emissions from open burning and wastewater CH_4 emissions. Further details are provided in Chapter 6 of the NIR2017.

Table 2.20:
SUMMARY OF METHODS AND EMISSION FACTORS FOR THE WASTE SECTOR.

GHG Source & 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			T1	DF			Tier 1 FOD Model was used
1 Managed waste disposal sites	NA		IE		NA		Included in aggregated Solid Waste Disposal Estimates
2 Unmanaged waste disposal sites	NA		IE		NA		
3 Uncategorised waste disposal sites	NA		IE		NA		
B - BIOLOGICAL TREATMENT OF SOLID WASTE	NE		NE		NE		
C - INCINERATION AND OPEN BURNING OF WASTE							
1 Waste incineration	NE		NE		NE		
2 Open burning of waste	T1	DF	T1	DF	T1	DF	
D - WASTEWATER TREATMENT AND DISCHARGE	NA		T1	DF	T1	DF	
1 Domestic wastewater treatment and discharge			IE		IE		Included in aggregated Wastewater Treatment and Discharge Estimates
2 Industrial wastewater treatment and discharge			IE		IE		
E - OTHER	NO		NO		NO		

2.8.4.3. Recalculations

Recalculations were performed for the category Solid waste disposal for all years between 2000 and 2017 due to the following changes:

(i) The population, waste per capita and the percentage of waste going to solid waste disposal sites was corrected in the FOD model for the years 1950 to 2000. In the previous submission these numbers were only input for the years from 2000 onwards, while default values were left for the years prior to this.
(ii) The fraction of methane in developed gas was previously indicated to be 0.52 and this was corrected to the IPCC default value of 0.5.

The recalculation of the Solid waste disposal emissions produced outputs that were 34.8% higher than the previous submission for 2000, and this declined to a 5.2% increase in the recalculated 2015 estimate. Overall, the current recalculated estimates for Waste were 25.1% higher for 2000 and 4.2% higher 2015.

2.8.4.4. Planned improvements

The most challenging task in estimating GHG emissions in South Africa was the lack of specific-activity and emissions factor data. As a result, estimations of GHG emissions from both solid waste and wastewater sources were largely computed using default values suggested in IPCC 2006 Guidelines and, as a consequence, margins of error were large.

The DFFE has recently undertaken a study to collect actual activity data for this category for the period 2000 – 2017 for the waste streams listed below:

- activity data collection for solid waste disposal in South Africa
- activity data collection for wastewater treatment in South Africa
- activity data collection for waste incineration and open- burning of waste
- activity data collection for biological treatment of solid waste

This data is currently being used to recalculate emissions from the waste sector for the entire time series and will be reported in the 2000 – 2019 GHG inventory.

South Africa has identified the following areas to be considered in the improvement plan for the future:

(i) Obtain data on the quantities of waste disposed of into managed and unmanaged landfills.
(ii) Improve the methane correction factor and rate constants.
(iii) 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.
(iv) Obtain information on population distribution trends between rural and urban settlements as a function of income.
(v) Conduct a study to trace waste streams and obtain more information on the bucket system which is still widely used in South Africa.
(vi) It is planned that by the 1st BTR the time-series will be starting from 1990 and extending to 2021.

3. MITIGATION ACTIONS AND THEIR EFFECTS

3.1. INTRODUCTION

South Africa has committed to a low carbon trajectory that encompasses both its contribution to the international effort to reduce global greenhouse gas (GHG) emissions; and its ambitions toward development and poverty eradication (DEA, 2011a). The "peak, plateau and decline (PPD) trajectory" is used as a benchmark against which South Africa mitigation efforts are measured. In summary PPD:

- GHG emissions will peak in the period 2020 to 2025 in a range with a lower limit of 398 million tonnes of carbon dioxide equivalent (Mt CO_2-eq) and upper limits of 583 Mt CO_2-eq and 614 Mt CO_2-eq for 2020 and 2025 respectively.
- GHG emissions will plateau for up to ten years after the peak, within the range with a lower limit of 398 Mt CO_2-eq and upper limit of 614 Mt CO_2-eq.
- From 2036 onwards, emissions will decline in absolute terms to a range with lower limit of 212 Mt CO_2-eq and upper limit of 428 Mt CO_2-eq by 2050.

In line with the PPD, South Africa has pronounced the National Determined Contribution under the Paris agreement, i.e. national emissions in 2025 and 2030 will be limited to a range.

3.2. MITIGATION POLICY CONTEXT AND IMPLEMENTATION FRAMEWORK

South Africa has expressed its commitment to limit the average global temperature increase to below a maximum of 2°C above pre-industrial levels, recognising the need to ensure that such agreements are inclusive, fair and effective. The DFFE is responsible for the development and implementation of South Africa's climate change mitigation response. Some of the key policies that drive the climate change response are outlined below.

3.2.1. Driving Policies for Climate Change

3.2.1.1. 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.

3.2.1.2. National Climate Change Response Policy

The National Climate Change Response Policy (NCCRP) was approved by Cabinet in October 2011 (DEA, 2011a). This set out an overall climate change policy framework for South Africa. 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 NCCRP presents the government's vision for an effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society. The objectives of the policy are to (a) effectively manage inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity, and (b) make 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).

3.2.1.3. Climate Change Bill

In June 2018, South Africa released a draft National Climate Change Bill (DEA, 2018b) for public consultation and this is now in the advanced stages of being legislated. This bill, once approved by Cabinet, will provide 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. The Climate Change Bill addresses issues related to institutional and coordination arrangements across the three spheres of government, namely national, provincial and local. In terms of the mitigation system, the bill 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 time period. Carbon budgets will be developed to specifically cover industry and the threshold to be published by the Minister.

3.2.2. Tracking Mitigation Impacts

3.2.2.1. National emissions trajectory

The national emissions trajectory (DEA, 2011b) serves as the benchmark against which South Africa's GHG emission reduction performance will be measured. It also informs South Africa's international obligations. A broad range of structural changes will be necessary to ensure that the South African economy achieves a just transition to aclimate-resilient and low carbon economy and society. This requires assessing the current situation of the country and aligning development with climate goals through reliable data and analysis, for which collaboration with experts is necessary.

3.2.2.2. Low Emissions Development Strategy

Article 4.19 of the Paris Agreement calls on signatories to formulate and communicate long-term low GHG emission development strategies (LEDS), and the Conference of Parties Decision 1/CP.21, paragraph 35, invites parties to communicate the LEDS by 2020. Cabinet approved South Africa's Low Emissions Development Strategy (LEDS) on 9 September 2020 and the LEDS was submitted to the UNFCCC. The Strategy sets out a direction for South Africa as it

refines its low carbon emission development pathway to meet its commitments to the international community and address developmental agenda/priorities and needs. South Africa acknowledges that successful implementation will require decades of dedicated effort. Therefore, this Strategy is a living document, the beginning of the journey towards ultimately reaching a net-zero CO_2 economy by 2050. This involves three concrete actions implementation phases which must be carried out by a certain time, to also enable other action:

- Starting Right (to be completed prior to the end of the 2021 financial year): Focuses on actions relating to the current government administration. The most important aspect of this stage is to ensure that a true transition is kicked off. Avoiding decisions that will lead to emissions lock-in is thus a core priority of the "Starting Right" stage.
- Turning the Corner (to begin in parallel with the Starting Right stage and continue to 2025): Implementation of this phase will begin in parallel with the "Starting Right" stage, where appropriate, and continue to 2025. This period is decisive since within it new decision and investment criteria are broadly applied, bringing about changes to the day-to-day operation of many sectors of the economy at the same time. Resistance to change can become challenging if not managed appropriately, and must be anticipated and addressed with social acceptance and just transition actions. It is at this stage that multiple policies will need to work in concert for the new technological options to make economic sense for businesses and consumers. An overall understanding of the sectoral narratives of change and how they collectively feed into the national vision will be core to the success of this stage.
- Massive Rollout (2025 to 2050): This is the final phase, in which low-emissions climate-resilient option have become the new normal. The constant application of transformative action will drive large volumes of investment towards transformational change. Perseverance on the application of all aspects of change will be required to avoid imbalances or injustices which will compromise the change, and sectors that achieve important milestones must not be allowed to become complacent, but rather contribute to the broader change by supporting areas of natural synergy.

3.3. OVERARCHING MITIGATION POLICIES TO SUPPORT IMPLEMENTATION

3.3.1. National GHG Emission Reporting Regulations and Pollution Prevention Plans

In the previous BUR (DEA, 2019a), the gazetted NGERs and how these pertain to the declaration of GHGs as priority air pollutants (DEA, 2016) were discussed. Paragraph 3 (1) of the Notice, declaring GHGs as priority air pollutants, requires the submission of Pollution Prevention Plans (PPPs) by persons conducting a production process set out in Annexure A to the Notice, which involves emission of GHGs in excess of 0.1 Megatonnes (Mt) annually, reported as carbon dioxide equivalents (CO_2e). A PPP is also required of persons undertaking a production process listed in Annexure A as a primary activity.

Regulation 4(1) of the National Pollution Prevention Plans Regulations (DEA, 2017c) states that a person must submit a first PPP to the Minister within five months from the date of promulgation of the regulations, and a subsequent PPP must be submitted within five months of the existing plans being reconciled (DEA, 2018c). Due to business requests to extend the submission date of PPPs, the Minister published the extension for the submission of PPPs to 21 June 2018.

Guidelines for the development of pollution prevention plans in respect of GHG's have been developed (DEA, 2018c). These guidelines assist a person submitting a pollution prevention plan to understand the process for submission and approval of the pollution prevention plans and annual progress reports. These annual reports, importantly, also require the description of any deviation from the approved PPP and any remedial actions that were taken. The implementation of these approved plans is monitored through annual progress reports for the preceding calendar year, submitted to the Minister by 31 March each year. The first PPP cycle 2016-2020 ended on 31 December 2020, and the subsequent submissions for the period 2021 to 2025 was due for companies' submission by 31 May 2021. Progress was made on the implementation of the National Pollution Prevention Plans (PPPs) Regulations. Successes were also made towards gathering data and understanding of mitigation measures put forward and implemented by companies towards the national climate change mitigation efforts. By 31 March 2020, the Department had received thirty-nine (39) PPPs submissions from companies.The Department was able to process the submitted PPPs and the PPP annual progress reports within regulated timelines as per the delegated powers. Through this programme, it is estimated that about 17 Mt (CO_2e) is potentially mitigated.

3.3.2. Carbon Tax Act

The BUR3 reported on the impending implementation of the draft Carbon Tax Bill that was released for public comment in 2015 (National Treasury, 2015) and that was under a process of stakeholder consultation. Two iterations of the Bill were published for public comment, and some amendments were made, which included:

- The percentages of allowances in respect of some activities were amended.
- Section 14 now provides for a maximum of 100% allowance where stipulated in Schedule 2, and where a 100% allowance is not available, the maximum sum of allowances applied is 95%.

On 1 June 2019, the Carbon Tax Act came into effect (Act No. 15 of 2019). Carbon tax is being implemented in phases with the first phase being 1 June 2019 to December 2022. Upon implementation in 2019, the carbon tax levy was set at a rate of R120 per ton of CO_2e of GHG emitted by a taxpayer. During the first phase the rate of R120 per ton is being adjusted each year by the consumer price index (CPI) plus 2%. Thereafter, it will increase annually by CPI. A taxpayer is liable to pay tax should they undertake an activity which exceeds the threshold for the activity listed in Schedule 2 of the Act. Tax can be reduced by using the various allowances provided in respect of each activity (such as trade exposure allowances, carbon offset allowances, performance allowances and carbon budget allowances) which are provided in Schedule 2 of the Act. The carbon tax is levied in terms of Section 54A of the Customs and Excise Act (Act No. 91 of 1964) as an environmental levy. The carbon tax is paid to, and administered by, the South African Revenue Service (SARS).

The Carbon Tax Act was amended in the 2020 Taxation Laws Amendment Act, Act 34 of 2019, to incorporate technical corrections on the calculation of the GHG emissions tax base as well as to the allowance mechanisms. Further amendments in the 2020 Taxation Laws Amendment Act, Act No 23 of 2020, provide an additional deduction for petroleum refiners for the production of petrol, of which the sale price is regulated in South Africa.

3.3.2.1. Carbon Offset Regulations

In terms of section 19(c) of the Carbon Tax Act there is a provision for the development of the Carbon Offset Regulations, which were gazetted on 29 November 2019 (National Treasury, 2019c). The Carbon Offset Regulations were gazetted after extensive consultations on the Carbon Offsets Paper of 2014, 1st Draft Carbon Offset Regulations which were

published in June 2016, and 2nd Draft Regulations published in November 2018, followed by a stakeholder workshop held in March 2019 for clarification of comments and finalisation of the Regulations. The Regulations outline the eligibility criteria for offset projects and set out the procedure for claiming the offset allowance. The following main amendments were made to the gazetted Regulations:

- Inclusion of renewable energy:
  - Small-scale renewable energy projects up to 15MW for both Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) and non-REIPPPP projects are eligible as carbon offsets.
  - Projects greater than 15MW, REIPPPP projects from the third bidding window and non-REIPPPP projects, except for technologies with a cost less than R1.09 / kWh, will be eligible as carbon offsets.
- Eligibility of energy efficiency projects:
  - Stakeholders were of the view that some electrical efficiency and on-site co-generation projects should be eligible as offsets as they reduce indirect (scope 2) and not direct (scope 1) emissions covered by the tax, thereby improving efficiency. The Regulation was amended to only allow electrical efficiency and co-generation projects which "do not co-produce useful thermal energy implemented on activities that are covered by the carbon tax resulting in reduced fuel consumption" as eligible offsets.
- Clarification of eligible projects and the use of credits generated prior to the implementation of the carbon tax:
  - Projects and offsets issued for a specific monitoring period up to 31 May 2019 will be eligible for offsets.
  - Project activities that are covered under the carbon tax with these offsets must be used within the first phase of the carbon tax (up to Dec 2022), except for qualifying renewable energy projects the first phase of the carbon tax (up to Dec 2022), except for qualifying renewable energy projects.
  - For project activities not covered by the carbon tax in the first phase, these offsets can be used until the end of the crediting period as stipulated under the relevant carbon standard.

The Carbon Offset Administration System seeks to encourage GHG emission reductions in sectors or activities not directly covered by the tax and provide flexibility for taxable entities to access GHG mitigation options at a lower cost than investment in their current operations. Investments in public transport, agriculture, forestry and other land use (AFOLU) and waste sectors are likely to qualify. Carbon offsets involve specific projects or activities that reduce, avoid, or sequester emissions, and are developed and evaluated under specific methodologies and standards, which enable the issuance of carbon credits.

During the first phase of the carbon tax, carbon offset projects developed under existing international standards, such as the Clean Development Mechanism (CDM), Verified Carbon Standard (VCS) and the Gold Standard (GS), will be eligible for use by companies to reduce their carbon tax liability. Scope is also given for approved domestic South African standards, to be utilised in subsequent phases of the carbon tax. The Designated National Authority, residing within the Clean Energy Branch of the Department of Mineral Resources and Energy (DMRE), which was established to support the development and implementation of CDM projects under the Kyoto Protocol of the UNFCCC, will be responsible for administering the carbon offset scheme.

Carbon offset projects will also generate sustainable development benefits and employment opportunities in South Africa by encouraging investments in energy efficiency and renewable energy, rural development projects, and initiatives aimed at restoring landscapes, reducing land degradation and biodiversity protection. Because carbon offset projects are localised, e.g., municipal waste to energy projects,

transport energy efficiency, public transport etc., the potential employment and development benefits accrue to local communities. The carbon offset mechanism can, therefore, be a means to facilitate creation of decentralised and sustainable urban and rural economies.

The DMRE is in the process of developing a Carbon Offset Administration System and this is discussed in the MRV chapter (section 6.3.3.2).

3.3.2.2. Carbon sequestration in the Carbon Tax Act

The Carbon Tax Act provides information on the quantification of the various components of the tax equation; however, the sequestration component ('S' in the equation) is more complex and is not fully defined in the Carbon Tax Act. Carbon sequestration allows companies to reduce their tax liability through carbon storage. Effective rules and modalities for the quantification of sequestration are being developed by the DFFE. A project, currently being finalised by the DFFE, provides a Rulebook for accounting of forest plantations and the timber processing industry GHG emissions and removals (Sequestration) under the Carbon Tax Act. These rules cover the activities of afforestation, deforestation and forest management, and include rules for the inclusion of harvested wood products using a mass-balance approach. In addition to the Rulebook, a Methodological Guideline and reporting templates are being finalised.

3.3.2.3. Trade Exposure Allowance Regulations

In December 2019, Draft Regulations for Trade Exposure Allowance were proposed in terms of section 10 of the Carbon Tax Act and were published for public comment (National Treasury, 2019a). On Friday, 19 June 2020, the Regulations in terms of Section 19(b) for purposes of Section 10 for the Trade Exposure Allowance was gazetted (National Treasury, 2020a). These Regulations provide a list of sectors and sub-sectors and their respective trade exposure allowances. It also provides an alternative approach for the determination of the allowance for all affected companies.

3.3.2.4. GHG Emission Intensity Benchmark Regulations

Benchmark proposals for the liquid fuels, gas and coal to liquid fuels, mining, cement, iron and steel, paper and pulp, ferroalloys, titanium, chemicals, sugar and clay brick sectors were developed between 2016 and 2019. This information was incorporated into the Draft GHG Emissions Intensity Benchmark Regulations (National Treasury, 2019b). These Regulations, which support the Carbon Tax Act, were published for public comment in December 2019 and gazetted in June 2020 (National Treasury, 2020b). These Regulations provide for the determination of the emissions intensity benchmark a taxpayer must use based on the sector/subsector and the related benchmark value.

3.3.2.5. Renewable Energy Premium

In terms of Section 6(2)(c) of the Carbon Tax Act, taxpayers whose main activity is electricity generation from fossil fuels can offset the costs of purchasing renewable energy (the renewable energy premium), either under the REIPPPP or from non-REIPPPP projects, against their carbon tax liability. The Notice for the Renewable Energy Premium gazetted in June 2020 (National Treasury, 2020c) provides the quantity of the allowance.

3.4. OTHER PROGRAMMES

3.4.1. Carbon Budgets

The NCCRP calls for a carbon budgeting process as part of the policy measures to reduce greenhouse gas emissions in the country in alignment with the overall national goal, for a long-term emissions trajectory range for the whole economy to 'peak, plateau and decline'. The Phase I carbon budget process is voluntary as there is no legal basis to set emission limits for sectors or companies. It covers the period 2016 to 2020 and uses a bottom-up approach to allocating carbon budgets. It is set out as a pilot to prepare for the implementation of a future mandatory phase of carbon budgets. The phase I Carbon Tax design includes a 5% tax free allowance for companies participating in the carbon budget process. Thus companies that have been allocated carbon budget are eligible for the 5% reduction in carbon tax liability.

3.5. SECTORAL MITIGATION POLICIES AND MEASURES

The sectoral policies and measures (PAMs) are here defined as policy instruments implemented by government and applied across the economy, over a wide range of sectors, in order to help South Africa achieve its emission reduction goals. The PAMs may include regulatory instruments (specifically legislation, regulations and standards), economic instruments (for example, incentives and taxes), government procurement programmes or direct investment by government. These may be cross-cutting (across more than one sector) or specific to individual sectors or subsectors, and may achieve abatement through action by government or induce action by others. Many government departments and agencies, cities and provinces, are already implementing measures which have mitigation as a goal (for instance the emissions constraint in the Integrated Resource Plan (DoE, 2019)), or have significant mitigation benefits (for instance energy efficiency measures and the extension of efficient public transport, such as bus rapid transit systems).

3.5.1. Energy

Table 3.1 presents a list of mitigation actions for the energy sector. The main policies in this sector are the Integrated Resource Plan, the National Energy Efficiency Strategy, the Green Transport Strategy and the National Land Transport Act. The Carbon Tax, Carbon Budgets and Pollution Prevention Plans also impact this sector, but these policies are discussed under section 3.3. The overarching quantitative goals of the National Energy Efficiency Strategy informs progress of PAMs related to improving efficiencies in energy usage. The overarching quantitative goals of the Integrated Resource Plan (DoE, 2019) informs progress of PAMs related to improving sustainable energy supply and demand. As such where no quantitative goals are mentioned for a PAM, the goals of the key policy driver should be referred to.

Table 3.1:
DOMESTIC MITIGATION ACTIONS IN THE ENERGY SECTOR.

NAME OF ACTION	12L tax incentive programme

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Improve uptake of lower carbon technologies / initiatives to reduce greenhouse gas emissions in the industrial and commercial sectors and to stimulate job creation in the green economy.	The tax incentive aims to encourage the efficient utilisation of energy in an effort to combat the adverse effects of greenhouse gas emissions related to fossil fuel-based energy use on climate change. 12L provides for a 95c per verified kWh (or kWh equivalent) of energy efficiency savings, that has been signed off by the monitoring and verification body and has been approved by the SANEDI 12L evaluation panel for the assessment year in question. The tax incentive is applicable for a period of 12 months of savings.	Public tax incentive	South African National Energy Development Institute (SANEDI)	CO_2 Energy sector	The 12L tax incentive does not set any quantitative goals, however it is hoped that the number of applicants can be doubled during the extension period from 2020 to 2022. The 12L tax incentive programme can contribute to the targets set out in the Post-2015 NEES industry and mining targets: (a) 16% reduction in the weighted mean specific consumption of manufacturing by 2030 relative to 2015 baseline; (b) 40 PJ cumulative annual savings from energy efficient interventions in mining. (2016, DMRE)	Ongoing - 2013- 2022 The incentive was promulgated 1st of November 2013 and was claimable until the 1st of January 2020. In 2015 amendments were made and the minister announced the increase from 45c/kWh to 95c/kWh increase of the incentive. Further to the changes, initially only waste heat recovery was claimable as savings in co-generation, but now co-generation in terms of combined heat and power are also claimable. The tax incentive has now been extended until 31 December 2022.	kWh savings; Reduction of CO_2 through the efficient use of energy	No calculations were conducted on the primary data received from SANEDI. The $kgCO_2e$ saved by each project was provided directly by SANEDI. These values consider the various energy carriers present in the projects. The SANEDI emission data sets are based on information provided by claimants which is assured by an accredited entity. The process is initiated by the compilation and submission of a baseline benchmarking model and report to SANEDI for approval, which outlines the business as usual scenario in which the energy saving measure would not have been implemented. Once the baseline is approved, the energy performance assessment report must be compiled which demonstrates the energy savings for the assessment year. The baseline and performance assessment must be conducted by a monitoring and verification professional certified by the South African National Accreditation System. The energy savings must then be certified by SANEDI through issuing of a savings certificate. Assumption: An average project lifetime of 5 years is assumed for the savings.	2015: 5.1 2016: 6.1 2017: 10.8 2018: 16.8 2019: 17.9 Total savings: 56.7 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

NAME OF ACTION	Energy Efficiency Standards and Appliance Labelling project

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
To ensure that consumers are informed about the relative energy efficiency of an appliance before purchasing.	The information provided on the label informs users of the energy efficiency rating of each appliance, the manufacturer and product model. For some appliances, the label will also have non-energy data such as water consumption per cycle and appliance noise level. (DoE, 2017). Mandatory labelling of household appliances is in place (DTI, 2014), and minimum energy performance standards (MEPS) have been introduced or are proposed for most of the major categories of appliances.	Public sector procure-ment programme; Policy & Standards	Department of Mineral Resources and Energy (DMRE)	CO_2 Energy sector	This will contribute to the targets set out in the post-2015 NEES, particularly the residential target of a 33% reduction in the average specific energy consumption of new household appliances purchased by 2030 relative to the 2015 baseline. (2016, DMRE)	Ongoing - 2011 - 2030 In 2005 the first National Energy Efficiency Strategy was developed along with the introduction of a voluntary labelling scheme. This was the precursor to the mandatory standards and Labelling (S&L) programme. The voluntary scheme targeted directly only refrigerators. Thereafter the South African Bureau of Standards (SABS) developed the South African National Standard "SANS 941- Energy Efficiency for Electrical and Electronic Apparatus". Minister of Trade and Industry published the 'Compulsory Specification for Energy Efficiency and Labelling of Electrical and Electronic Apparatus' in 2014 and the first mandatory standards came into force in 2015. The first covered set of appliances includes refrigerators, washing machines, dryers, dishwashers, electric water heaters, ovens, air conditioners and heat pumps.	kWh savings; Reduction of CO_2 through the efficient use of energy	No calculations were undertaken as part of this report, as only high-level, secondary data values (in $MtCO_2e$) were provided for the period 2011- 2030. The data relates to the cumulative energy savings from technological advancements related to electrical appliances. The emission savings are calculated based on a time-dependent grid emission factor. This is published by Eskom an published in their annual reports.	Between 7.6 $MtCO_2e$ (low autonomous energy efficiency improvement scenario) and 22.7 $MtCO_2e$ (high autonomous energy efficiency scenario). Note that 'autonomous energy efficiency refers to the improvement of efficiency regardless of a price change of energy.	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

Table 3.1:
DOMESTIC MITIGATION ACTIONS IN THE ENERGY SECTOR.

NAME OF ACTION	Eskom Integrated Demand Management (IDM) Programme

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Provides for the efficient use of energy resources and related incentives / rebates.	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.	Public sector subsidy programme	Eskom IDM team	CO_2 Energy sector	975 MW savings, with the residential lighting target set at 455MW (Eskom, 2016)	Ongoing - 2005 to present The IDM programme was placed on hold in 2014 due to Eskom's prevailing financial constraints. The IDM programme was revived in February 2015 to pursue industrial energy efficiency and residential lighting projects. As part of the residential energy efficiency projects rolled out, a total of 70 million compact fluorescent lamps have been distributed (Eskom, 2018).	kWh savings; Reduction of CO_2 through the efficient use of energy	Emission savings ($MtCO_2e$) = activity data (GWh) x grid emission factor (tCO_2e/GWh). The emission savings were calculated by multiplying the activity data (primary data set provided by Eskom IDM Department) by the relevant grid emission factor. The grid emission factor is published by Eskom in its annual reports. Assumption: It was assumed that the measures run for 5 years. In the absence of activity 2019 data, it was also assumed that the 2019 activity data value was the same as the value provided for 2018.	2005: 0.1 2006: 0.4 2007: 1.2 2008: 3.7 2009: 7.7 2010: 12.1 2011: 18.0 2012: 24.7 2013: 31.7 2014: 38.7 2015: 45.8 2016: 51.3 2017: 56.3 2018: 59.2 2019: 61.5 Total Cumulative Savings-412.40	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

NAME OF ACTION	Municipal Energy Efficiency and Demandside Management programme

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Provides for the efficient use of energy resources and related incentives / rebates.	Disbursement of grant funding to municipalities to implement energy efficient retrofits within the municipal infrastructure.	Public sector grant funding programme.	DMRE	CO_2 Energy sector	Energy Conservation Target: energy efficiency potential is between 20-30% across many segments. This action will contribute to the Post-2015 NEES targets (2016 DMRE) for municipalities: 20% reduction in the energy intensity in the provision of electricity-intensive municipal services.	Ongoing- Implementation period was 2011- 2018 but assumed that reductions continue for 5 years thereafter. Since its start significant funding (over R1 billion) has been dedicated towards this programme and 54 municipalities have participated.	kWh savings; Reduction of CO_2 through the efficient use of energy	Emission savings ($MtCO_2e$) = activity data (GWh) x grid emission factor (tCO_2e/GWh). The emission savings were calculated by multiplying the activity data (secondary data set provided by Department of Environment, Forestry and Fishers) by the relevant grid emission factor. The Department of Forestry, Fisheries and the Environment provided high-level data (in GWh) for the period 2011- 2015. Values were also provided for the period 2015- 2018, however these were classified as "expected savings". Assumption: It was assumed that the measures are ongoing and that the annual emission savings were the equivalent to the amount recorded for 2019. It was further assumed that the measures run for 5 years.	2012: 0.1 2013: 0.2 2014: 0.4 2015: 0.9 2016: 1.9 2017: 3.7 2018: 7.3 2019: 14.4 Total cumulative Savings-28.9 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of the green economy due to uptake of energy efficient technologies.

Table 3.1:
DOMESTIC MITIGATION ACTIONS IN THE ENERGY SECTOR.

NAME OF ACTION	The National Cleaner Production Centre South Africa (NCPC) programme									
PRIMARY OBJECTIVE	**DESCRIPTION**	**NATURE OF ACTION**	**ADMINISTERING GOVERNMENT / AGENCY / ACTOR**	**COVERAGE**	**QUANTITATIVE GOALS**	**STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)**	**PROGRESS INDICATORS**	**METHODOLOGY AND ASSUMPTIONS**	**ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019**	**CO-BENEFITS**
The action aims to facilitate energy efficiency measures, particularly in the industrial and commercial sectors, as a means to mitigate greenhouse gas emissions related to the energy sector and stimulate job creation in the green economy.	Implement projects in the private sector that achieve energy savings and improved economic competitiveness in South African businesses through resource and process efficiency.	Private sector energy efficiency funding programme.	National Cleaner Production Centre	CO_2 Energy sector	No specific quantitative goals are provided but will contribute towards South Africa's energy efficiency targets.	Ongoing - 2011 to present	kWh savings; Reduction of CO_2 through the efficient use of energy	The savings in this report are based on the emission calculations conducted by the NCPC. The NCPC calculates the emission savings for the projects based on the energy carrier relevant to each specific project. These emissions were aggregated and provided by the NCPC for each year the programme has run for. Assumptions: assumed that project savings implemented during the programme remain for a period of 5 years.	2011: 0.1 2012: 0.1 2013: 0.1 2014: 0.3 2015: 0.5 2016: 0.5 2017: 0.5 2018: 0.7 2019: 0.5 Total cumulative savings- 3.3 $MtCO_2e$ $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

NAME OF ACTION	Private Sector Energy Efficiency (PSEE) Programme									
PRIMARY OBJECTIVE	**DESCRIPTION**	**NATURE OF ACTION**	**ADMINISTERING GOVERNMENT / AGENCY / ACTOR**	**COVERAGE**	**QUANTITATIVE GOALS**	**STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)**	**PROGRESS INDICATORS**	**METHODOLOGY AND ASSUMPTIONS**	**ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019**	**CO-BENEFITS**
The action aims to facilitate energy efficiency measures, particularly in the industrial and commercial sectors, as a means to mitigate greenhouse gas emissions related to the energy sector and stimulate job creation in the green economy.	Implement projects in the private sector that achieve energy savings and improved economic competitiveness in South African businesses through resource and process efficiency.	Private sector energy efficiency projects; economic incentive.	Private sector	CO_2 Energy sector	No specific targets provided but this action will contribute to the Post-2015 NEES industry and mining targets: (2016 DMRE) (a) 16% reduction in the weighted mean specific consumption of manufacturing by 2030 relative to the 2015 baseline; (b) 40 PJ cumulative annual savings from energy efficient interventions in mining.	Completed 2013 to 2015 however assumes that projects remain in place to date. Potential sources of funding, effective delivery mechanism and an appropriate hosting body will be identified to allow the development of a permanent successor scheme.	kWh savings	Emission savings ($MtCO_2e$) = activity data (GWh) x grid emission factor (tCO_2e/GWh) The calculations in this report are based on secondary data sets (energy savings in GWh), accessed from the National Business Initiative report on the outcomes of the programme. The activity data sets are multiplied by the South African grid emission factor for that year (calculated using data in the related Eskom annual report) to derive the $MtCO_2e$ value. Assumptions: assumed that projects implemented during the programme remain in place to date.	2014: 0.1 2015: 0.1 2016: 0.1 2017: 0.1 2018: 0.1 2019: 0.1 Total cumulative savings: 0.6 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

Table 3.1:
DOMESTIC MITIGATION ACTIONS IN THE ENERGY SECTOR.

NAME OF ACTION	Private sector embedded solar generation

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Solar photovoltaic (PV) generation, which can be quickly deployed, is expected to be the key technology behind small-scale embedded generation.	Installation of embedded solar PV for electricity generation.	Private sector energy efficiency projects; economic incentive.	South Africa Solar PV update published by the Association for Renewable Energy Practitioners.	CO_2 Energy sector	This action will contribute to the solar PV targets set in the IRP (2019 IRP (DMRE, 2019). By 2030, South Africa aims for additional capacity of 6 GW solar power. It is expected that another 114 MW will come online in 2020, followed by 300 MW in 2021, and 400 MW in 2022, when an additional 1 GW will be added as well. By 2030 the cumulative total is expected to be 8,288 MW.	Ongoing - 2017 to present.	kWh generated and MW installed capacity; Reduction of CO_2 through the use of cleaner energy sources.	Emission savings ($MtCO_2e$) = activity data (GWh) x grid emission factor (tCO_2e/GWh). The calculations in this report are based on secondary activity data sets (new installed capacity additions in MW, converted to GWh), accessed from the South Africa Solar PV Update Report published by the Association for Renewable Energy Practitioners. Assumptions: Assumed a capacity factor of 15% for the solar PV panels and an operational time of 6hrs each day. These assumptions were used to calculate an estimate of the electricity generated by the installed solar PV in each year. This was then multiplied by the grid emission factor to obtain the carbon emission reductions. The grid emission factors were sourced from the Eskom annual reports.	2018: 0.1 2019: 0.2 Total cumulative savings- 0.3 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of renewable energy technologies. Strengthening of green economy due to uptake of renewable energy technologies.

NAME OF ACTION	Renewable Energy Independent Power Producer Procurement (REIPPP) programme

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
The Integrated Resource Plan makes provision for the generation of 17.8 GW of renewable energy by 2030, to be commissioned under the 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.	Public sector renewable energy procurement programme.	Eskom	CO_2 Energy sector	17.8 GW of renewable energy by 2030. (DMRE, 2010).	Ongoing- 2011 to present.	kWh renewable energy; Reduction of CO_2 through the use of cleaner energy sources.	Emission savings ($MtCO_2e$) = activity data (GWh) x grid emission factor (tCO_2e/GWh) The secondary activity data sets (electricity generated by renewable energy projects in each year sourced from Eskom Integrated Annual reports) are multiplied by the appropriate annual grid emission factor to yield the emissions that are avoided through the use of renewable energy generation. A conversion factor of 0.277778 was used to convert GJ to MWh in order to convert the coal emission factor to the correct unit. Assumption: Coal generation baseline was assumed.	2012: 1.4 2013: 1.2 2014: 1.3 2015: 2.1 2016: 3.1 2017: 4.0 2018: 3.3 2019: 3.9 Total cumulative savings-20.3 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of renewable energy technologies. Strengthening of green economy due to uptake of renewable energy technologies.

Table 3.1:
DOMESTIC MITIGATION ACTIONS IN THE ENERGY SECTOR.

NAME OF ACTION	Natural gas fuel switch programme

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
To provide an economical and eco-friendly energy, by supplying natural gas to 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 to natural gas.	Switch to natural gas from emission intensive fuels.	Public and private sector programme.	Department of Mineral Resources and Energy.	CO_2 Energy sector	Short-term target: 600 vehicles and 1000 minibus taxis converted by Jan 2015, using 330,000 litres gas / month; Medium term targets: 14000 vehicles converted, 28 CNG Filling facilities, 28 Conversion workshops, and 7,700,000 Litres equivalent of gas (295,000 GJ) per month dispensed.	Ongoing - 2000 to present. While an accurate number of converted taxis does not exist at this point, it is estimated that in the Cities of Johannesburg, Tshwane and Ekurhuleni combined there are approximately 1,000 CNG taxis.	Reduced emissions from fuel use.	The total primary natural gas supply in the country was taken from the Department of Mineral Resources and Energy's Energy Balance. These are located on the DMRE website. The emission savings from this was assumed to be the difference between the emissions from coal and the emissions from natural gas. In order to calculate the savings, the GJ of gas supplied was multiplied by the difference between the emission factors for coal and natural gas. An assumption for the years 2017 to 2019 was made to equal the 2016 energy balance number as these figures had not been updated by the Department of Mineral Resources and Energy.	2000- 2010: 43.3 2011: 6.7 2012: 6.7 2013: 6.3 2014: 7.1 2015: 7.1 2016: 6.4 2017: 6.4 2018: 6.4 2019: 6.4 Total cumulative savings- 102.8 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

NAME OF ACTION	Bus Rapid Transport (BRT) System

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Promotes the efficient use of energy resources and the limitation of adverse environmental impacts in relation to land transport.	Provision of quick and safe public transport by bus. Implemented in Tshwane, Johannesburg, Durban and Cape Town. The reduction of GHG emissions is primarily achieved by modal shift from private passenger cars to public transport.	Public sector project.	Department of Transport and Local Governments	CO_2 Energy sector	Modal shift in Green Transport Strategy (DoT, 2017): 20% shift of passenger transport from private cars to public transport and non-motorised transport by 2022. DoT Annual Performance Plan 2019/20: (DoT, 2019) Strategic Goal 3: Improved rural access, infrastructure and mobility; Develop and monitor implementation of detailed Integrated Public Transport Network (IPTN) plans in 16 district municipalities by 2022/23; Strategic Goal 4: Improved public transport services; Fund and monitor implementation of Integrated Public Transport Networks (IPTNs) in thirteen (13) cities by 2022/23; Strategic Goal 4: Improved public transport services; Monitor implementation of the Transport Appeal Tribunal (TAT) Amendment Act.	Ongoing- 2007 to 2022 The National Land Transport Transition Act (DoT, 2000) was repealed by the gazetted National Land Transport Act (DoT, 2009) in April 2009. The Green Transport Strategy (DoT, 2017) replaced the Public Transport Strategy (DoT, 2007) from August 2017. The City of Cape Town's MyCiTi BRT system started operations in May 2010, just before the 2010 World Cup. Its first service was a shuttle from the Airport to the CBD. The initial Phase 1A trunk and feeder services started operating in May 2011. The Go George BRT system began operation in December 2014. The Tshwane A Re Yeng BRT services began operations in November 2014 with the launch of Phase 1A (DEA, 2016d)	kWh savings	ASIF approach (Eichhorst et al. 2018) Weekday average BRT Passenger trips: MyCiti (2011-2019): 56023; GoGeorge (2016-2019): 12949; A Re Yeng (2016-2019): 6663; Libhongolethu (2017-2019): 9882; (Derived from (National Treasury, 2014; National Treasury, 2016; National Treasury, 2018; National Treasury, 2021)) Average trip length: 23 km (van Ryneveld, 2014) Modal Shift Car: 10%; Minibus-Taxi: 61%; Bus: 8% (DEA, 2016b) Occupancy: Car: 1.4; Minibus-Taxi:14 (Stone et al. 2018) BRT: 56 (derived from DEA, 2016b) Fuel split of road transport modes (Stone et al. 2018): Car Gasoline: 96%; Car Diesel: 4%; Car Hybrid Gasoline: 0.02%; Minibus-Taxi Gasoline: 92%; Minibus-Taxi Diesel: 8%; Bus Diesel: 100% Energy consumption factor (L/100km) of road transport (Stone et al. 2018): Car Gasoline: 7.8; Car Diesel: 7.4; Car Hybrid Gasoline: 6; Minibus-Taxi: Gasoline: 13.7; Minibus-Taxi Diesel: 12.7 Net calorific values per fuel type (MJ/l): Gasoline: 34.2; Diesel: 38.1 (DEA, 2018e) Emission Factors for CO_2 per fuel type (kg/TJ): Gasoline: 69300; Diesel: 74100 (IPCC, 2006) GWP (IPCC, 1996) Average trip distance information of GoGeorge; A Re Yeng and Libhongolethu were not available. Modal shift information for GoGeorge; A Re Yeng and Libhongolethu were not available. The modal shift information for Rea Vaya BRT was used instead.	2011: 0.001 2012: 0.001 2013: 0.001 2014: 0.001 2015: 0.001 2016: 0.001 2017: 0.002 2018: 0.002 2019: 0.002 Total cumulative savings- 0.01012 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of economy due to uptake of energy efficient technologies.

Table 3.1:
DOMESTIC MITIGATION ACTIONS IN THE ENERGY SECTOR.

NAME OF ACTION	Transnet Road-to-Rail programme

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Promotes the efficient use of energy resources and the limitation of adverse environmental impacts in relation to land transport.	Encourages the shift of freight from road to rail.	Public sector project.	Transnet	CO_2 Energy sector	A 30% shift in freight from road to rail by 2050 (Green Transport Strategy)y, DoT, 2017)).	Ongoing - 2012 to present Accelerating modal shift from road to rail is included in the Minister of Public Enterprises' Statement of Strategic Intent (SSI). Government's National Climate Change Response White Paper, 2011, identifies a modal shift from road to rail as a flagship carbon mitigation programme for South Africa.	MJ savings; reduction of CO_2 through switching to a lower intensity mode of transport).	Data sets provided by Transnet.	2012: 0.2 2013: 0.2 2014: 0.5 2015: 0.4 2016: 0.2 2017: 0.6 2018: 0.7 2019: 0.1 Total cumulative savings: 2.9 $MtCO_2e$	Reduced air pollution due to the mitigation of fossil fuel combustion for energy purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

NAME OF ACTION	Electric Vehicles

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Shift to electric vehicle use from internal combustion engine vehicles.	The support of EV local development (OEMs, Chargers, and EV innovation), EV businesses including suppliers funding, and banks buy-in on EVs by structuring vehicle finance for EVs.	Economic	The Department of Forestry, Fisheries and the Environment	CO_2, CH_4, N_2O Energy sector	No quantitative goals provided.	Ongoing- 2007 to 2025 The charging network in South Africa is growing, there are currently around 214 public chargers in South Africa. The DST in partnership with the Technology Innovation Agency (TIA) is supporting the development of electric vehicle components (motors, battery management systems) and research on the use as well as localisation of renewable energy-based charging points (Parmar, 2020).	tCO_2e avoided	Average battery electric vehicle (BEV) population (2013-2018): 236 (derived from IEA, 2018) Average plugin hybrid electric vehicle (PHEV) population (2015-2018): 456 (derived from IEA, 2018) Distance travelled per vehicle: 21000 km (Stone et al. 2018) Substitution fuel ratio for PHEVs (petrol: electric): 60% / 40% Vehicle energy economy: BEV – 0.69 MJ/km; PHEV – 1.68 MJ/km fuel split of road transport modes (Caetano et al. 2017) Modal split in baseline scenario: Car Gasoline: 96%; Car Diesel: 4% (Stone et al. 2018) Energy consumption factor (L/100km) of road transport (Stone et al. 2018): Car Gasoline: 7.8; Car Diesel: 7.4 Net Calorific Values Per Fuel Type (MJ/l): Gasoline: 34.2; Diesel: 38.1 (DEA, 2018e) Emission Factors for CO_2 Per Fuel Type (Kg/Tj): Gasoline: 69300; Diesel: 74100 (IPCC, 2006) Gwp (Ipcc, 1996)	2013: 0.1 2014: 0.2 2015: 1.2 2016: 2.6 2017: 3.4 2018: 3.9 2019: 3.9 Total cumulative savings 15.3 $MtCO_2e$	Reduce energy consumption; Reduce air pollution.

The National Energy Efficiency Strategy of 2005 set an overall reduction target in energy intensity of 12% by 2015, and sectoral energy intensity improvements as follows: industry and mining (15%), power generation (10%), transport (9%), commercial and public building sector (15%), and residential (15%). The Post-2015 National Energy Efficiency Strategy aims to build on these achievements and provides new targets for 2030 for the following sectors:

- Public sector:
  - Public buildings: a 50% reduction in the energy consumption by 2030 relative to a 2015 baseline;
  - Municipal services: a 20% reduction in the energy intensity of municipal service provision. The specific services included are street lighting, traffic lights, water supply and wastewater treatment;
  - Municipal services: a 30% reduction in the fossil fuel intensity of municipality vehicle fleets;
- Residential sector:
  - A 33% reduction in the average specific energy consumption of new household appliances purchased in South Africa by 2030 relative to a 2015 baseline;
  - A 30% improvement in the average performance of the residential building stock by 2030 relative to a 2015 baseline;
- Commercial sector:
  - A 37% reduction in the specific energy consumption by 2030 relative to a 2015 baseline;
- Industry and mining sector:
  - A 10% reduction in weighted mean specific energy consumption in manufacturing by 2030 relative to a 2015 baseline;
  - A cumulative total energy saving of 40 PJ arising from specific energy saving interventions undertaken by the mining sector;
- Agriculture sector:
  - A total electricity saving of 1 PJ through officially supported projects by 2030;
- Transport sector:
  - A 20% reduction in the average vehicle energy intensity of the South African road vehicle fleet relative to a 2015 baseline; and
- Production and distribution:
  - A total of 10 PJ of electricity derived from grid-connected co-generation plant by 2030;
  - Average total electricity distribution losses below 8% by 2030, and average non-technical losses below 0.5%.

The Integrated Resource Plan (DoE, 2019) provides an update on South Africa's efforts to diversify its energy mix and reduce the reliance on coal.

The technology mix for electricity production took into consideration the roles different technologies played in providing base-load and peaking power. The plan also expanded on the future scale and role of nuclear energy and renewable energy technologies. The Integrated Resource Plan continues to reiterate that coal will continue to play a role in providing energy in the future, but it is to be limited to electricity generation. Coal will provide base-load power in the foreseeable future, although coal will be replaced substantially over time by improvements in solar, wind, nuclear and gas energy sources. These alternative options reduce GHG emissions and other pollutants and help to improve security of supply. In most cases, they also lower the cost of providing energy when external costs are accounted for.

Table 3.2:
DOMESTIC MITIGATION ACTIONS IN THE ENERGY SECTOR.

CONSIDERATION	ACTION
Immediate term security supply	• Undertake a power purchase programme to supplement Eskom's declining plant performance. • Reduce the extensive utilisation of diesel peaking generators in the immediate to medium term. • Extend Koeberg power plant design life by another 20 years. • Support Eskom to comply with Minimum Emissions Standards (MES) over time.
Energy mix and just transition	• Decommission approximately 24 100 MW of coal power plants between 2030 and 2050. • Coherent policy development in support of a just transition plan.
Wind and PV	• Retain current annual build limits on renewables (wind and PV) pending the finalisation of a just transition plan.
Coal	• New coal power projects must be based on high efficiency, low emission technologies and other cleaner coal technologies.
Gas to power	• Development of gas infrastructure is supported by the Integrated Resource Plan, 2019, in addition to new gas to power capacity that has been made available and converting existing diesel-fired power plants to gas.
Nuclear	• Commence preparations for a nuclear build programme to the extent of 2 500 MW at a pace and scale the country can afford.
Regional power projects	• South Africa will participate in strategic power projects that enable the development of cross-border infrastructure needed for regional energy trading.

The PAM driver for implementing mitigation actions in the transport sector is the Green Transport Strategy (DoT, 2017), including Bus Rapid Transit (BRT) Systems, road to rail shift for freight transport, and electric vehicles, as is framed by the National Land Transport Act (NLTA). The Green Transport Strategy replaced The Public Transport Strategy and Action Plan. The objective of the Green Transport Strategy is a reduction in transport emissions of 5% by 2050. Various measures are provided, and these include a 30% shift of freight transport from road to rail; a 20% shift of passenger transport from private cars to public transport and eco-mobility transport; the promotion of alternative fuels such as compressed natural gas (CNG) or biogas and liquid biofuels as transport fuels, and the promotion of electric and hybrid-electric vehicles.

The purpose of the NLTA is to further the process of transformation and restructuring of the national land transportation system initiated by the repealed National Land Transportation Transition Act (NLTTA).

The NLTTA provided a set of principles, which prioritised public over private transport while stressing the need for coherent planning which integrated transport planning with land use planning. The shift in transport planning from the NLTTA to NLTA was the devolution of the operating licence function from provinces to municipalities with regards to the planning, implementation and management of modally integrated public transport networks and travel corridors for transport within the municipal area.

3.5.1.1. Challenges, gaps and constraints

The Department of Transport reports on the progress of the implementation of public transport and freight transport actions in the country in their annual performance plans and annual reports. The Department was set to approach and appeal to National Treasury for more funding; consolidate fragmented funding streams; and identify alternative funding sources. Further inherent dependencies on other spheres of government, departments and agencies called for more coordinated intergovernmental relations; building capacity at implementing spheres and agencies; and more focused oversight capabilities (National Committee on Transport, 2019a).

Key implementation constraints for the Green Transport Strategy to increase the uptake of electric vehicles included issues of government procurement policy and infrastructure needs for such vehicles. The Department is currently busy with its Integrated Transport Plan to review the international trends on these issues, as well as looking at the long-term development of automotive parts in collaboration with the Department of Science and Technology (National Committee on Transport, 2019b). Relationships between local government and mini-bus taxi operators were a challenge to improving BRT services in the Cape Town, George and eThekwini Municipalities. Ongoing consultations with the taxi industry by the departments indicates that progress is being made to find a solution.

3.5.2. IPPU

The mitigation actions implemented in the IPPU sector are shown in Table 3.3. These include the Carbon Budgets, Pollution Prevention Plans and the Carbon Tax. These were discussed in the previous BUR, with updates provided in section 3.3.

3.5.3. AFOLU

The DAFF Strategic Plan for 2015/16 to 2018/19 mentions the rehabilitation of 1 500 ha of state-owned forests, as well as the replanting of 11 500 ha of temporarily unplanted plantation land. It identifies the activities of grassland restoration, however, does not provide any specific targets. The more recent DFFE Strategic Plan for 2017/2018 to 2023/24 provides for the afforestation of 15 000 ha, rehabilitation of 1 500 ha of state-owned forest, rehabilitation of grasslands and wetlands, and also includes the reduction in land degradation (40 452 ha). The Draft Climate Change Sector Plan for the DAFF makes provision for the afforestation of 100 000 ha of plantation area and identifies woodland and thicket restoration as activities. The rehabilitation of woodlands, thickets and natural forests contribute significantly to the mitigation of climate change and also achieve the combined aims of improving rural livelihoods, restoring biodiversity, and replenishing natural capital / ecosystem services.

In relation to the mitigation actions reported, South Africa undertook a national Land Degradation Neutrality target setting process during 2017/18. This process was initiated in response to the United Nations Convention to Combatting Desertification (UNCCD)'s call for signatory countries to voluntarily commit to Land Degradation Neutrality. Targets were developed in line with the guidelines of the UNCCD's Global Mechanism whilst simultaneously addressing the Sustainable Development Goal target number 15.3 (Von Maltitz et al., 2019). This resulted in an ambitious set of targets being set for 2030. Amongst these targets were those related to agriculture, grasslands and forests (DEA, 2018d):

- Improve productivity and Soil Organic Carbon stocks in 6 000 000 ha of cropland by 2030.
- Rehabilitate and sustainably manage 1 809 767 ha of 'forest' by 2030.
- Rehabilitate and sustainably manage 2 436 170 ha of grassland by 2030.
- Rehabilitate and sustainably manage 2 646 069 ha of savanna (< 5m) by 2030.
- Clear 1 063 897 ha of alien invasive species by 2030.
- Clear 633 702 ha of bush encroached land by 2030.

Table 3.4 presents the mitigation actions for the AFOLU sector. Policies in the AFOLU sector do not often have emission reduction targets, as the policies are not focussed on mitigation but rather biodiversity and sustainability. There are, however, a few policies which mention afforestation, grassland rehabilitation and conservation agriculture which could lead to an enhancement of the land carbon sink.

Table 3.3:
DOMESTIC MITIGATION ACTIONS IN THE IPPU SECTOR.

NAME OF ACTION	Nitrous oxide reduction projects

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Reduced nitrous oxide emissions during the production of nitric acid.	Reduction of nitrous oxide emissions in nitric acid production. Five projects in three companies are registered with the UNFCCC CDM.	Private sector project	UNFCCC CDM	N_2O IPPU sector	No quantitative goals yet in existence.	Ongoing- 2006 to present	Nitrous Oxide reductions	No calculations were conducted as the emission reductions were availableunavailable from the data provided by the Chemical Allied Industries Association (CAIA).	17.87 $MtCO_2e$	Not quantified

NAME OF ACTION	Carbon budgets (energy and process emissions are considered)

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Reduction of CO_2 through the efficient use of energy; cleaner technologies and other measures.	The aim of the carbon budgets is to reduce emissions in companies.	Private sector project	DFFE	CO_2 IPPU sector	No quantitative goals yet in existence.	Ongoing- 2017 to present	tCO_2e savings	No data available for quantification at the time of writing. In future, data could be sourced from the pollution prevention plan reports provided by industrial entities to the Department of Forestry, Fisheries and the Environment.	To be incorporated when data becomes available.	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes. Increase in jobs due to uptake of energy efficient technologies. Strengthening of green economy due to uptake of energy efficient technologies.

Table 3.4:
DOMESTIC MITIGATION ACTIONS IN THE AFOLU SECTOR.

NAME OF ACTION	Afforestation

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Encourages and supports sustainable land use practices, raising awareness and promoting resource conservation ethics.	Department of Forestry, Fisheries and the Environment afforestation programmes, including the Working for Land and Working for Ecosystems afforestation programmes.	Regulations and standards.	DFFE	CO_2 AFOLU sector (Land sub-sector)	To afforest 100,000 hectares of land in certain parts of the country. Potential emission savings has been estimated at 2.2 $MtCO_2$ if 100000ha are afforested (DFFE, 2020).	Ongoing - 2006 to present The National Forestry Action Programme (DWAF, 1997) was published in 1997 and had the expressed purpose of mobilising and organising national and international resources and catalysing action to implement programmes and plans in a coordinated manner. A review of the NFAP in 2003, led to the development of the National Forest Policy (DWAF, 2005) a globally adopted framework for national forest policy development, planning and implementation. The process of developing a long-term strategy for the forestry sector was initiated in 2007, resulting in the Forestry 2030 Roadmap, which was finalised after a two-year period of consultation and deliberation between government and industry. Recently (2019) included plantations >100ha in the National GHG Emission Reporting Regulations (DFFE, 2020b) to obtain more accurate data on afforested and deforested areas.	tCO_2e sequestered; afforested area (ha)	Number of hectares planted/afforested annually were obtained from Forestry South Africa fact sheets[5] (FSA, 2018) Mitigation potential factor: 1.5 t C/ha/yr (DFFE, 2020). Assumption: A plantation reaches a long-term C balance after five years (half rotation length).	2000- 2010: 0.9 2011: 0.07 2012: 0.06 2013: 0.04 2014: 0.03 2015: 0.03 2016: 0.03 2017: 0.03 2018: 0.04 2019: 0.04 Total cumulative savings 1.27 $MtCO_2$	Sustainable, performing ecosystems and increased land productivity. Increased biodiversity and soil quality can improve subsistence farming which can positively impact human health. Improvements in subsistence farming can increase economic livelihoods and therefore, resilience to negative climate impacts.

[5] FSA. (2018). South African Forestry and Forest Product Industry Facts 1980-2018. Forestry South Africa, Pietermaritzburg, KwaZulu-Natal.

NAME OF ACTION	Conservation Agriculture (CA)

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Aims are to promote sustainability within the agriculture sector and a reduction of the carbon footprint in Agriculture.	Advocates for implementation of minimum soil disturbance (no-tillage), permanent cover and crop association.	Programmes	Department of agriculture through Landcare programme and SANBI; Grain SA	CO_2 AFOLU sector (Land sub-sector)	The AFOLU Strategy (DFFE, 2020) indicates that there are 6 302 642 ha to be converted to CA over the next 20 years. Potential accumulated emission reductions are estimated to be 119$MtCO_2$ by 2040.	Ongoing On February the 9th 2018 the Minister published the Draft Conservation Agriculture Policy (DAFF, 2018a) for public comment, and in August 2018 the Draft Climate Smart Agriculture Strategic Framework (DAFF, 2018b) was published for public comment.	tCO_2e sequestered; area under conservation agriculture	AFOLU strategy (DFFE, 2020) indicates that conservation area was 14% of the annual crop area in 2018, growing at a rate of 7.5% per year. Annual crop area in 2018: 11 126 022 ha (DEA, 2019). Area extrapolated for each year based on this. Mitigation potential factor: 0.2 tC/ha/yr. DFFE 2020 applied a value of 0.3 tC/ha/yr, but not all conservation activities are adopted (Findlater et al, 2019) therefore a value of 0.2 tC/ha/yr was applied. Assumptions: Soil carbon was assumed to accumulate for the IPCC default period of 20 years; Annual growth rate in conservation area remains constant at 7.5% per annum.	2000 - 2010: 3.7 2011: 0.5 2012: 0.6 2013: 0.6 2014: 0.7 2015: 0.7 2016: 0.8 2017: 0.8 2018: 0.9 2019: 1.0 Total cumulative savings: 10.3 $MtCO_2$	Sustainable, performing ecosystems and increased land productivity. Increased biodiversity, catchment management, water quality and soil quality can improve subsistence farming which can positively impact human health. Improvements in subsistence farming can increase economic livelihoods and, therefore, resilience to negative climate impacts.

Table 3.4:
DOMESTIC MITIGATION ACTIONS IN THE AFOLU SECTOR.

NAME OF ACTION	Forest and woodland restoration and rehabilitation

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
To restore and rehabilitate forests and woodlands so as to improve sustainability, ecosystem services and biodiversity.	Restoring state forests and woodlands stem from the Draft Climate Change Plan for South African Agriculture and Forestry Sectors (2010) and the DAFF Strategic Plan 2015/2016 to 2019/2020. (DAFF, 2015)	Regulations and standards.	Public sector programme; DFFE	CO_2 AFOLU sector (Land sub-sector)	To restore an additional 80 000 hectares of agricultural land and 2 500 hectares of state forests and woodlands. Furthermore, to replant 8 625 hectares of temporary unplanted (TUP) Category B and C State plantations per annum to address the approximately 30 000 hectares of TUP areas. AFOLU strategy indicates the potential for 6 $MtCO_2$ savings by 2040 through the Expanded Public Works Programme (EPWP) government programme.	Ongoing	tCO_2e sequestered; forest area rehabilitated	Number of hectares restored were derived from DAFF Annual Reports. Mitigation potential factor: 1.8 tC/ha/yr (DFFE, 2020. Assumptions: mitigation potential factor is as for indigenous forests; growth occurs for more than 20 years. Clearing of alien invasive species is not included as there was insufficient data for the quantification of its impacts.	2013: 0.005 2014: 0.009 2015: 0.01 2016: 0.01 2017: 0.02 2018: 0.02 2019: 0.02 Total cumulative savings: 0.94 $MtCO_2$	Improved ecosystem services, sustainability and biodiversity. Improved waster use. Creation of jobs Sustainable, performing ecosystems and increased land productivity. Increased biodiversity and soil quality can improve subsistence farming which can positively impact human health. Improvements in subsistence farming can increase economic livelihoods and, therefore, resilience to negative climate impacts.

NAME OF ACTION	Grassland rehabilitation (VeldCare - LandCare Programme)

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
To restore and rehabilitate grasslands and grazing lands and to reduce soil erosion.	Grassland rehabilitation programme. The programme supports grassland rehabilitation by providing a framework to promoting sustainable grazing management that limits topsoil loss and disturbance, enhance forage production and cover and maintain key forage species diversity amongst others.	Regulations and standards.	Public sector programme.	CO_2 AFOLU sector (Land sub-sector)	AFOLU Strategy (DFFE, 2020) indicates that there is another 935 000 ha grassland that can be rehabilitated. It is indicated that the EPWP government programmes have the potential to reduce emissions by 0.76 $MtCO_2$ over the next 20 years.	Ongoing	tCO_2e sequestered; grassland area rehabilitated	Annual area of rangeland and grazing land rehabilitated or restored under VeldCare was obtained from reported performance of the LandCare Grant in the Annual Division of Revenue Bill. Mitigation potential factor: 0.6 tC/ha/yr (DFFE, 2020). Assumptions: Soil carbon was assumed to accumulate for the IPCC default period of 20 years; Bush encroachment and clearing of alien vegetation was not included due to a lack of information for its quantification.	2007: 0.01 2008: 0.02 2009: 0.02 2009: 0.02 2010: 0.02 2011: 0.03 2012: 0.04 2013: 0.4 2014: 0.5 2015: 0.6 2016: 0.6 2017: 0.6 2018: 0.6 2019: 0.7 Total cumulative savings: 4.09 $MtCO_2$	Sustainable, performing ecosystems and increased land productivity. Increased biodiversity and soil quality can improve subsistence farming which can positively impact human health. Improvements in subsistence farming can increase economic livelihoods and, therefore, resilience to negative climate impacts.

Table 3.4:
DOMESTIC MITIGATION ACTIONS IN THE AFOLU SECTOR.

NAME OF ACTION	Thicket restoration

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
To restore and rehabilitate thickets to reduce land degradation and enhance carbon storage.	Thickets have been shown to have a large carbon storage capacity. Restoration projects involve replanting of thicket vegetation to increase carbo storage in the biomass and soil.	Regulations and standards.	Public sector programme.	CO_2 AFOLU sector (Land sub-sector)	AFOLU strategy indicates the potential for 34 $MtCO_2$ savings by 2040 through thicket restoration, with the EPWP government programme estimated to potentially contribute 3.5 $MtCO_2$ savings in this time period.	Ongoing	tCO_2e sequestered; thicket area rehabilitated	Not yet quantified due to a lack of data.	Emission reductions not yet quantified.	Sustainable, performing ecosystems and increased land productivity. Increased biodiversity and soil quality can improve subsistence farming which can positively impact human health. Improvements in subsistence farming can increase economic livelihoods and, therefore, resilience to negative climate impacts.

Table 3.5:
DOMESTIC MITIGATION ACTIONS IN THE WASTE SECTOR.

NAME OF ACTION	National Waste Management Strategy

PRIMARY OBJECTIVE	DESCRIPTION	NATURE OF ACTION	ADMINISTERING GOVERNMENT / AGENCY / ACTOR	COVERAGE	QUANTITATIVE GOALS	STATUS AND PROGRESS (STEPS TAKEN OR ENVISAGED TO ACHIEVE THE ACTION)	PROGRESS INDICATORS	METHODOLOGY AND ASSUMPTIONS	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$ TILL 2019	CO-BENEFITS
Encourages and supports sustainable land use practices, raising awareness and promoting resource conservation ethics.	Provides the overall approach to national waste management during the lifecycle of waste, including waste avoidance and reduction, re-use and recycling, recovery, and treatment and disposal.	Regulations and standards.	Public sector programme.	CH_4 Waste sector	By 2016: 25% of recyclables diverted from landfill sites for re-use, recycling or recovery.; All metropolitan municipalities, secondary cities and large towns have initiated separation at source programmes; 95% of urban households and 75% of rural households have access to adequate levels of waste collection services; 80% of waste disposal sites have permits; 69 000 new jobs created in the waste sector; 80% of municipalities running local awareness campaigns. (DEA, 2011c) (Selected list of goals)	Ongoing- 2011 to present The 2018 Revised and Updated NWMS (DFFE, 2021) is released for public comment together with a Status Quo Assessment of Waste Management in South Africa and a State of Waste Report that updates the National Waste Information Baseline Report of 2012 in December 2019. Since implementation of the 2011 NWMS, there are some improvements in waste collection and disposal services, including a successful programme to license landfills and the initiation of separation at source programmes in some metropolitan areas.	tCO_2e mitigation; percentage of waste recycled	No calculations were undertaken as part of this report. High-level, secondary data sets were provided (in $MtCO_2e$) by the Department of Environment, Forestry and Fisheries for the years 2011-2017. The provided data sets were aggregated per category (biogas, composting and material recovery facility projects) and per year. Assumptions: It was assumed that the waste diversion projects are ongoing and saving the equivalent amount of $MtCO_2e$ as in the last recorded year (2017).	2000- 2010: 2.6 2011: 0.2 2012: 0.2 2013: 0.1 2014: 0.1 2015: 0.1 2016: 0.1 2017: 0.1 2018: 0.1 2019: 0.1 Total cumulative savings: 3.7 $MtCO_2e$	Prevents pollution of water, soil and air. Reduces waste to landfill which has positive health impacts on society. Stimulate job creation in the green economy through waste reduction, reuse and recycling.

Several South African policy documents mention and promote Climate Smart Agriculture (CSA) or Conservation Agriculture (CA) specifically. The Agricultural Policy Action Plan mentions that CSA includes numerous well-developed approaches to agriculture and the Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries recommends a number of CSA measures for implementation (DAFF, 2015b). In the Department's Integrated Growth and Development Plan (DAFF, 2012) a section is devoted to ecological sustainability, where the importance of protecting natural resources is highlighted. The Draft Conservation Agriculture Policy highlights conservation agriculture and rangeland restoration as important activities for sustainable agriculture, however, these activities will also have implications for GHG mitigation. No targets are provided in these documents.

Overgrazing and overutilisation of plant resources result in a loss of vegetative cover leading to soil erosion. Soil erosion has been found to be a pervasive problem on rangelands and grasslands, and is particularly of concern in areas of communal land tenure (Shackleton, 1993). Degradation relating to rangeland management was the most common theme emerging from the NBI-2000 and follow up Land Degradation Assessment studies. Both assessments found that communal areas had some of the worst rangeland degradation in the country. Sustainable land management initiatives and soil erosion control as part of the Landcare program are almost exclusively implemented on areas of communal land tenure (Von Maltitz et al. 2019). Because of its high and ongoing transformation and low degree of protection (only 3%), the grassland biome has long been considered one of the most threatened biomes in South Africa.

3.5.3.1. Challenges, gaps and constraints

Going forward, it is important that emphasis is placed on enhancing institutional relations between governmental departments including the DFFE, Department of Agriculture, Land Reform and Rural Development (DALRRD), and provincial departments and their entities, in order to fast-track the implementation of mitigation actions related to agriculture and forestry, improve monitoring and evaluation functions, eliminate duplication of effort and silo approaches, and increase co-ordination and alignment of activities (National Committee on Agriculture, Land Reform and Rural Development, 2019). In the new administration, the Department of Agriculture sits within the Department of Rural Development and Land Reform which will contribute toward an improvement in intergovernmental relations.

There is also the challenge that the AFOLU sector does not have PAMs that are specific for GHG mitigation and the actions currently mentioned in strategies are not detailed enough. For example, in rehabilitation of land the type of actions to be undertaken and on land types these are to occur on need to be specified. The lack of specific targets makes tracking emission reductions very challenging and also makes it difficult to hold departments accountable.

3.5.4. Waste

Table 3.6 presents the mitigation actions for the waste sector. The main driving legislation in the waste sector is the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008).

The National Environmental Management: Waste Act (Act No. 59 of 2008) establishes the requirement for a National Waste Management Strategy (NWMS) to be implemented, and to be revised and updated. The NWMS (DFFE, 2021) is a government-wide strategy that applies to all organs of state that have a responsibility for waste management, the private sector, and civil society. The DFFE is responsible for developing the strategy in consultation with other spheres of government and all stakeholders.

The approach of structuring strategic goals, adopted in the revised NWMS, differs significantly from the previous NWMS (DEA, 2011c). It seeks to provide a simpler conceptual structure based on three main implementation themes framed as overarching goals, and is informed by global emerging trends in the management of the central implementation themes:

- Waste Minimisation: prevention and resource economy.
- Effective and Sustainable Waste Services: collection and integrated waste management planning.
- Waste Awareness and Compliance: waste management norms and standards.

The quantitative goals are associated with waste minimisation, and compliance to waste norms and standards and include:

- Divert 40% of waste from landfill within 5 years; 55% within 10 years; and at least 70% of waste within 15 years leading to Zero-Waste going to landfill.
- Effective and Sustainable Services: All South Africans live in clean communities with waste services that are well managed and financially sustainable.
- Compliance, Enforcement and Awareness: Mainstreaming of waste awareness and a culture of compliance resulting in zero tolerance of pollution, litter and illegal dumping.

The near-term priority waste management flagship programme is directly aligned with the NWMS.

3.5.4.1. Challenges, gaps and constraints

Constraints to the implementation of waste management actions are most prevalent at the level of local government. There is inadequate processing and recycling capacity in the country to improve recycling and re-use programmes (National Committee on Environment, Forestry and Fisheries, 2019a). Stakeholder consultation processes related to climate change projects were delayed due to timelines to finalise national legislation such as the Climate Change Bill. Progress to reboot the waste tyre recycling programme was constrained. Two major tyre processors' contracts had been suspended over non-compliance on exports and new companies were being appointed (National Committee on Environment, Forestry and Fisheries, 2019b). The Waste Bureau had to pick up existing gaps that were supposed to be handled by the Recycling and Economic Development Initiative of SA (National Committee on Environment, Forestry and Fisheries, 2019c). The Bureau was given this responsibility, which was beyond their normal scope, and had to engage in a process of shortlisting for the supply chain management of the waste tyre industry.

3.6. ANALYSIS OF POLICY IMPACTS ON EMISSION REDUCTIONS

Emission reductions can be tracked in two ways, namely through the GHG inventory emission estimates and by tracking and monitoring the impacts of individual actions. Tracking individual actions is important for understanding the impact of a particular action and whether policies associated with these actions are achieving the desired effect. Some policies are, however, overarching and have far reaching impacts across all sectors. For these policies, the emission reduction impacts can be seen through reductions in the overall GHG emissions.

Chapter 2 discusses the GHG emissions for South Africa in detail, but in summary the emissions increased from 2000 to about 2013, after which emissions appear to be stabilising (Figure 2.4). In this section the overarching indicators for monitoring emissions are discussed.

3.6.1. Analysis of Impact of Sectoral PAMs

In the BUR3 (DEA, 2019a) numerous actions and activities in each sector were identified and reported on. There was, however, a lack of data for determining emission reductions on many of the activities. In this BUR, a more limited list of actions has been identified by DFFE so as to focus monitoring and tracking efforts going forward. The aim is to track these actions and follow them through to wider impacts and support. The actions are focussed around the PAMs that are developing within each sector and which will also be impacted by the overarching policies.

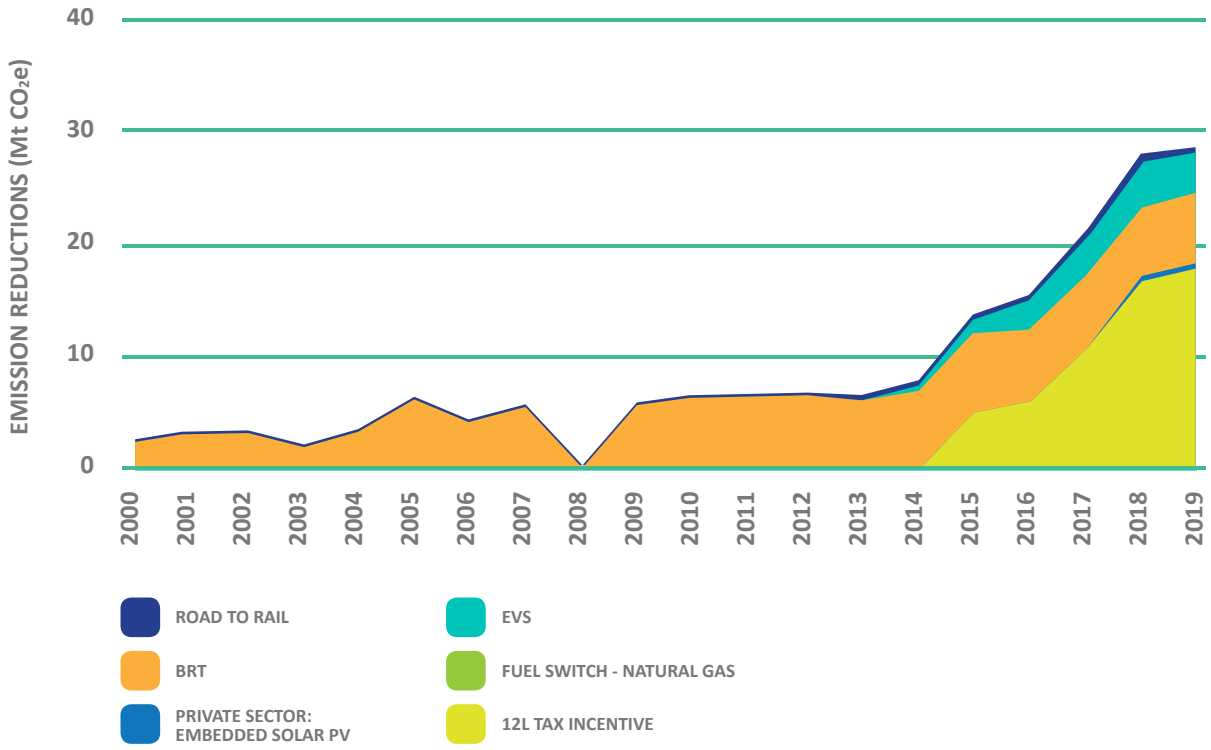
Annual emission reduction savings, related to the selected mitigation actions, were calculated and the results are reported in this section. Different calculation methodologies were applied to different actions (see methodology in Annex B1), but typically, the calculations involve the multiplication of the activity data by a relevant emission factor. For example, many of the energy-related mitigation actions were quantified using a South African grid emission factor (in tCO_2e/MWh), for specific years (which reflects the increasing trend related to the inclusion of renewable energy on the national grid). Details of each mitigation action (objectives, methods, assumptions, coverage, quantitative goals, progress of implementation, and steps taken to envisage goals) are provided in Annex B1.

3.6.1.1. Energy

The energy sector mitigation actions include energy efficiency, renewable energy and various transport related actions (Table 3.6). The total energy sector emission reductions were estimated at 21.1 $MtCO_2e$ in 2017 and 28.57 $MtCO_2e$ in 2019, which is up from the 13.72 $MtCO_2e$ estimated for 2015. The largest contributor was the 12L tax incentive programme, which showed an increase of 12.85 $MtCO_2e$ between 2015 and 2019. The Bus Rapid Transit (BRT) System had the lowest contribution, and the road-to-rail programme showed an increase in 2017 and a decline in 2019.

In addition to these actions, there were energy savings from the Energy Efficiency Standards and Appliance Labelling project. However, these were stated as low and high ambition estimates (between 7.6 $MtCO_2e$ and 22.7 $MtCO_2e$ (Green House, 2016)) so specific annual savings could not be determined. Emission savings from this project were, therefore, not included in the total energy emissions savings. Additionally, there were several energy efficiency programmes (Table 3.7) where the emission reductions were determined, however, it is possible that some of the underlying projects quantified in these programmes are registered with international market-based mechanisms (IMM). It was not possible to separate out these Clean Development Mechanism (CDM) and Verified Carbon Standard (VCS) projects because the activity data sets were provided in an aggregated format. In the interest of transparency, these emission reductions were, therefore, excluded from the total energy sector savings and reported separately. International carbon credit projects will be discussed separately in section 3.7. Considering these actions, the Eskom Integrated Demand Management (IDM) programme is by far the largest contributor to emission reductions in the energy sector.

Annual trends and accumulated savings: Energy



- *12L tax incentive programme: 56.7 $MtCO_2e$ (2015–2019)*
- *Embedded solar generation: 0.3 $MtCO_2e$ (2018–2019)*
- *Natural gas fuel switch: 102.8 $MtCO_2e$ (2000–2019)*
- *BRT: 0.01 $MtCO_2e$ (2011–2019)*
- *Electric vehicles: 15.3 $MtCO_2e$ (2013–2019)*
- *Road-to-rail: 2.9 $MtCO_2e$ (2012–2019)*
- *Additional projects which have overlap with international*

Table 3.6:
EMISSION REDUCTIONS IN THE ENERGY SECTOR.

NAME OF ACTION	FOCUS AREA	DESCRIPTION	INDICATOR	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$) 2015	2017	2019
12L TAX INCENTIVE PROGRAMME	Energy efficiency	A tax incentive which aims to encourage the efficient utilisation of energy through a tax deduction of 95c per verified kWh (or kWh equivalent) of energy efficiency savings.	kWh savings; tCO_2e savings	5.07	10.76	17.92
PRIVATE SECTOR EMBEDDED SOLAR GENERATION	Renewable energy generation	Installation of embedded solar PV for electricity generation.	kWh generated; MW installed capacity	Data unknown	Data unknown	0.2
NATURAL GAS FUEL SWITCH PROGRAMME	Fuel switch	Switch to natural gas from emission intensive fuels.	tCO_2e savings	7.12	6.42	6.42
BUS RAPID TRANSPORT SYSTEM (BRT)	Lower emission public transport activity	Provision of quick and safe public transport by bus. Implemented in Tshwane, Johannesburg, Durban and Cape Town.	kWh savings	0.002	0.002	0.002
ELECTRIC VEHICLES	Modal shift in transport sector	Shift to electric vehicle use from internal combustion engine vehicles.	tCO_2e avoided	1.17	3.35	3.94
TRANSNET ROAD-TO-RAIL PROGRAMME	Modal shift in transport sector	Promotes the efficient use of energy resources and the limitation of adverse environmental impacts in relation to land transport.	MJ savings	0.36	0.59	0.09
TOTAL EMISSION REDUCTIONS FOR THE ENERGY SECTOR				13.72	21.12	28.57

Table 3.7:

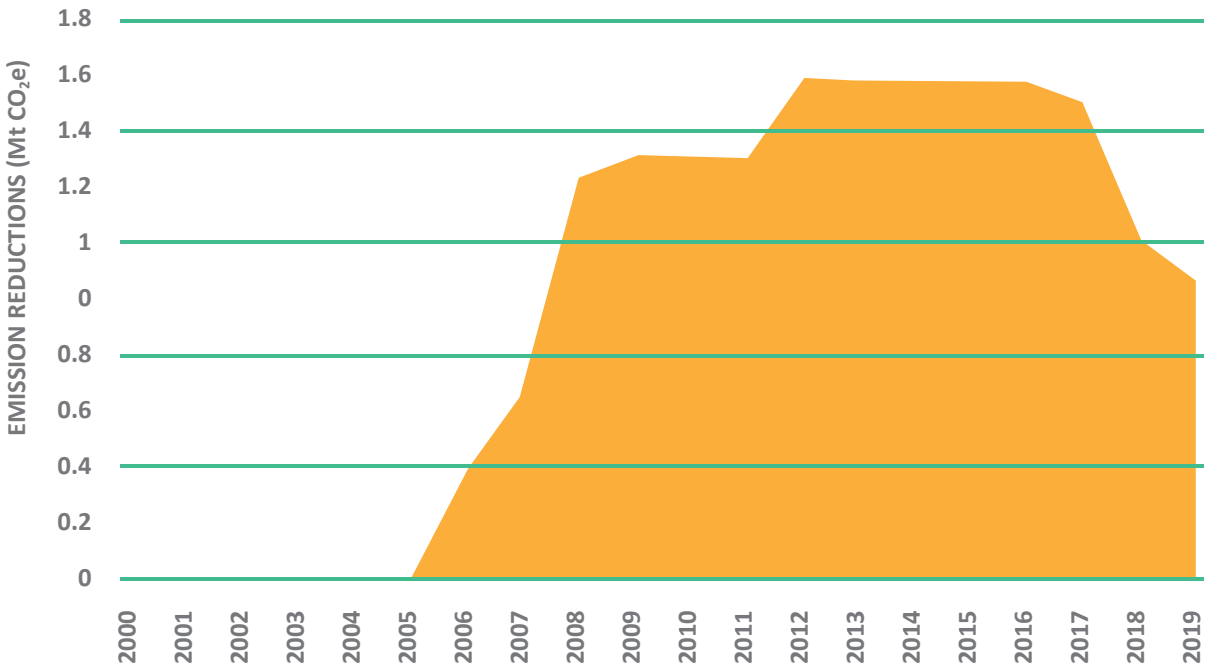
ADDITIONAL ENERGY SECTOR ACTIONS AND EMISSION REDUCTIONS FROM PROJECTS THAT INCLUDE REGISTERED CARBON CREDIT OFFSET PROJECTS.

NAME OF ACTION	FOCUS AREA	DESCRIPTION	INDICATOR	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$) 2015	2017	2019
ENERGY EFFICIENCY STANDARDS AND APPLIANCE LABELLING PROJECT	Energy efficiency	Implementation of energy efficient appliances in South Africa via the Standards and Labelling project.	kWh savings	Estimated to be between 7.6 and 22.7 $MtCO_2e$		
ESKOM IDM PROGRAMME	Energy efficiency	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.	kWh savings	45.81	56.26	61.48
MUNICIPAL ENERGY EFFICIENCY AND DEMAND-SIDE MANAGEMENT PROGRAMME	Energy efficiency	Disbursement of grant funding to municipalities to implement energy efficient retrofits within the municipal infrastructure.	kWh savings	0.93	3.70	14.4
NCPC PROGRAMME	Energy efficiency	Implement projects in the private sector that achieve energy savings and improved economic competitiveness in South African businesses through resource and process efficiency.	kWh savings	0.50	0.50	0.49
PSEE PROGRAMME	Energy efficiency	Implement projects in the private sector that achieve energy savings and improved economic competitiveness in South African businesses through resource and process efficiency.	kWh savings	0.13	0.12	0.12
RENEWABLE ENERGY INDEPENDENT POWER PRODUCER PROCUREMENT PROGRAMME	Renewable efficiency	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.	kWh renewable energy	2.09	4.00	3.94
TOTAL ADDITIONAL EMISSION REDUCTIONS IN THE ENERGY SECTOR				49.46	64.58	80.43

3.6.1.2. IPPU

The IPPU sector produced emission reductions of 0.95 $MtCO_2e$ in 2019, which is lower than the 1.59 $MtCO_2e$ emission reductions in 2015 (Table 3.8). The nitrous oxide reduction projects have been running since 2006, and between 2006 and 2019 an accumulated 17.9 $MtCO_2e$ emissions have been saved. Carbon budgets, which inclue both energy and process emissions, and the National PPP Regulations have only recently been introduced so the full impact of these PAMs related to emissions has not yet been assessed. Emission reductions for these PAMs will be reported in the next BUR.

Annual trends and accumulated savings: IPPU



- ***Nitrous oxide reduction project: 17.9 $MtCO_2e$ (2006 - 2019)***

Table 3.8:
EMISSION REDUCTIONS IN THE IPPU SECTOR.

NAME OF ACTION	FOCUS AREA	DESCRIPTION	INDICATOR	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$) 2015	2017	2019
NITROUS OXIDE REDUCTION PROJECTS	Process emissions	Reduction of nitrous oxide emissions in nitric acid production.	Nitrous oxide reduction	1.59	1.53	0.95
CARBON BUDGETS (NOTE, BOTH ENERGY AND PROCESS EMISSIONS ARE INCLUDED)	Energy and process emissions	The aim of the carbon budgets is to reduce direct emissions in the industrial sectors.	tCO_2e savings	Could not be determined at this stage as there has only been one reporting cycle and the data is still aggregate which could lead to double counting with the energy sector.		
TOTAL EMISSION REDUCTIONS FOR THE IPPU SECTOR				1.59	1.53	0.95

3.6.1.3. AFOLU

In the AFOLU sector the actions are aimed at enhancing the carbon sinks in forest lands, croplands and grasslands. The total amount of CO_2 sequestered in this sector amounted to 1.7 $MtCO_2e$ in 2019 (Table 3.9). Conservation agriculture has the largest contribution to the sink, while forest rehabilitation has the smallest. Forest rehabilitation estimates are likely to be underestimated since only the reforestation of indigenous forest was included. Estimates for thicket restoration have not yet been determined.

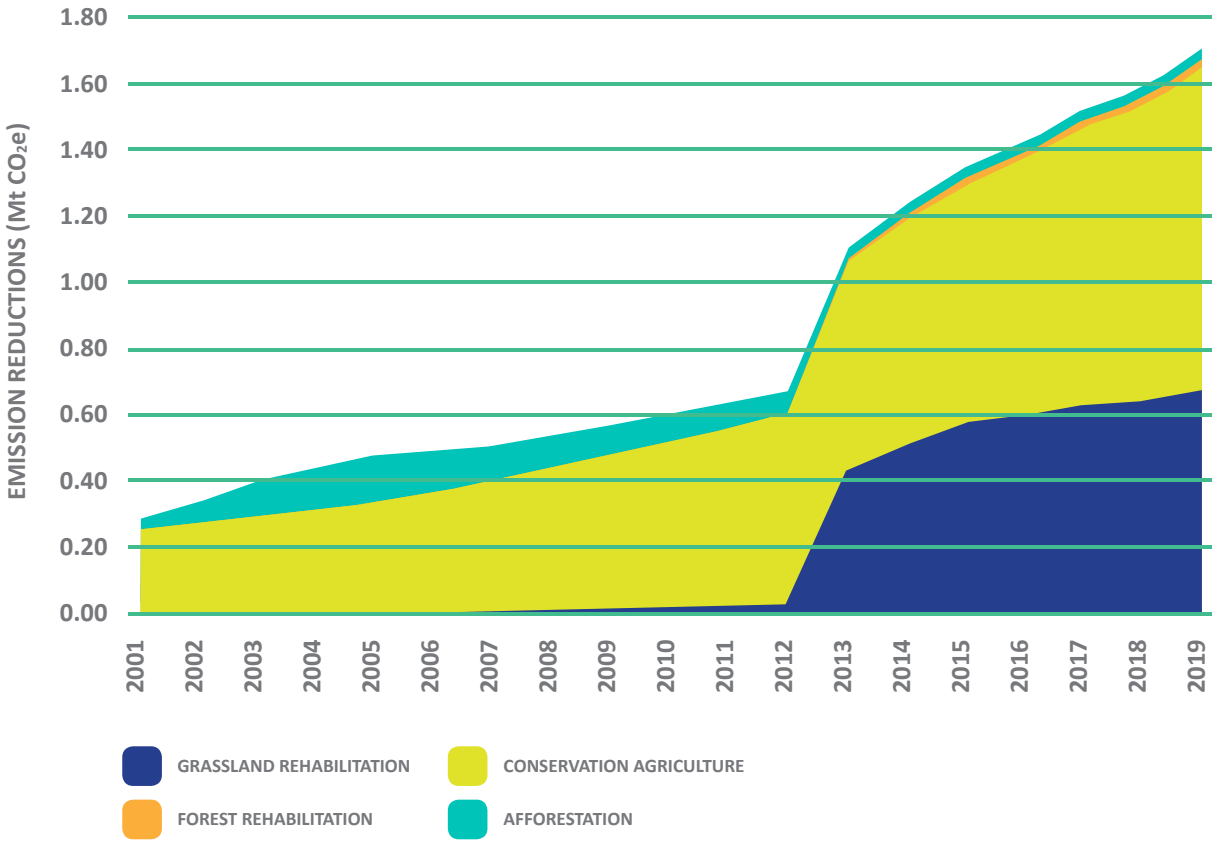
These reductions are estimated to be what has been achieved to date, based on the limited mitigation PAMs in this sector. DFFE is currently developing an AFOLU strategy (DFFE, 2020) which will define the way forward for this sector. As part of this strategy the mitigation potential of these activities was determined. Afforestation is estimated to have the potential to produce 2.2 $MtCO_2$ over the next 20 years, while forest and woodland rehabilitation have the potential to produce 22 $MtCO_2$ in the same period.

Grassland rehabilitation and conservation agriculture are estimated to be able to produce 40 $MtCO_2$ and 75 $MtCO_2$, respectively, over the next 20 years. It is also estimated that government programmes could contribute 44 $MtCO_2$ to this total, while the rest would come from private investment.

DFFE is developing a National Reducing Emissions from Deforestation and Forest Degradation (REDD+) Programme. From 2015, research was commissioned to identify and assess the 16 elements of the REDD+ mechanism. This was part of the readiness assessment (i.e., Phase 0) and in 2017 an expert workshop was held to technically assess the Forest Definition and Scope of implementation of the REDD+ programme in South Africa. More recently a study was conducted resulting in three REDD+ component reports which included a phase 1 assessment of the scope of implementation. Currently DFFE is developing a National Strategic Framework for REDD+ and also constructing an interim sub-national Forest Reference Emissions Level (FREL).

The REDD+ programme is one of the Land Based Climate change demonstration activities. Although some of the activities in Table 3.10 are associated with REDD+ programme, these are extracted from projects and programmes currently undertaken in the AFOLU sector generally. The activities of REDD+ programme and carbon benefits have not been quantified yet. The FREL will be the baseline for the assessment of carbon benefits for the REDD+ programme.

Annual trends and accumulated savings: AFOLU



- *Afforestation: 1.29 $MtCO_2$ (2000–2019)*
- *Conservation agriculture: 10.27 $MtCO_2$ (2000–2019)*
- *Forest rehabilitation: 0.1 $MtCO_2$ (2013–2019)*
- *Grassland rehabilitation: 4.25 $MtCO_2$ (2006–2019)*

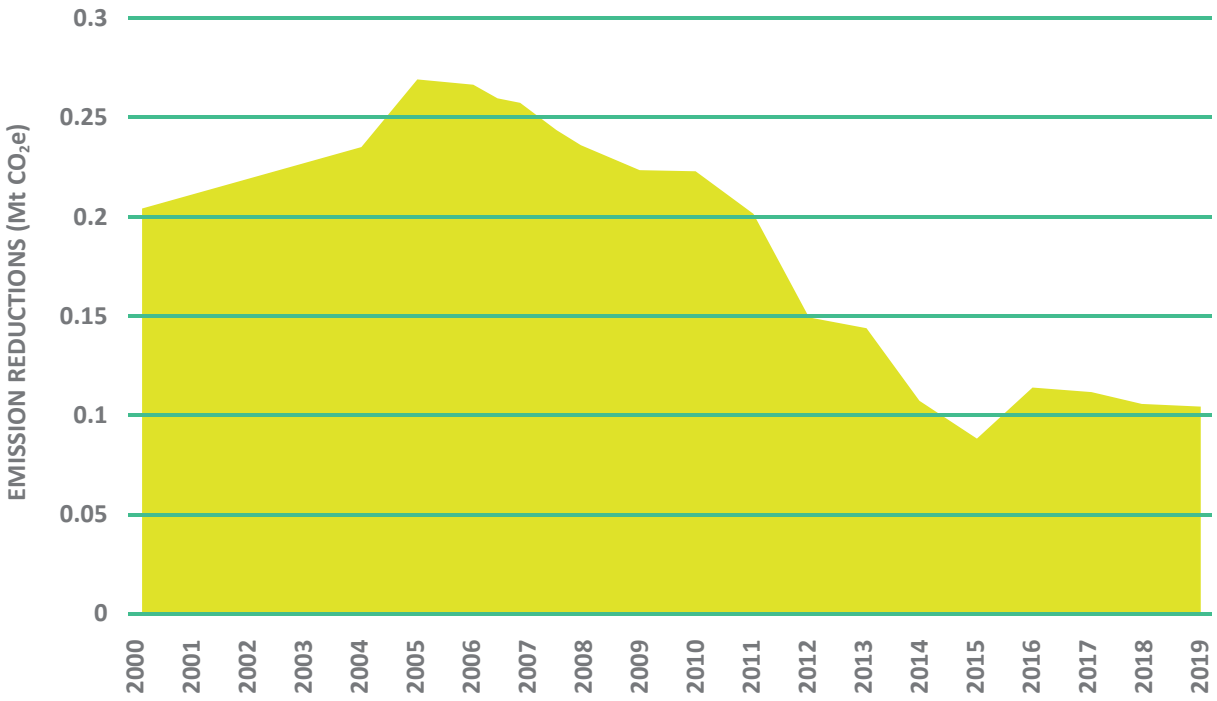
Table 3.9:
EMISSION REDUCTIONS IN THE AFOLU SECTOR.

NAME OF ACTION	FOCUS AREA	DESCRIPTION	INDICATOR	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$) 2015	2017	2019
AFFORESTATION	Forest land sink	DFFE's afforestation programmes, including the Working for Land and Working for Ecosystems afforestation programmes.	tCO_2e sequestered	0.03	0.03	0.04
CONSERVATION AGRICULTURE (CA) (LANDCARE PROGRAMME)	Cropland sink	Reduction of the carbon footprint in agriculture. Increase the absorption of CA into farming of cereal crops.	tCO_2e sequestered	0.72	0.83	0.96
FOREST REHABILITATION	Forest land sink	Restoring state forests and woodlands stems from the Draft Climate Change Sector Plan for DAFF (2015b) and the DAFF Strategic Plan 2015/2016 to 2019/2020 (DAFF, 2015a).	tCO_2e sequestered	0.01	0.02	0.02
THICKET RESTORATION	Forest land sink	Restoring thickets is supported by the Draft Climate Change Sector Plan for DAFF (2015b) and the DAFF Strategic Plan 2015/2016 to 2019/2020 (DAFF, 2015a).	tCO_2e sequestered	Not yet quantified		
GRASSLAND REHABILITATION (VELDCARE - LANDCARE PROGRAMME)	Grasslands sink	Grassland rehabilitation programme.	tCO_2e sequestered	0.58	0.64	0.68
TOTAL EMISSION REDUCTIONS FOR THE AFOLU SECTOR				1.34	1.52	1.7

3.6.1.4. Waste

Projects to reduce emissions in the waste sector are supported by the National Waste Management Strategy (NWMS). Projects under this strategy have led to a 0.1 $MtCO_2e$ reduction in emissions in 2019 (Table 3.10) and an accumulated savings of 3.7 $MtCO_2e$. There has been a slow reduction in emission savings since 2005.

Annual trends and accumulated savings: Waste



- ***National Waste Management Strategy: 3.7 $MtCO_2e$ (2000 - 2019)***

Table 3.10:
EMISSION REDUCTIONS IN THE WASTE SECTOR.

NAME OF ACTION	FOCUS AREA	DESCRIPTION	INDICATOR	ACTUAL EMISSION REDUCTIONS ($MtCO_2e$) 2015	2017	2019
NATIONAL WASTE MANAGEMENT STRATEGY	Waste Management	Provides the overall approach to national waste management during the lifecycle of waste, including waste avoidance and reduction, re-use and recycling, recovery, and treatment and disposal.	tCO_2e mitigated	0.09	0.11	0.11
TOTAL EMISSION REDUCTIONS FOR THE WASTE SECTOR				0.09	0.11	0.11

3.6.1.5. Challenges, gaps and constraints

There are several challenges in quantifying the emission reductions of the various actions across the sectors included above:

- Aggregated activity data:
  - o In the energy sector, the activity data is obtained as aggregated data making it difficult to separate out the CDM project reductions from the reductions due to government PAMs. This means that the total emission reductions reported for the energy sector are under-estimated as programmes with possible CDM projects are excluded.
- Lack of Global Warming Potentials (GWPs):
  - o In some cases, the emission reductions are provided in tCO_2e, yet the information regarding which GWPs were applied in the calculations has not yet been made available by the party responsible for calculating the emission reductions, where it is has not been calculated by the DFFE. This may lead to some inconsistencies. A structured reporting process, through the National Greenhouse Gas Emissions Reporting (NGER) system will assist in improving the accuracy of reporting. For the NGERs, activity data and emission factor data are required to be reported, and this will allow for the improvement of the emission calculations in the future.
- Lack of activity data:
  - o In the AFOLU sector it is challenging to set up a baseline and project scenarios for actions due to the inadequate reporting of activity data, such as plant and tree species composition, and individual responses implemented. The main reason being that most projects and policies in this sector are not designed for mitigation. As the sector becomes more aware of the data needs, this should improve. Also, climate change is starting to be included in sector strategies, which will highlight the need for appropriate activity data.
  - o Similar issues are seen in the waste sector.

3.6.1.6. Overall emission reduction impacts of sectoral PAMs

The total accumulated emission reductions between 2000 and 2019 are 216 $MtCO_2e$. Eighty-three percent of these emission reductions can be attributed to mitigation actions in the energy sector. Energy sector emission reduction contributions have increased since 2015, while the contribution has declined from all other sectors. Figure 3.1 shows the annual emission reductions relative to the national GHG emission inventory. Annual savings are estimated at 16.8 $MtCO_2e$, 18.5 $MtCO_2e$ and 24.3 $MtCO_2e$ in 2015, 2016 and 2017, respectively. As previously discussed, these estimates do not include any projects that have IMM project overlap. Since not all the excluded projects are IMM projects the emission reduction estimates provided here are likely to be underestimates.

Total accumulated savings (2000 - 2019): 215.6 $MtCO_2$

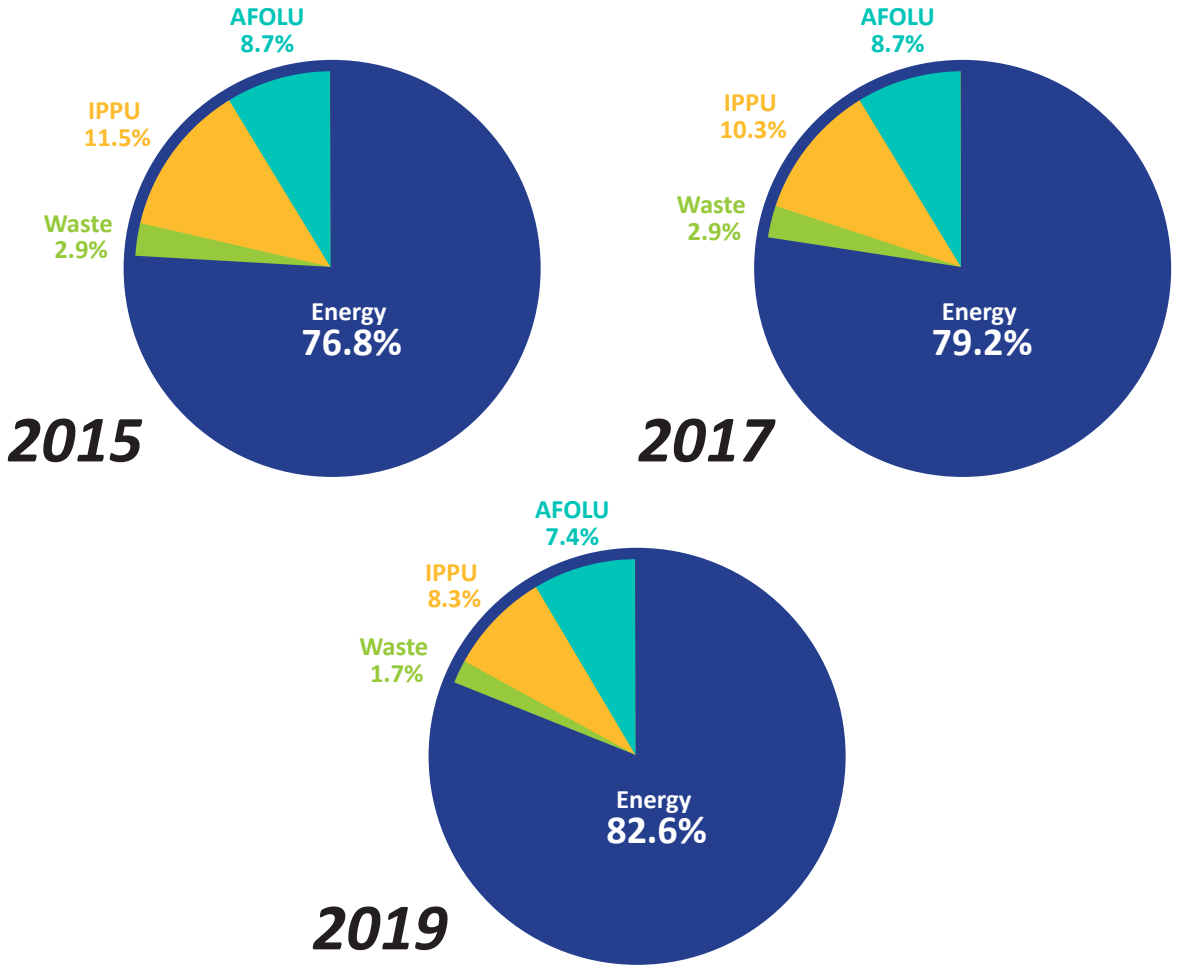
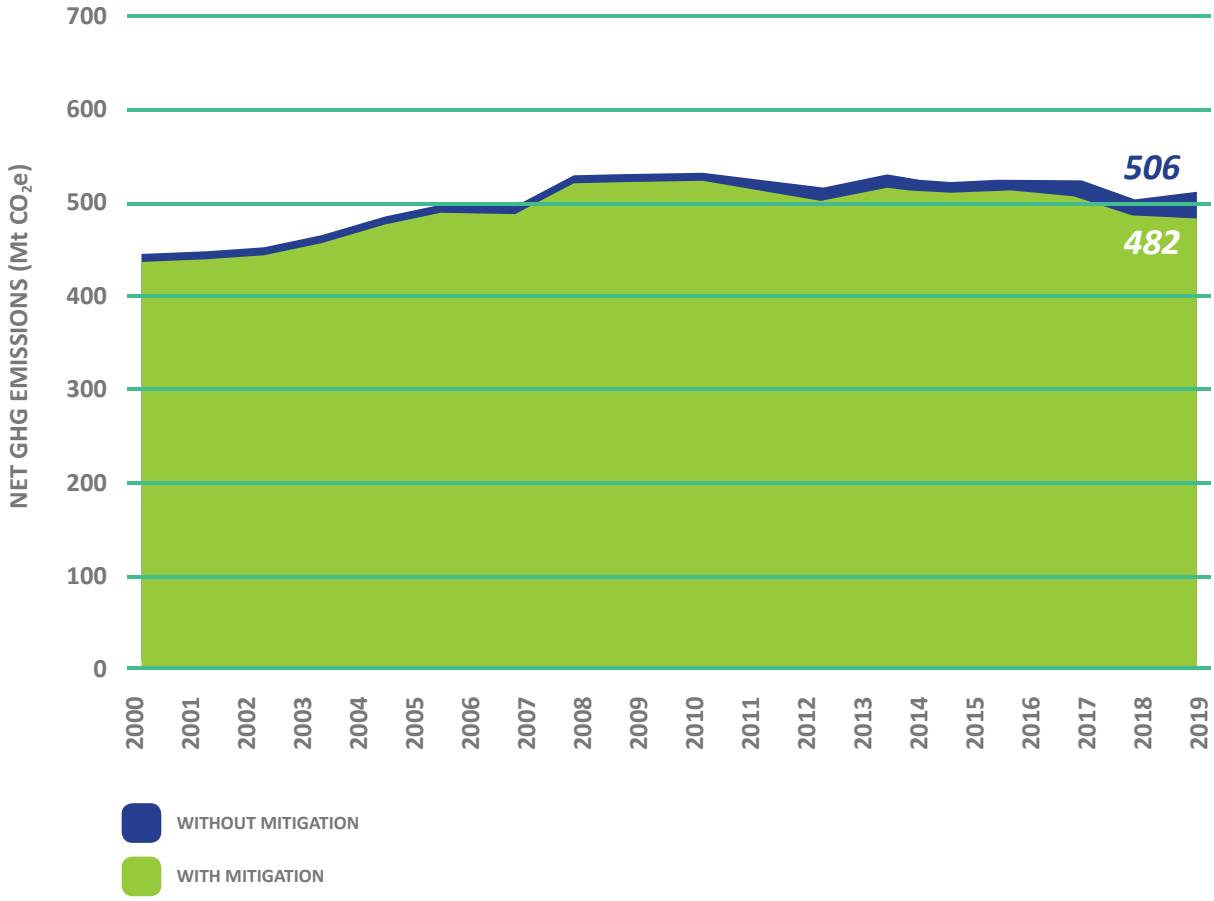


Figure 3.1:
ACHIEVED MITIGATION RELATIVE TO GHG EMISSIONS INVENTORY.



3.6.1.7. Co-benefits of actions

South Africa has started to identify the co-benefits of the mitigation actions and these are shown in Table 3.11.

Table 3.11:
IDENTIFIED CO-BENEFITS OF THE PAMS.

Sector	Action	Co-benefits		
		Environmental	Social	Economic
ENERGY	12L tax incentive programme	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes.	Increase in jobs due to uptake of energy efficient technologies.	Strengthening of green economy due to uptake of energy efficient technologies.
	Energy Efficiency Standards and Appliance Labelling project			
	Eskom IDM programme			
	Municipal Energy Efficiency and Demand-side Management programme			
	NCPC programme			
	PSEE programme			
	Natural gas fuel switch programme			
	Bus Rapid Transport System (BRT)			
	Transnet Road-to-Rail programme			
	Electric vehicles			
	Private sector embedded solar generation	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes.	Increase in jobs due to uptake of renewable energy technologies.	Strengthening of green economy due to uptake of renewable energy technologies.
	Renewable Energy Independent Power Producer Procurement programme			
IPPU	Carbon budgets and pollution prevention plans	Reduced air pollution due to the mitigation of fossil fuel combustion for energy generation purposes.	Increase in jobs due to uptake of energy efficient technologies.	Strengthening of green economy due to uptake of energy efficient technologies.
AFOLU	Afforestation	Sustainable, performing ecosystems and increased land productivity.	Increased biodiversity and soil quality can improve subsistence farming which can positively impact human health.	Improvements in subsistence farming can increase economic livelihoods and, therefore, resilience to negative climate impacts.
	Forest rehabilitation			
	Thicket restoration			
	Grassland rehabilitation			
	Conservation agriculture	Sustainable, performing ecosystems and increased land productivity.	Increased biodiversity, catchment management, water quality and soil quality can improve subsistence farming which can positively impact human health.	Improvements in subsistence farming can increase economic livelihoods and, therefore, resilience to negative climate impacts.
WASTE	National waste management strategy	Prevents pollution of water, soil and air	Reduces waste to landfill which has positive health impacts on society.	Stimulates job creation in the green economy through waste reduction, reuse and recycling.

Quantification of these co-benefits is complex. At this stage, the number of jobs in the green economy is being monitored for several sectoral programmes (Table 3.12). There is a challenge in the collation of information related to the green jobs, since this is not a performance indicator required for reporting purposes to National Treasury for national mitigation activities that are subsidised. Key sources of employment in the green economy include the REIPPPP, LandCare programme and the Extended Public Works Programme.

Table 3.12:
NUMBER OF GREEN JOBS IN SECTORAL PROGRAMMES.

Year	Renewable Energy Independent Power Producer Procurement programme (Full Time Equivalents)	LandCare work opportunities	Extended Public Works Programme (Full Time Equivalents)
2014	-	2 836	33 138
2015	24 964	2 043	28 141
2016	31 207	2 483	28 633
2017	35 607	2 012	40 368
2018	40 134	4 689	41 390
2019	48 334	Data unknown	Data unknown

3.7. ASSESSING THE IMPACT OF INTERNATIONAL MARKET-BASED MECHANISMS

There are a number of South African projects registered with the three main IMM standards: Clean Development Mechanism (CDM), Gold Standard and Verified Carbon Standard (VCS). Many of these projects have issued respective carbon credits, which have been verified by independent auditors.

Certified emission reductions (CERs) are issued under the CDM; verified emissions reductions (VERs) under the Gold Standard; and verified carbon units (VCUs) under the VCS. To date there are 360 CDM projects submitted to the DMRE. Of the 140 Project Design Documents, 90 have been registered by CDM and 15 issued with certified emission reductions. Projects cover all sectors and include projects on biofuels, energy efficiency, waste management, co-generation, fuel switching, hydro-power and other projects under the agriculture, mining, housing, transport and residential sectors. The VCS project details are obtained from the VCS database, while the Gold Standard projects need to be requested directly from Gold Standard.

The total carbon credits under these verified standards totalled 25.7 $MtCO_2e$ in 2017 and 2019, with the energy sector contributing 79.4% to the total (Table 3.13). A detailed list of projects is provided in Table 3.14, Table 3.15, Table 3.16 and Table 3.17. Combining the reductions from the PAMs with the IMM project reductions, the total savings in 2017 and 2019 are 49.93 $MtCO_2e$ and 57.02 $MtCO_2e$ respectively (Figure 3.2).

Table 3.13:
SUMMARY OF THE SOUTH AFRICAN IMM PROJECT EMISSION REDUCTIONS.

	Savings ($MtCO_2e$)				
Year	Energy	IPPU	AFOLU	Waste	Total
2004	0.06	0.00	0.00	0.00	0.06
2005	0.55	0.00	0.00	0.00	0.55
2006	0.55	0.00	0.00	0.07	0.62
2007	0.65	0.00	0.00	0.10	1.92
2008	0.74	0.00	0.00	0.37	3.28
2009	1.93	0.00	0.00	1.51	5.62
2010	3.25	0.00	0.00	1.87	7.30
2011	3.90	1.08	0.02	1.87	7.97
2012	9.61	1.82	0.02	2.88	15.03
2013	12.13	1.82	0.02	2.95	17.62
2014	15.65	1.82	0.06	2.98	21.22
2015	18.47	1.82	0.06	2.98	24.03
2016	19.30	2.16	0.06	3.02	24.91
2017	20.02	2.16	0.06	3.05	25.66
2018	20.04	2.16	0.06	3.05	25.68
2019	20.04	2.16	0.06	3.05	25.68
TOTAL	146.88	25.65	0.41	29.75	207.15

GHG emission reductions for the energy sector for IMM projects are 0.06 $MtCO_2e$ in 2004 and then grow to 20.04 $MtCO_2e$ in 2019. Waste and IPPU projects have contributed 29.75 $MtCO_2e$ and 25.65 $MtCO_2e$ to total emission reductions respectively between 2000 and 2019. A lesser contribution is made from projects in the AFOLU sector with 0.06 $MtCO_2e$ estimated in emission reductions.

Figure 3.2:
EMISSION REDUCTIONS FROM PAMS ACTIONS AND IMM PROJECTS.

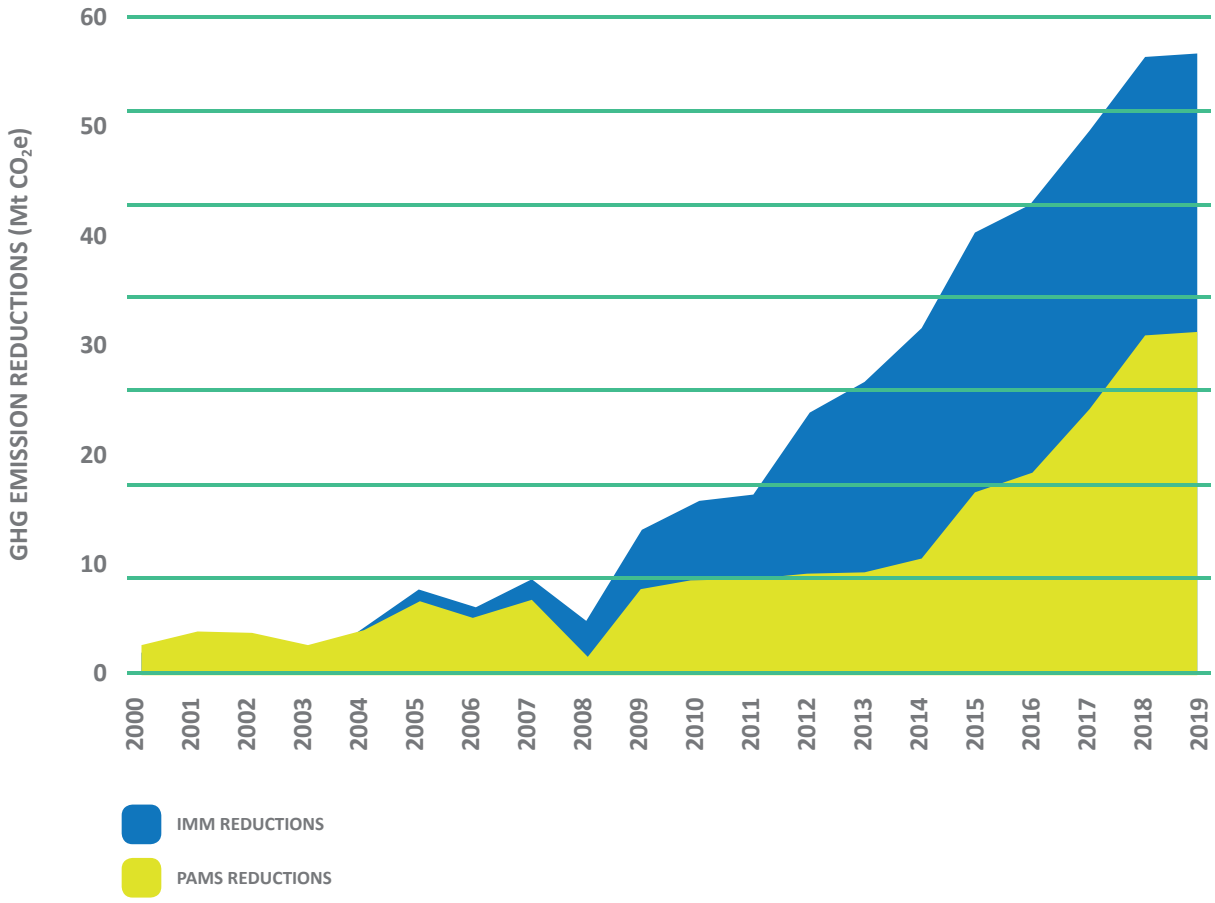


Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Bethlehem Hydroelectric project, South Africa	A hydroelectricity project which will be distributed into the currently coal intensive South African grid.	From 2009-2023	0.33	CO_2	205 391	Energy Industries	CDM	Registered with Issuances
Coega Industrial Development Zone Windfarm, South Africa	Construction and operation of 25 wind turbines which will generate 141.7 GWh annually.	From 2013-2020	0.65	CO_2	0	Energy Industries	CDM	Registered
De Aar Grid Connected 10 MW Solar Park, South Africa	Construction and operation of a solar park with the rated capacity of 10 MW.	From 2013-2020	0.11	CO_2	0	Energy Industries	CDM	Registered
Trigeneration at Mobile Telephone Networks (MTN), 14th Avenue Commercial Site, South Africa	Installation of an on-site, energy efficient, 2.126 MW trigeneration plant.	From 2013-2022	0.05	CO_2	0	Energy Demand	CDM	Registered with a monitoring report/s
Grahamstown Invasive Biomass Power Project, South Africa	Involves the utilisation of wood chips from Invasive Alien Plants as the sustainable biomass feedstock.	From 2013-2022	0.15	CO_2	0	Energy Industries	CDM	Registered
Dassieklip Wind Energy Facility, South Africa	Establish a commercial Wind Energy Facility and associated infrastructure on a site located near the town of Caledon in the Western Cape Province.	From 2013-2023	0.40	CO_2	0	Energy Industries	CDM	Registered
Prieska Grid Connected 20 MW Solar Park, South Africa	The project envisages the construction and operation of a solar park with the installed capacity of 20.65 MWh. The solar park will be equipped with several arrays of photovoltaic (PV) panels. It is expected that Trina PV solar panels supplied by Gestamp Solar will be used for this project. Produced electricity will be supplied to the Eskom electricity network.	From 2013-2023	0.23	CO_2	0	Energy Industries	CDM	Registered
Neusberg Grid Connected Hydroelectric Power Plant, South Africa	Building a new anaerobic lagoon for a piggery and line it with an impermeable membrane and seal it with an expandable membrane roof. Harvesting of the biogas produced as an energy source.	From 2014-2021	0.33	CO_2	0	Energy Industries	CDM	Registered
Kathu Grid Connected 100 MW Solar Park, South Africa	The project development envisages the construction and operation of a solar park with an output capacity of up to and including 100 MW. The solar park will be equipped with a cluster of photovoltaic (PV) panel arrays, and the associated infrastructure. Produced electricity will be supplied to the Eskom electricity network.	From 2014-2021	1.19	CO_2	0	Energy Industries	CDM	Registered
Cookhouse Wind Farm, South Africa	African Clean Energy Developments (ACED) is proposing to establish a commercial Wind Energy Facility and associated infrastructure on a site located near the town of Cookhouse in the Eastern Cape Province Of South Africa.	From 2014-2024	1.69	CO_2	0	Energy Industries	CDM	Registered

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Red Cap Kouga Wind Farm, South Africa	Red Cap Kouga Wind Farm (Pty) Ltd is developing the Kouga Wind Farm in Oyster Bay, South Africa. The project will comprise the installation of 32 Nordex N90 2500 HS wind turbines, each turbine of 2.5MW with a total installed capacity of 80 MW. This site will be able to generate 290,500 MWh per year, using a P50 capacity.	From 2014-2024	1.32	CO_2	0	Energy Industries	CDM	Registered
Hopefield Wind Energy Facility, South Africa	The establishment of a commercial wind energy facility and associated infrastructure on a site near Hopefield in the Western Cape Province. This proposed project will be a greenfield wind energy facility.	From 2014-2024	0.86	CO_2	0	Energy Industries	CDM	Registered
Fuel Switch at Corobrik's Driefontein Brick Factory, South Africa	A complete fuel switch was implemented in December 2007 at Driefontein Brick Factory. This fuel was used in the clay brick-firing tunnel kiln. The fuel conversion was from coal to natural gas and involved the extension of the Sasol- owned natural gas pipeline and the installation of a combustion system.	From 2015-2021	0.26	CO_2	0	Energy Industries	CDM	End of crediting peroid
TWE Golden Valley Wind Power Project, South Africa	The purpose of the TWE Golden Valley Wind Power Project is the construction of a 147.6 MW wind power plant in the Eastern Cape Province of South Africa.	From 2015-2022	1.77	CO_2	0	Energy Industries	CDM	Registered
Lomati Biomass Power Generation Project in Mpumalanga Province, South Africa	A greenfield grid-connected biomass cogeneration power plant is proposed at Barberton town, Umjindi municipality, Mpumalanga province, South Africa. The plant will be owned by Lomati Energy (Pty) Ltd, an independent energy company.	From 2015-2024	0.26	CO_2	0	Energy Industries	CDM	Registered
West Coast 1 Wind Farm, South Africa	The project developer Moyeng Energy (Pty) Ltd is proposing to establish a commercial Wind Energy Facility and associated infrastructure on a site located near the town of Vredenburg in the Western Cape Province of South Africa.	From 2015-2024	1.07	CO_2	0	Energy Industries	CDM	Registered
Karoo Renewable Energy Facility (NobelsfonteiWind and Solar PV), South Africa	The Karoo Renewable Energy Facility (Nobelsfontein Wind) Project is developed by South African Renewable Green Energy Pty Ltd. The project site is located within the Northern Cape and Western Cape provinces, approximately 34 km south of the town of Victoria West. The majority of the site is located within the Ubuntu Local Municipality, with a smaller portion within the Beaufort West Local Municipality.	From 2014-2024	5.6	CO_2	0	Energy Industries	CDM	Registered
Rheboksfontein Wind Energy Facility, South Africa	Micawber 895 (Pty) Ltd is developing the Rheboksfontein Wind Energy Facility (hereinafter the "Project") in Western Cape, South Africa. The project will comprise the installation of 35 Vestas V112 wind turbines, each turbine of 3MW with a total installed capacity of 105 MW and is expected to generate 360,500 MWh/year.	From 2015-2025	1.25	CO_2	0	Energy Industries	CDM	Registered

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Amakhala Emoyeni Grid Connected 138.6 MW Wind Farm, Phase 1, South Africa	The proposed "Amakhala Emoyeni Grid Connected 138.6 MW Wind Farm, Phase 1, and South Africa" project is a Greenfield renewable energy power plant. The aim of the project is to supply wind-generated electricity to the grid of the Republic of South Africa.	From 2016-2026	1.11	CO_2	0	Energy Industries	CDM	Registered
Bokpoort Concentrating Solar Power Project, South Africa	The purpose of the proposed project activity is to reduce green-house gas emissions by installing a greenfield grid-connected parabolic trough concentrated solar thermal power plant. This type of technology is clean, safe, sound and environmentally friendly in comparison to conventional sources of fossil fuel power generation in South Africa.	From 2016-2026	0.62	CO_2	493 366	Energy Industries	CDM	Registered with Issuances
Transalloys Manganese Alloy Smelter Energy Efficiency Project, South Africa	An industrial energy efficiency project that will reduce the electricity consumption in the production of silicomanganese alloy (a key component in steel making) at its Witbank facility in South Africa.	From 2004-2014	0.83	CO_2	648 606	Energy Industries; metal production	CDM	End of crediting peroid
Fuel switch project on the Gluten 20 dryer of Tongaat Hulett Starch Pty (Ltd) Germiston Mill, South Africa	The purpose of the project is to reduce greenhouse gas emissions and unpleasant offgas smells in a product dryer of Tongaat Hulett Starch (Pty) Ltd by switching fuel from coal to natural gas.	From 2010-2017	0.05	CO_2	0	Energy Industries	CDM	End of crediting peroid
The Capture and Utilisation of Methane at the Sibanye Gold Owned Beatrix Mine, South Africa	The proposed project activity involves the destruction and utilisation of methane at this mine.	From 2011-2020	0.09	CH_4, CO_2	9 643	Fugitive emissions from industrial gases	VCS	Registered
Tongaat Hulett Sugar Refinery Steam Optimisation Project	The proposed project activity is a steam optimisation project centred on a step change in the sugar crystallisation process that allows for the use of waste heat vapour in the evaporation process as an alternative energy source to the primary steam currently used within this process.	From 2014-2024	0.48	CO_2	0	Energy Demand	CDM	Registered
Use of waste gas at Namakwa Sands, South Africa	The project will use cleaned furnace off-gas, which was previously flared, to generate electricity using internal combustion engines. The actual quantity of gas available for the project depends on the furnace performance and availability.	From 2013-2022	0.51	CO_2	222 006	Energy Industries; Manufacturing Industries	CDM	Registered
IFM Integrated Clean Energy Project, South Africa	The purpose of the proposed project activity is to utilise waste furnace off-gas as a source of energy to generate clean electricity and contribute to lower greenhouse gas emissions by replacing fossil fuel-based electricity from the South African national grid.	From 2013-2023	0.86	CO_2	0	Energy Industries; Manufacturing Industries	CDM	Registered

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
SA Calcium Carbide Furnace Waste Gas to Electricity, South Africa	SA Calcium Carbide (SACC) (Pty) Ltd in Newcastle, South Africa is to develop an electricity generation project utilising furnace waste gas that has been flared since the construction of the industrial facility.	From 2013-2023	0.21	CO_2	0	Manufacturing Industries	CDM	Registered
Hernic's Electricity Generation from Waste Gas Project, South Africa	The proposed project activity is an initiative to recover combustible waste gas from four existing closed ferrochrome furnaces at Hernic. The envisaged project will use the combustible waste gas in fifteen internal combustion gas engines with a maximum capacity rating (MCR) of 1.698MW each.	From 2014-2024	0.76	CO_2	0	Energy Industries; Manufacturing Industries	CDM	Registered
Samancor Chrome Middelburg Electricity from Waste Gas, South Africa	The proposed project activity is an initiative to recover waste energy in the form of flared waste gas from two existing ferrochrome closed furnaces at MFC. The envisaged project will use the combustible waste gas in an estimated twenty gas engines with a guaranteed maximum continuous rating (MCR) of 1.698 MW2 each.	From 2014-2024	0.95	CO_2	0	Energy Industries	CDM	Registered
Samancor Chrome Witbank Electricity from Waste Gas, South Africa	The proposed project activity is an initiative to recover waste energy in the form of flared waste gas from two existing closed ferrochrome furnaces at FMT. The envisaged project will use the combustible waste gas in fourteen gas engines with a guaranteed maximum continuous rating (MCR) of 1.698 MW2 each.	From 2014-2024	0.71	CO_2	0	Energy Industries; Manufacturing Industries	CDM	Registered
Distributed Energy Generation's Waste Heat to Power Project at XAWO, South Africa	The proposed project activity is an initiative to recover waste heat in a non-combustible waste gas from six existing semi-closed type ferrochrome furnaces at XAWO. The envisaged project will divert the waste heat to an Organic Rankine Cycle (ORC) facility, which will convert low-grade heat into usable electrical energy.	From 2016-2025	0.79	CO_2	0	Energy Industries; Manufacturing Industries	CDM	Registered
Kanhym Farm manure to energy project, South Africa	Kanhym is the biggest pig farm in South Africa, home at any given time to more than 45,000 pigs. The proposal is to build a new anaerobic lagoon upstream from the current one line it with an impermeable membrane and seal it with an expandable membrane roof.	From 2008-2015	0.36	CH_4, CO_2	0	Energy Industries; Agriculture	CDM	Registered
Manufacture and utilisation of bio-coal briquettes in Stutterheim, South Africa	The project activity involves setting up a production facility to manufacture bio-coal pellets and briquettes in Sutterheim, Eastern Cape of South Africa. The briquettes shall be sold to existing customers wherein fossil fuel- coal is presently used or proposed to be used, as the primary fuel for generation of thermal energy in absence of project activity. Thus, the project activity will replace coal combustion in coal-fired boilers.	From 2015-2024	0.53	N_2O, CO_2	0	Biomass Energy	CDM	Registered

Table 3.14:
EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Mondi Richards Bay Biomass Project, South Africa	The project activity includes the collection of biomass residues from plantations and nearby Chipping facilities, transported to Mondi Business Paper Richards Bay (hereafter referred to as Mondi), cleaned (for example removal of metal objects and sand), shredded and fired as fuel in a co-fired boiler, replacing coal. The proposed project activity is designed to increase the use of self-generated bark and enable the introduction of third party generated biomass residues as feed into a co-fired boiler for the generation of steam.	From 2005-2015	6.60	CH_4, CO_2	0	Biomass Energy	CDM	Validation replaced
Green Power for South Africa	The objective of the proposed programme of activities is to install wind and solar projects to generate electricity. The generated electricity will be connected to the national grid.	From 2011-2039	8.63	CO_2	598 331	Solar PV	CDM	Registered with Issuances
SASSA Low Pressure Solar Water Heater Programme, South Africa	The objective of the PoA is to install South African Bureau of Standards approved non-pressure storage tank and vacuum tube solar collectors of SASSA to low-income households.	From 2011-2038	2.61	CO_2	99 170	Solar Water Heating	CDM	Registered with Issuances
South Africa Renewable Energy Programme (SA-REP), South Africa	The purpose of the Programme of Action (PoA) is to support the development and implementation of small-scale grid connected renewable energy project.	From 2012-2040	0.45	CO_2	88 537	Solar, Wind and Other	CDM	Registered with an Issuance Request
Kuyasa low-cost urban housing energy upgrade project, Khayelitsha, Cape Town, South Africa	Energy efficiency project involving the installation of solar water heaters, ceiling insulation and compact fluorescent light bulbs (CFLs) in RDP houses.	From 2005-2012	0.05	CO_2	9 532	EE Households	CDM	End of Crediting Period
Compressed Air Energy Efficiency PoA, South Africa	The purpose of the PoA is to reduce greenhouse gas emissions through the implementation of energy efficiency measures in the compressed air system.	From 2012-2038	0.19	CO_2	0	EE Industry	CDM	Validation terminated
Green Steam Low Pressure Solar Water Heater Programme for South Africa	Installations of low-pressure vacuum tube solar water heaters to low-income households across South Africa.	From 2011-2039	0.09	CO_2	0	Solar Water Heating	CDM	Validation
Technology Transfer mechanism Introduction of Vertical Shaft Brick Kiln (VSBK) Technology at Vhavenda Brick, South Africa	The project will involve a technology transfer mechanism upgrading from Clamp Kilns to Vertical Shaft Brick Kilns (VSBKs) – proven to be the cleanest and most energy efficient way of firing clay masonry products.	From 2013-2023	0.16	CH_4, CO_2	0	EE Industry	CDM	Registering
CDM Africa Wind and Solar Programme of Activities for South Africa	Programme for the installation of either wind or solar projects generating electricity into the national grid across South Africa.	From 2013-2039	13.41	CH_4, CO_2	0	Solar and Wind	CDM	Registered

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Market Coke Waste Heat Recovery Project, South Africa	Exxaro Resources Limited (Exxaro) plans to construct the Market Coke Plant (the project facility) at their Grootegeluk Coal Mine in Limpopo Province of South Africa.	From 2015-2025	1.66	CO_2	0	EE Own Generation	CDM	Rejected
Indwe Wind Project, South Africa	The objective of the proposed project is to construct a grid connected wind energy project in South Africa. It will have installed electricity generation capacity of 57.5 MW. The generated electricity will be sold to Eskom in order to diversify the grid generation.	From 2012-2041	1.08	CH_4, CO_2	0	Wind	CDM	End of Crediting Period
Kloof #3 Ice Chiller project, South Africa	The project involves the introduction of ice- chiller system where ice would be the prime carrier of chill energy as opposed to water.	From 2010-2017	0.38	CO_2	0	EE Industry	CDM	End of Crediting Period
Sustainability CFL Replacement Programme of Activities in South Africa	The objective of the project is to maintain energy efficiency of S.A's residential lighting stock achieved by the previous Eskom CFL projects by distributing the Compact Fluorescent Lamps (CFLs) free of charge.	From 2012-2039	0.21	CO_2	0	EE Households	CDM	Registered
Dorper Wind Farm (Pty) Ltd, South Africa	The objective of the project is to build grid connected wind energy project in South Africa and contribute to the necessary energy expansion needed.	From 2013-2031	6.31	CH_4, CCO_2	0	Wind	CDM	End of Crediting Period
Omnia Steam Turbine Project, South Africa	The proposed project activity will generate energy from the wasted pressure release. This will be done by replacing the pressure reducing the valves with a steam turbine which will generate electricity. The technology to be employed involves the installation of a steam turbine.	From 2009-2016	0.10	CO_2	0	Manufacturing Industries	CDM	End of Crediting Period
Solar Energy and Energy Efficiency in Africa, South Africa	This programme will install South African Bureau of Standards (SABS) approved solar water heaters and PVA to households free of charge or at minimal cost.	From 2012-2040	0.00	CO_2	0	Solar	CDM	Validation terminated
Vertical Shaft Brick Kiln (VSBK) Programme of Activities for South Africa	The goal of the PoA is to improve the energy efficiency of the brick firing process in South Africa.	From 2012-2040	0.04	CH_4, CO_2	0	EE Industry	CDM	Validation
Energy Efficient Cook stoves in South Africa	The proposed small scale CPA involves the installation of energy efficient improved biomass based improved cooking stoves in households.	From 2012-2040	0.22	CH_4, CO_2, N_2O	0	EE Households	CDM	Registered
NCP Fuel Switch and Energy Efficient Boiler project, South Africa	The project is a fuel switch from coal to methane gas at the NCP manufacturing facility	From 2011-2020	0.36	CO_2	0	Fossil Fuel SWitch	CDM	Validation

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Grid Connected Wind Power Plant in Witberg, South Africa	The objective of the project is to reduce greenhouse gases by installing a wind power plant with a generating capacity of 150 MW and supply it into SAs national electricity.	From 2014-2020	2.64	CH_4, CO_2, N_2O	0	Wind	CDM	Validation terminated
Karbochem Combined Heat and Power Project, South Africa	The project involves the replacement of coal with Sasol gas as energy source for the steam production.	From 2009-2016	1.64	CH_4, CO_2, N_2O	0	Fossil Fuel Switch	CDM	End of Crediting Period
Cogeneration from Waste Smelter Gas at Richards Bay Minerals, South Africa	The project activity involves the use of the flared waste gas to generate electricity and heat. The cogeneration plant will be made up of 6 internal combustion engines, each providing an electrical output of 1.5MW of electricity. The engines will run entirely on the furnace gas which is currently flared into the atmosphere.	From 2010-2017	0.20	CH_4, CO_2, N_2O	0	EE Own Generation	CDM	End of Crediting Period
Refrigeration Plant Efficiency Programme of Activities, South Africa	The goal of this project is to retrofit commercial refrigeration plants in up to 167 Pick n Pay stores across South Africa.	From 2011-2020	0.40	CH_4, CO_2, N_2O	0	EE Service	CDM	Validation
South African Wind Power Projects	The goal of the project is to promote the installation of grid connected wind energy generation facilities across South Africa.	From 2012-2019	0.65	CH_4, CO_2, N_2O	0	Wind	CDM	Registered
Silicon Smelters Energy Efficiency Improvement Project (Furnace F), South Africa	The project will reduce greenhouse gases emissions by reducing the use of fossil fuel based electricity consumption by installing more energy efficient cylindrical rotating electric arc furnace, electrode assemblies, and control and peripheral systems.	From 2012-2022	0.16	CH_4, CO_2, N_2O	0	EE Industry	CDM	Validation terminated
Tubatse Chrome 30 MW Waste Energy Recovery & Power Generation Project, South Africa	The waste energy recovery power generation project at Tubatse Chrome will recover thermal energy from exhaust gases removed from 6 ferrochrome submerged arc furnaces (SAF).	From 2013-2023	0.98	CH_4, CO_2, N_2O	0	EE Own Generation	CDM	Validation terminated
Springbok Grid Connected 55.5 MW Wind Farm, South Africa	The aim of the proposed project is to construct and operate a wind farm with an installed capacity of up to 55.5mw and supply electricity generated to the National Grid.	From 2014-2021	0.64	CH_4, CO_2, N_2O	0	Wind	CDM	Registered
Wind and solar PoA in South Africa	The objective of the proposed programme is to install wind and solar projects into the grid of South Africa.	From 2012-2019	0.12	CH_4, CO_2, N_2O	0	Hybrid Renewables	CDM	Registered
Renewable Energy Carbon Programme for Africa (RECPA), South Africa	The purpose of the programme is to support the development and implementation of small-scale renewable energy projects in South Africa in order to displace grid-connected, fossil fuel-based electricity generation, thereby reducing GHG emissions.	From 2012-2019	0.93	CH_4, CO_2, N_2O	0	Hybrid Renewables	CDM	Registered

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Grid-Connected Wind Power Programme in South Africa	The objective of the proposed programme is to reduce greenhouse gas emissions through the production of electricity from wind.	From 2013-2020	2.12	CH_4, CO_2, N_2O	0	Wind	CDM	Validation terminated
Waste energy to electricity at ArcelorMittal's Vanderbijlpark Steel, South Africa	The objective of the project is to construct and operate a new waste energy recovery system which consists of the two new direct reduction kilns. It will have an installed power capacity of 40 MW.	From 2012-2021	1.77	CH_4, CO_2, N_2O	0	EE Own Generation	CDM	Validation terminated
New Denmark Colliery CMM flaring project South Africa	The project proposes destruction of methane from New Denmark Colliery mine by flaring	From 2010-2017	0.17	CH_4, CO_2, N_2O	0	Coal Bed / Mine Methane	CDM	End of Crediting Period
New Energies Commercial Solar Water Heating Programme, South Africa	The project aims at retrofitting of existing electric water heating technologies with solar based water heating technologies and installation of new solar water heating at newly built facilities.	From 2008-2015	0.01	CH_4, CO_2, N_2O	0	Solar	CDM	Validation
New England Landfill Gas to Energy Project, South Africa	The project proposes to collect and utilise the landfill gas (LFG) generated at the New England Landfill site.	From 2010-2017	0.36	CH_4, CO_2, N_2O	0	Landfill Gas	CDM	End of Crediting Period
South African Solar Water Heater Programme	The PoA is a programme for the installation of Solar Water Heaters in SA for domestic use.	From 2009-2016	0.05	CH_4, CO_2, N_2O	0	Solar	CDM	Validation terminated
Biomass Energy Generation through Gasification or Direct Combustion, South Africa	The Programme of Activities will involve renewable energy projects in South Africa, where energy will be derived from renewable biomass through gasification or direct combustion.	From 2012-2020	0.00	CH_4, CO_2, N_2O	0	Biomass Energy	CDM	Withdrawn before Publication
Standard Bank Low Pressure Solar Water Heater Programme for South Africa	The objective of the Programme of Activities is to install South African Bureau of Standards (SABS) approved non-pressure (also called low-pressure) Solar Water Heaters to low-income households at minimal cost.	From 2012-2019	1.41	CH_4, CO_2, N_2O	0	Solar	CDM	Registered
Caledon Wind Farm, South Africa	The purpose of the project activity is to generate power from wind energy in the Western Cape, South Africa. The electricity will be sold to Eskom.	From 2015-2025	1.48	CH_4, CO_2, N_2O	0	Wind	CDM	Registering
Grid Connected Wind Power Plant in Klawer, South Africa	The objective of the proposed project is to use wind turbine to generate electricity.	From 2014-2020	0.41	CH_4, CO_2, N_2O	0	Wind	CDM	Validation terminated
Solar Energy Programme for South Africa	The goal of the PoA is to develop Solar PV (Photovoltaic) facilities that will supply renewable electricity into the South African national grid.	From 2012-2019	2.43	CH_4, CO_2, N_2O	0	Solar	CDM	Registered

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
South African Large-Scale Grid Connected Solar Park Programme	The programme seeks to develop a series of grid connected solar power projects that supply clean electricity to either the national grid of the RSA or an identified consumer via RSA's grid.	From 2012-2019	0.46	CH_4, CO_2, N_2O	0	Solar	CDM	Registered
NuPlanet Small Scale Hydropower PoA, South Africa	The purpose of the project is to support the development of hydropower projects that will supply renewable electricity into the grid.	From 2012-2019	0.17	CH_4, CO_2, N_2O	0	Hydro	CDM	Registered
ACP Thermal Harvesting Project, South Africa	The aim of the project activity is to convert waste heat into electricity. The ACP Thermal Harvesting™ Project envisages the construction and operation of a Waste Energy Recovery System.	From 2018-2027	0.02	CH_4, CO_2, N_2O	0	EE Own Generation	CDM	Registered
Southern Cape Cleaner Energy Project, South Africa	The project activity will reduce greenhouse gas (GHG) emissions by supplying clean electricity into the national grid and replacing electricity generated from fossil fuel sources.	From 2009-2019	0.63	CH_4, CO_2, N_2O	0	Biomass Energy	CDM	End of Crediting Period
Capture and combustion of methane in coal mines, South Africa	The objective of the proposed PoA is to reduce greenhouse gas emission through capturing and flaring of mine methane.	From 2012-2019	1.26	CH_4, CO_2, N_2O	0	Coal Bed / Mine Methane	CDM	Validation terminated
Installation of energy efficient ventilation fans at the KDC East Gold Mine, South Africa	The purpose of the PoA is to reduce greenhouse gas emissions through the implementation of energy efficiency ventilation project in underground mining operations.	From 2013-2022	0.21	CH_4, CO_2, N_2O	0	EE Industry	CDM	Registering
BioTherm Hernic Ferrochrome Cogeneration Project, South Africa	The aim of this project is to flare the poisonous CO rich off gas produced as a by-product of the smelting process, into CO_2. A proposed power generation facility will use the off gas as the primary fuel source. The electricity produced will be fed back into Hernic substation.	From 2011-2021	1.49	CH_4, CO_2, N_2O	0	EE Own Generation	CDM	Validation terminated
Boskor Renewable Electricity Plant (BREP), South Africa	The project activity involves generating electricity from sawmill residues, for sale onto the national grid.	From 2008-2018	0.14	CH_4, CO_2, N_2O	0	Biomass Energy	CDM	End of Crediting Period
Olifantsrivier Wind, South Africa	The objective of the proposed project activity is to supply renewable energy, generated from solar resources to the South African national grid.	From 2015-2024	2.88	CH_4, CO_2, N_2O	0	Wind	CDM	Validation terminated
Cogeneration and/or trigeneration at commercial sites, South Africa	The objective of the proposed project is to install and operate a new 2.136 MWe natural gas-based tri-generation unit at an existing site of MTN.	From 2012-2019	0.03	CH_4, CO_2, N_2O	0	EE Supply Side	CDM	Registered
Langa Energy Photovoltaic Solar Energy Facility, South Africa	The objective of the proposed project is to construct and operate a solar park with installed capacity of about 100 MW of electricity.	From 2013-2023	0.81	CH_4, CO_2, N_2O	0	Solar	CDM	Validation terminated

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
The Consteel Energy Efficiency project at Cape Gate, South Africa	The proposed project involves the installation of energy efficient consteel system. The Consteel technology, which was implemented in this project reduces energy consumption of steel production, while also increasing the output.	From 2012-2021	0.15	CH_4, CO_2, N_2O	0	EE Industry	CDM	Validation terminated
LED's kick-off, South Africa	The CDM Programme of Activities (CPA) will involve the distribution of Light Emitting Diode lighting devices in mining and petrochemical plant activities.	From 2012-2019	0.34	CH_4, CO_2, N_2O	0	EE Service	CDM	Registered
Microscale solar electrical programme, South Africa	The objective of the proposed PoA is to promote small scale activities (CPAs) that installs solar photovoltaic electrical systems.	From 2011-2018	0.04	CH_4, CO_2, N_2O	0	Solar	CDM	Validation terminated
ETA Solar Water Heater Programme, South Africa	The objective of the project is increasing the use of solar water heaters in residential and commercial applications throughout S.A. by installing and supplying solar water heaters.	From 2012-2019	0.14	CH_4, CO_2, N_2O	0	Solar	CDM	Registered
Residential Hot Water Efficiency Programme, South Africa	The objective of the PoA is to install solar water heaters and heat pumps at residential facilities throughout SA.	From 2012-2019	0.20	CH_4, CO_2, N_2O	0	Solar	CDM	Registered
South African Grid Connected Wind Farm Programme	The objective of the proposed PoA is to contribute to the development and promotion of renewable energy in the South Africa. It seeks to develop a series of grid connected wind power projects.	From 2012-2019	2.20	CH_4, CO_2, N_2O	0	Wind	CDM	Registered
Heat Retention Cooking, South Africa	The aim of this project is to introduce a heat-retention cooker known as Wonder bag. This is an insulated container designed to hold a hot-pot safely for several hours, so that food can be cooked through heat retention.	From 2012-2019	0.37	CH_4, CO_2, N_2O	0	EE Households	CDM	Validation terminated
Clanwilliam Hydro Electric Power Scheme, South Africa	The objective of the project is to supply clean electricity to the grid of the Republic of South Africa. It envisages the construction and operation of a run-off-river hydroelectricity power plant.	From 2008-2015	0.88	CH_4, CO_2, N_2O	0	Hydro	CDM	End of Crediting Period
North West, KwaZulu-Natal & Eastern Cape CFL Replacement Project (2), South Africa	The proposed PoA objective is to boost the energy efficiency of South Africa's residential lighting stock by distributing Compact Fluorescent Lamps (CFLs) free of charge.	From 2012-2022	0.15	CH_4, CO_2, N_2O	0	EE Households	CDM	Registered
Southern African Solar Electrical Energy Programme (SASEE), South Africa	The objective of the proposed PoA is to promote small scale activities (CPAs) that installs solar photovoltaic electrical systems.	From 2011-2018	0.19	CH_4, CO_2, N_2O	0	Solar	CDM	Validation
Sasol Gas Turbine Co-generation at Sasol Secunda Synfuels plant, South Africa	The objective of the project is to substitute some of the electricity imported from Eskom with electricity generated on site at Secunda using natural gas and project fuel.	From 2010-2020	10.84	CH_4, CO_2, N_2O	0	EE Own Generation	CDM	Validation terminated

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Grid Connected Photovoltaic (PV) Renewable Electricity Generating Facilities PoA, South Africa	The goal of the PoA is to develop grid connected concentrated solar power and Photovoltaic (PV) power generating facilities in South Africa.	From 2012-2019	0.13	CH_4, CO_2, N_2O	0	Solar	CDM	Registered
Small Scale Grid-connected Solar Power Programme, South Africa	The objective of the proposed PoA) is to promote small scale activities (CPAs) that installs solar photovoltaic electrical systems.	From 2012-2019	0.08	CH_4, CO_2, N_2O	0	Solar	CDM	Registered
Body Coal and Clamp Kiln Fuel Switch at Allbrick, South Africa	The objective of the proposed project involves implementing a fuel switch from coal to charcoal produced from wood waste in the clamp kilns.	From 2013-2022	0.03	CH_4, CO_2, N_2O	0	Biomass Energy	CDM	Rejected
Grid Connected Wind Power Plant in Nelson Mandela Bay, South Africa	The project will aim to produce 60 MW of electricity for the NMBM and will be sold from the project developer to the Municipality on a yearly basis. This will replace the conventional manner of relying on coal to produce electricity.	From 2013-2020	0.45	CH_4, CO_2, N_2O	0	Wind	CDM	Validation
Compressed air energy efficiency at Harmony Gold Mining Company, South Africa	The objective of the proposed project activity is to reduce greenhouse gas emissions through the implementation of energy efficiency measures in the compressed air.	From 2012-2022	0.24	CH_4, CO_2, N_2O	0	EE Industry	CDM	Validation terminated
Installation of energy efficient ventilation fans at South Deep and Beatrix Gold Mines, South Africa	The purpose of the PoA is to reduce greenhouse gas emissions through the implementation of energy efficiency ventilation project in underground mining operations.	From 2013-2022	0.13	CH_4, CO_2, N_2O	0	EE Industry	CDM	Registered
Gauteng, Free State, Mpumalanga, Limpopo & Northern Cape CFL Replacement Project (1), South Africa	The objective of the PoA is to boost the energy efficiency of South Africa's residential lighting stock by distributing Compact Fluorescent Lamps (CFLs) free of charge to households across South Africa.	From 2012-2022	0.16	CH_4, CO_2, N_2O	0	EE Households	CDM	Registered
Biomass residues power generation Programme, South Africa	The Biomass residues power generation Programme aims to promote and support the implementation, replacement or retrofit of power-and-heat plants.	From 2014-2021	1.35	CH_4, CO_2, N_2O	0	Biomass Energy	CDM	Registered
Electricawinds 30 MW Wind Project at Riverbank, South Africa	The project will see Electrawinds Seweco (Pty) Ltd install 10 wind turbines of 3 MW, making a total power capacity of 30 MW for this project. Together the 10 wind turbines will generate 80,300 Gwh annually.	From 2013-2020	0.57	CH_4, CO_2, N_2O	0	Wind	CDM	Validation terminated
Hot Water Heating Programme for South Africa	The objective of this small-scale programme of activities is to install heat pumps and solar water heaters throughout South Africa.	From 2012-2019	0.08	CH_4, CO_2, N_2O	0	Solar	CDM	Registered
South Africa Wind Energy	The objective of the proposed PoA is to construct and operate wind farms in South Africa.	From 2012-2019	0.66	CH_4, CO_2, N_2O	0	Wind	CDM	Registered

Table 3.14:

EMISSION REDUCTIONS OF ACTIONS IN THE ENERGY SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Small Scale Renewable Energy Carbon Programme (SRECP), South Africa	The purpose of the programme is to support the development and implementation of small-scale renewable energy projects in South Africa.	From 2012-2019	0.16	CH_4, CO_2, N_2O	0	Hybrid renewables	CDM	Registered
Installation of energy efficient ventilation fans, South Africa	The goal of the Programme of Activities is to reduce greenhouse gas emissions through the installation of energy efficiency ventilation fans at sites across South Africa.	From 2012-2019	0.41	CH_4, CO_2, N_2O	0	EE Industry	CDM	Validation terminated
Lighting up Africa, South Africa	Solar Lamp Project will replace kerosene-based lighting with purpose designed solar lamps.	From 2014-2024	0.00	CO_2	0	1. Energy (renewable / non-renewable	VCS	Registered
Saving the Planet, One Stew at a Time, South Africa	This project regards broad adoption of a heat-retention-cooking device in kitchens throughout South Africa. By using the device trademarked the “Wonderbag”.	From 2010-2020	0.51	CO_2	159 221	1. Energy (renewable / non-renewable	VCS	Registered
BRT REA VAYA Phase 1A and 1B, South Africa	The objective of the project is to establish an efficient, safe, rapid, convenient, comfortable and effective modern public transport system based on articulated buses which run on separated exclusive bus trunk lanes.	From 2009-2021	0.40	CH_4, CO_2, N_2O	0	7. Transport	VCS	Registered
Ngodwana Biomass to Energy Project, South Africa	The proposed project activity concerns a newly built, greenfield biomass to energy plant, situated in the Mpumalanga Province. Residual biomass feedstock (i.e., biomass by-products, residues and waste streams) will be sourced from Sappi Southern Africa Ltd.’s Ngodwana Mill operations for the generation of power.	From 2020-2030	0.00	CO_2	0	1. Energy (renewable / non-renewable	VCS	Registration requested
Longyuan Mulilo De Aar 2 North Wind Energy Facility, South Africa	The project envisages the installation of a new grid connected wind farm on a farm located in the Pixley Ka Seme District close to the town of De Aar in the Northern Cape Province.	From 2017-2020	0.87	CO_2	0	1. Energy (renewable / non-renewable	VCS	Registration requested
Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility, South Africa	The project envisages the installation of a new grid connected wind farm on a farm located in Swartkoppies and Maanhaarberg mountains to the south west of the town of De Aar in the Northern Cape Province.	From 2017-2020	0.57	CO_2	0	1. Energy (renewable / non-renewable	VCS	Registration requested
One True Measure (Pty) Ltd Solar PV Grouped Project, South Africa	Purpose of the grouped project is to generate electricity by using solar PV technology, and to deliver the electricity to the users.	From 2014-2024	0.01	CO_2	0	1. Energy (renewable / non-renewable	VCS	Under Validation

Table 3.15:
EMISSION REDUCTIONS OF ACTIONS IN THE IPPU SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Project for the catalytic reduction of N_2O emissions with a secondary catalyst inside the ammonia reactor of the No. 9 nitric acid plant at African Explosives Ltd ("AEL"), South Africa	The sole purpose of the proposed project activity is to significantly reduce current levels of N_2O emissions from the production of nitric acid at one of AEL's nitric acid plants (the "No. 9 Plant") at Modderfontein, South Africa.	From 2007-2019	1.52	N_2O	348 255	Chemical industries	CDM	Registered
Sasol Nitrous Oxide Abatement Project, South Africa	Nitrous Oxide (N_2O) is an undesired by-product gas from the manufacture of nitric acid. Nitrous oxide is formed during the catalytic oxidation of Ammonia. Over a suitable catalyst, a maximum 98% (typically 92-96%) of the fed Ammonia is converted to Nitric Oxide (NO).	From 2007-2021	12.48	N_2O	4 340 063	Chemical industries	CDM	Registered
Omnia N_2O Abatement Project II, South Africa	A new nitric acid plant is currently being built and expected to be commissioned in the first half of 2012. This new plant is designed by Uhde GmbH with a confirmed production capacity of 400,000 tonnes 100% concentrated nitric acid per year.	From 2012-2022	2.79	N_2O, CO_2	1 696 219	Chemical industries	CDM	Registered
Omnia Fertiliser Limited Nitrous Oxide (N_2O) Reduction Project, South Africa	The project activity involves the installation of an N_2O catalytic Destruction Facility, EnviNox™, in the tail gas section of the process downstream of the absorption column at Omnia Fertiliser nitric acid plant in Sasolburg, South Africa.	From 2008-2022	5.68	N_2O, CO_2	3 439 556	Chemical industries	CDM	Registered
N_2O abatement project at AEL 11_, South Africa	This project aims at reducing waste gas emissions of nitrous oxide (N_2O) produced during the production of nitric acid (HNO_3).	From 2008-2028	3.19	N_2O	332 002 (CDM)	Chemical industry	VCS	Registered

Table 3.16:

EMISSION REDUCTIONS OF ACTIONS IN THE AGRICULTURE, FORESTRY AND OTHER LAND USES SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	PROJECT STATUS	METHODOLOGY REFERENCE
Kuzuko Lodge Private Game Reserve Thicket restoration project, South Africa	The project is restoring more than 5000 hectares of degraded thicket vegetation in the Kuzuko Lodge Private Game Reserve in the Eastern Cape of South Africa. The restoration entails planting cuttings of the indigenous thicket tree, Portulacaria afra – commonly known as spekboom – into desertified landscape.	From 2014-2040	0.22	CH_4, N_2O	0	Agriculture, Forestry, Land Use	Registered	AR-ACM0003
Renencom Afforestation/Reforestation Grouped Project, South Africa	Renencom's afforestation project (project 1) consisted of planting of Bamboo on land situated within South Africa (Magaliesburg) which is unutilised (fallow grassland).	From 2010-2030	0.00	CO_2	0	Agriculture, Forestry, Land Use	Registered	AR-AMS0007
Peri-urban bamboo planting around South African townships	As part of the project bamboo plantations will be planted and managed under the Bamboo for Africa (BFA) Programme using funding specifically earmarked by sponsors for carbon offsetting. Plantations will be on community-owned, marginal lands and small holdings on the outskirts of townships across South Africa.	From 2011-2031	0.13	CO_2, CH_4	0	Agriculture, Forestry, Land Use	Registered	AR-AMS0002
Tree Planting in South African townships	The project will plant fruit trees and indigenous trees in townships across South Africa using funding specifically earmarked by sponsors for carbon offsetting	From 2011-2051	0.00	CO_2, CH_4	0	Agriculture, Forestry, Land Use	Registered	AR-AM0002

Table 3.17:

EMISSION REDUCTIONS OF ACTIONS IN THE WASTE SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
EnviroServ Chloorkop Landfill Gas Recovery Project, South Africa	The objective of the project is to extract landfill gas at the Site and combust the landfill gas (LFG) by flaring. Landfill gas consists of approximately 50% methane, which has a global warming potential 211 times greater than CO_2. Through the destruction of methane, the emissions of greenhouse gases are reduced.	From 2008-2022	2.07	CH_4, CO_2	857 308	Energy Industries; Waste	CDM	Registered
Alton Landfill Gas to Energy Project, South Africa	The objective of the Project is to collect and destruct/utilise the LFG generated at the closed Alton landfill. The purpose of LFG flaring is to dispose of the flammable constituents, particularly methane, safely and to control odour nuisance, health risks and adverse environmental impacts. Hence this will involve investing in a highly efficient gas collection system as well as flaring equipment.	From 2009-2019	0.26	CH_4, CO_2	0	Energy Industries; Waste	CDM	Registered

Table 3.17:
EMISSION REDUCTIONS OF ACTIONS IN THE WASTE SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Ekurhuleni Landfill Gas Recovery Project, South Africa	The Ekurhuleni Metropolitan Municipality (the EMM) is proposing a CDM project activity at four landfills owned by the EMM in Gauteng province, South Africa. Greenhouse gas emission reductions will be achieved by the combustion of recovered methane contained in landfill gas that would be otherwise emitted to the atmosphere and by the generation of electricity from the gas which will displace largely coal-fired power generation on the South African grid.	From 2010-2017	2.54	CH_4, CO_2	62 526	Waste Handling and Disposal	CDM	Registered
PetroSA Biogas to Energy Project, South Africa	PetroSA is a state-owned corporation that has since 1987 operated a gas to liquids plant at Duinzicht, some 12 kilometres from the town of Mossel Bay on the south coast of South Africa. The production process at Duinzicht leads to waste process water that since the inception of the Plant has been dealt with by way of anaerobic digestion. The anaerobic digestion is continuous and a critical process for the operation of the PetroSA plant. In the anaerobic digestion process biogas is naturally generated.	From 2006-2017	0.36	CH_4, CO_2	32 730	Waste	CDM	Registered
Tugela Mill Fuel Switching Project, South Africa	Currently, thermal energy produced for use at the Tugela Pulp and Paper Mill is supplied by coal fired boilers. Reducing the inputs of bark into landfill will result in climate benefits, by reducing emissions of methane to the atmosphere, as well as reducing pressure on the capacity of the existing landfill.	From 2007-2015	0.62	CH_4, CO_2	104 938	Waste Handling and Disposal	CDM	Registered
Durban Landfill-gas-to-electricity project Mariannhill and La Mercy Landfills, South Africa	The project involves the recovery of landfill methane for electricity generation.	From 2006-2020	0.89	CH_4, CO_2	275 745	Landfill Power	CDM	Registered with Issuances
Small-scale solar electrical programme, South Africa	Installation of solar electrical systems at the demand-side where there was no solar electrical system operating prior to the implementation of the activity; or a capacity addition envisages an increase in the installed power generation capacity of an existing solar electrical system.	From 2012-2040	0.11	CO_2	0	Waste Handling and Disposal	CDM	Registered
City of Cape Town Treatment of Organic Waste Streams CDM Projects, South Africa	The project objective is to capture the biogas produced by the anaerobic digestion (AD) of sludge at wastewater treatment works. The biogas produced will be combusted to generate "green energy" (electricity and heat) on site, at wastewater treatment facilities, within the Cape Town area.	From 2013-2041	0.41	CH_4, CO_2	0	Waste Handling and Disposal	CDM	Validation terminated
City of Cape Town Landfill Gas Extraction and Utilisation Programme, South Africa	The objective of the PoA is to capture and combust landfill gas (LFG) to generate electricity and heat at solid waste disposal sites (landfills) in the municipality of Cape Town, South Africa.	From 2014-2021	0.17	CH_4, CO_2	0	Landfill Gas	CDM	Registered

Table 3.17:
EMISSION REDUCTIONS OF ACTIONS IN THE WASTE SECTOR.

NAME OF PROJECT	PROJECT DESCRIPTION	TIME HORIZON	ACTUAL EMISSION REDUCTIONS ($MtCO_2$) IE. RESULTS ACHIEVED TILL 2019	COVERAGE (GREEN-HOUSE GAS TARGETED)	AMOUNT OF CERS ISSUED	SUB-SECTOR	CREDIT TYPE	PROJECT STATUS
Buffalo City Landfill Gas to Electricity Project, South Africa	The objective of the project is to extract the biogas produced by three Buffalo City Municipality owned landfill sites and use it to generate electricity.	From 2010-2020	0.31	CH_4, CO_2, N_2O	0	Landfill Gas	CDM	Validation terminated
Anaerobic Digestion and Renewable Energy Generation, South Africa	The objective of the Programme of Activities is to generate renewable energy through anaerobic digestion and biogas-based energy generation.	From 2013-2020	0.02	CH_4, CO_2, N_2O	0	Methane avoidance	CDM	Registered
Humphries Boerdery (Edms) Bpk piggery methane capture and electricity generation, South Africa	The project aims at generating electricity from anaerobic digestion of piggery manure at the Humphries Boedery Farm near Bela-Bela.	From 2009-2019	0.08	CH_4, CO_2, N_2O	0	Methane avoidance	CDM	End of crediting period
Landfill Gas Utilisation Programme of South Africa	Under this PoA, landfill gas (LFG) will be captured at participating landfills in South Africa.	From 2012-2020	0.34	CH_4, CO_2, N_2O	0	Landfill Gas	CDM	Validation
Reliance Composting Project in Cape Town, South Africa	Using “green” waste – in the form of plant material – collected from drop-off facilities within the City of Cape Town Municipality (CoCT), Reliance produces compost that is suitable for both conventional and organic farming.	From 2008-2027	0.54	CH_4, CO_2	74 396	Waste handling and disposal	VCS	Registered
Interwaste Landfill gas Grouped Project, South Africa	Interwaste has developed a municipal waste landfill gas recovery project and is looking towards producing compressed biogas fuel that can be supplied into external customers with the distribution in trucks. The project instance is located at the Interwaste FG landfill site.	From 2016-2016	0.12	CH_4, CO_2	76 438	Energy (renewable / non-renewable) waste	VCS	Registered
Johannesburg Landfill Gas to Energy Project, South Africa	The objective of the project is to collect and destroy / utilise the LFG generated at the Johannesburg landfill sites.	From 2012-2020	2.13	CH_4, CO_2	94 527	Waste handling and disposal	VCS	Registered
Durban Landfill-Gas Bisasar Road, South Africa	The project consists in an enhanced collection of landfill gas at the Bisasar Road landfill site of the municipality of Durban and the use of the recovered gas to produce electricity. The produced electricity will be fed into the municipal grid and replace electricity that the municipal electric company is currently buying from other suppliers.	From 2009-2023	3.79	CH_4, CO_2	124 884	Waste handling and disposal	VCS	Registered
The New Horizons (Athlone) Waste to Energy Project, South Africa	The New Horizons (Athlone) Waste to Energy Project aims to improve municipal solid waste (MSW) management through the installation of a unique materials recovery facility (MRF) and an anaerobic digestion system.	From 2017-2026	0.06	CH_4	0	Waste handling and disposal	VCS	Under Development

4. FINANCIAL RESOURCES, TECHNOLOGY TRANSFER, CAPACITY BUILDING AND TECHNICAL SUPPORT RECEIVED AND NEEDS

4.1. INTRODUCTION

The chapter provides an update from the previous BUR3 report on financial, capacity and technical support received and needed by South Africa that supports the country's climate action which includes financial outflows that benefit global climate action provided by South Africa as an in-kind contribution to regional and international organisations.

South Africa's Nationally Determined Contribution (NDC) (DEA, 2015) reiterates the country's need to pursue development in response to the triple challenge of poverty, inequality and unemployment, albeit with a focus on sustainable development. The South African NDC has committed the country to implement mitigation measures to bend the curve of South Africa's greenhouse gas (GHG) emissions towards a peak, plateau and decline trajectory. The NDC states that South Africa's emissions by 2025 and 2030 will be in a range between 398 and 614 $MtCO_2e$, as defined in national policy. The South African Government has reiterated that the envisioned GHG emissions reductions can only be achieved if adequate financial, technological and capacity-building support is provided. South Africa's National Adaptation Strategy acknowledges that substantial finance is required to achieve meaningful adaptation in South Africa. The current update, therefore, provides overall progress on climate finance flows that are crucial to support South Africa's climate action.

The current update covers the period from 2018 to 2019. The report presents an analysis of international and domestic climate-related finance flows, as well as non-monetised support, received within the reporting period. The report also includes financial support needed (or requested) by South Africa to develop its response to climate change by sector, as well as description of non-monetised technical and capacity-building needed. The report also entails a summary of South Africa's contribution to regional and international organisations which have climate benefits.

4.2. CLIMATE FINANCE

According to the National Climate Change Response Policy (NCCRP) White Paper, "Climate finance is defined 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).

Since reporting in the previous BURs, South Africa has been devoting efforts to enhance its reporting on climate finance to inform domestic decision making as well as meeting its reporting requirements under the UNFCCC. The Department of Forestry, Fisheries and the Environment (DFFE), in partnership with National Treasury and other key role-players, have initiated the development of the National Climate Finance Strategy to inform South Africa's efforts to mobilise, direct and coordinate flows of finance to address South Africa's climate change imperatives and address the national triple challenge of poverty, unemployment and inequality. The strategy will be informed by, respond to, and be implemented in collaboration with key stakeholders, to enhance the national climate change response and key implementation systems and actions. The National Climate Finance Strategy for South Africa is built on a shared vision and common understanding of South Africa's finance mobilisation approach and will enable a coordinated, long-term, inclusive and participatory national approach to resource mobilisation across the entire value chain of South Africa's climate change response. The strategy will provide the impetus for collaborative action by government, the private sector and civil society, to respond to South Africa's climate change priorities and realise sustainable development goals, while addressing the national social and economic challenges. This will give effect to South Africa's commitment to mobilising the resources that are necessary for both mitigation and adaptation.

Another achievement related to the reporting on climate finance flows is the institutionalisation of the Tracking and Evaluation Portal that tracks financial support provided, including supporters, responsible organisations, status, support channels and values. The portal presents a shared information platform on climate finance and ensures that monitoring, reporting and verification of climate finance are carried out in South Africa. By reporting, tracking and monitoring climate flows, policy makers, among others, can assess the scale of finance, identify the main actors (public and private) in the market, understand investment gaps, highlight opportunities and address barriers to mobilise finance in support of low-carbon, climate-resilient development.

4.2.1. Climate Finance Landscape

A high-level framework for understanding the actors and financial flows, in terms of the sources, intermediaries and facilitators, instruments and implementers of climate finance, is shown in Table 4.1. In addition to the entities involved with the flow of funds, there is a complex landscape of entities that form the enabling environment for climate finance. These entities include, among others, policy makers, regulatory agencies, rating agencies, buy- and sell-side research analysts, academia, the credit bureau, data providers, accountants, technical assistance providers, risk consultants and asset consultants.

"Another achievement related to the reporting on climate finance flows is the institutionalisation of the Tracking and Evaluation Portal that tracks financial support provided, including supporters, responsible organisations, status, support channels and values."

Table 4.1:
THE FLOW OF FUNDS THROUGH THE FINANCIAL LANDSCAPE (SOURCE: DEA, 2019B).

FLOW OF FUNDS

Sources of Funds	Public: National & International Private: Individuals, Companies & Organisations
Intermediaries and Facilitators	**Beneficial Owners:** - Foundations, Endowments - Banks - Insurance companies - Pension funds - Venture funds - Private equity funds - Development Finance Institutions - Multilateral agencies (UN) - Sovereign wealth funds - Microfinance Institutions - Savings and Credit Cooperative Societies - Export Credit agencies
	Dedicated Climate Funds: Local - Green Fund **Dedicated Climate Funds: International** - Green Climate Fund - Adaptation Fund - Climate Investment Funds - Multilateral Funds - Bilateral Funds
	Managers: - Asset Managers - Fund Managers
	Investment platforms and mechanisms: - Bond, equity and commodity exchanges - Kyoto-related: Emissions Trading System, Climate Development Mechanism, Joint Implementation - UN-REDD (Reducing Emissions from Deforestation and forest Degradation) - Risk pooling mechanisms - Crowdfunding, peer-to-peer and other Fintech-based mechanisms
Instruments	- Grants e.g. technical assistance grant from the Rockefeller Foundation to fund the position of a Chief Resilience Officer at the City of eThekwini. - Guarantees e.g. Government guarantees on Power Purchase Agreements signed with Independent Power Producers under the Renewable Energy Independent Power Producers Procurement Programme. - Non-concessionary and concessionary loans, debt and equity e.g. Industrial Development Corporation green bond. - Insurance e.g. weather-index insurance for agriculture. - Carbon credits. - Operations of private sector companies. - Transfers – these are inter-governmental transfers e.g. transfers to the DFFE for the implementation of the Working for Water programme.
Implementers	Government (National, Local, Provincial), Communities, Companies, Non-profit organisations
Projects, Programmes & Beneficiaries	**Examples:** - Renewable Energy Independent Power Producers - Disaster Risk Management programme - Working for Water programme - REDD+ - Gauging stations and early flood warning systems - Bus Rapid Transport System - Drip irrigation system manufacturer

4.2.2. Climate Finance Sources

Climate finance sources for South Africa can be classified into four different categories: bilateral finance, multilateral finance, domestic public finance and private sector finance. 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 and through bilateral finance institutions.

4.3. SUPPORT RECEIVED

4.3.1. International Financial Support Received

Support received for the period 1 Jan 2015 – 31 Dec 2017 that was reported in BUR 3 (DEA, 2019a) the reported amount was USD 206 million. The current biennial update provides information on additional climate finance flows recorded for the period 2018 to 2019 (Figures 4.1 and 4.2).

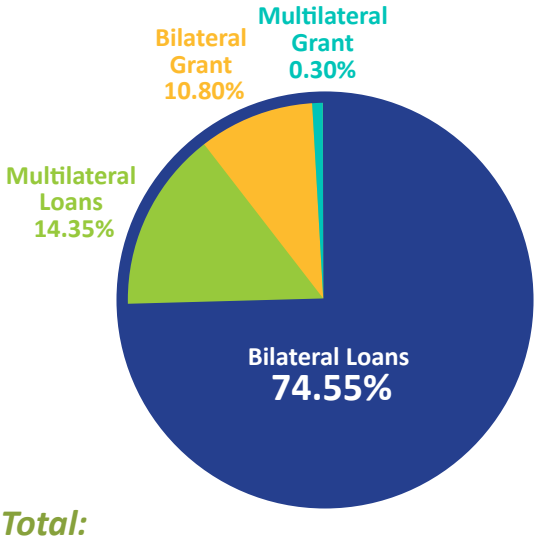
For this reporting period South Africa has received in excess of USD 4 billion in financial support from bilateral and multilateral sources that support or benefit climate change action in the country (Figure 4.1). Approximately 88.9% of the funds were in the form of loans (USD 4 343 million), and the rest being grants (USD 542 million). Relative to BUR3, the country has reported an increase of 51% of financial support received, both from bilateral and multilateral funding. However, this does not reflect an overall increase in funding level as this substantial increase could be substituted to under reporting in BUR3.

The commitment levels of climate grants and loans provided by bilateral and multilateral partners has increased from the previous reporting period (3rd BUR report).

The share of loans has increased, and this reflects the overall preference of loan commitments as opposed to grants for South Africa by most bilateral cooperating partners.

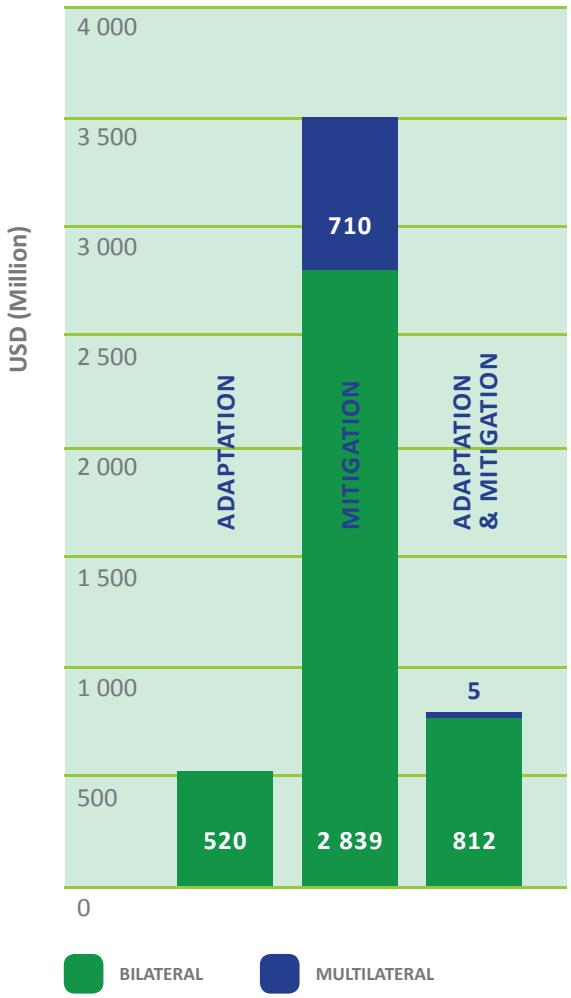
Additional information on bilateral and multilateral financial support committed between 2018 and 2019 is provided in Annexure B. The reported projects focus on Energy Efficiency with relevance to climate change. Additionally, the project has co-benefits (non-GHG effects), which has a bearing on non-GHG co-benefits dimensions in particular on gender equity, environmental and social welfare. All these are climate-related impacts. The majority of the funds support mitigation projects (Figure 4.2). The funding received from the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMUB) (under the Climate Support Programme) for the preparation of this BUR is included in the bilateral funds provided here.

Figure 4.1:
LOANS AND GRANTS RECEIVED FOR CLIMATE CHANGE IN SOUTH AFRICA (2018 AND 2019).



Total:
USD 4.89 billion

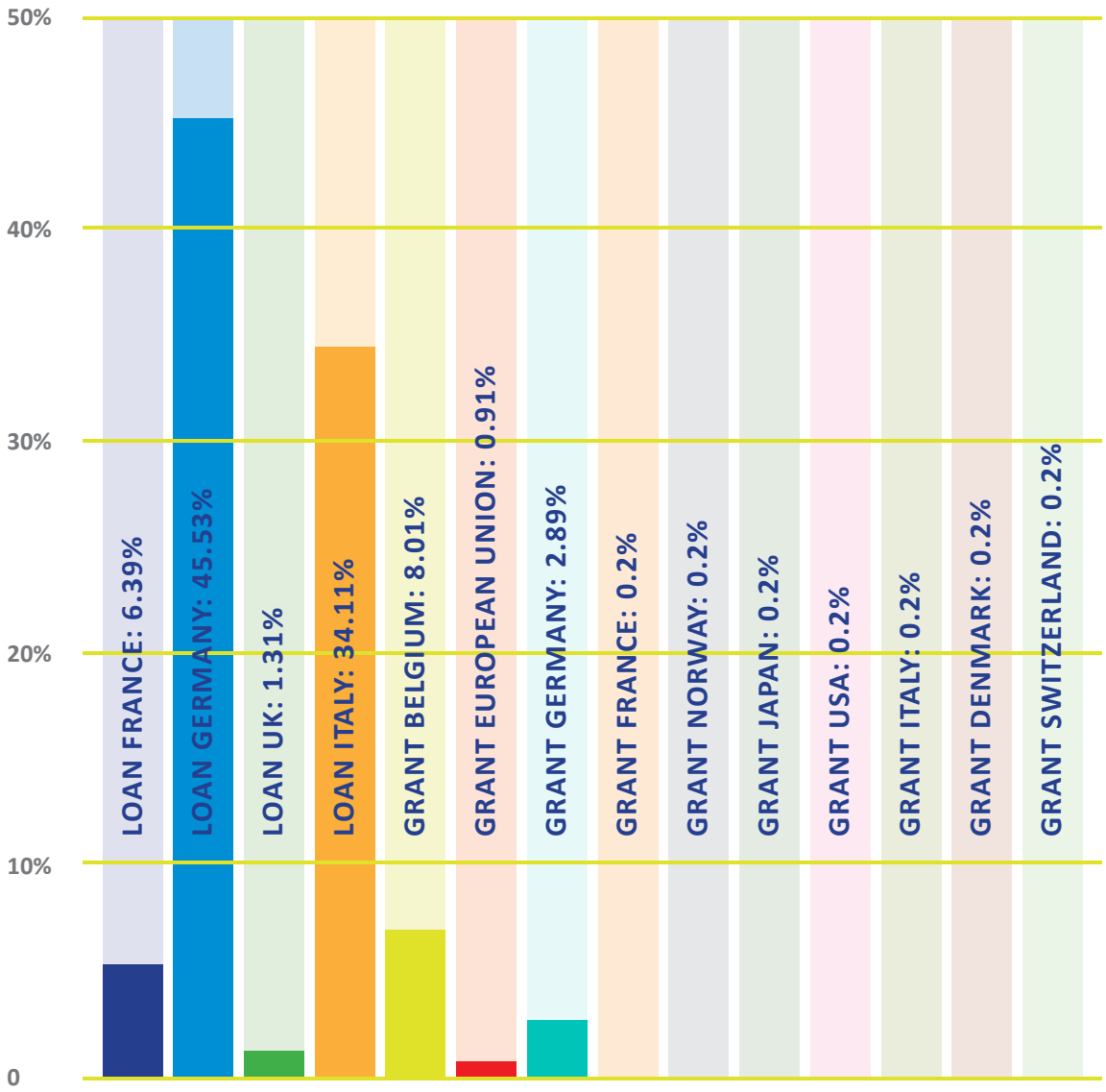
Figure 4.2:
TYPES OF PROJECTS FUNDED BY LOANS AND GRANTS IN SOUTH AFRICA (2018 TO 2019).



4.3.1.1. Bilateral support received / committed (2018–2019)

In terms of bilateral support, Germany contributed 48.4% (USD 2 019 million) of the funding and 94.0% of this was in the form of loans (Figure 4.3). The largest loan was to the Green Energy Efficiency Fund with the aim to encourage investments in energy efficiency and renewable energy projects to support SA's transition towards a low-carbon economy (PSEE, 2015). Funding is in the form of a loan for the capital required for an energy-efficiency project. Italy contributed 34.1% of the bilateral funds and these were in the form of loans from Enel Green Power who supports the development of renewable energy in South Africa. Belgium contributed the most (8.0%) in terms of grants, followed by Germany (2.9%). The Belgian grants are mostly for adaptation and resilience projects and projects supporting a Green Economy. Most of Germany's bilateral support is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), through the German Climate Support Programme, which supports South Africa in achieving ambitious climate action through strengthening South Africa's institutional support at national and sub-national levels.

Figure 4.3:
BREAKDOWN OF BILATERAL FUNDING TO SOUTH AFRICA (2018 TO 2019).



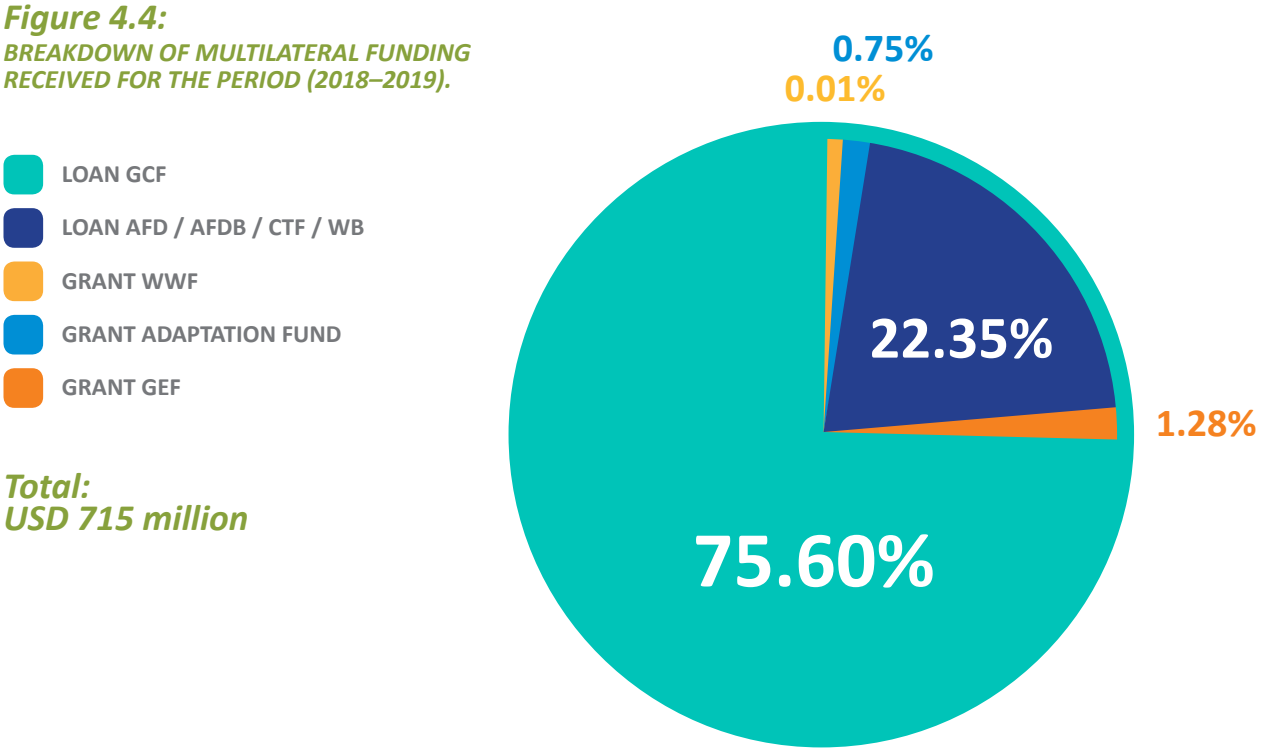
Total: USD 4 171 million

4.3.1.2. Multilateral support committed / received (2018–2019)

An analysis of multilateral support to South Africa is shown in Figure 4.4. The largest loan (USD 537 million) received during the reporting period was from the Green Climate Fund (administered by the Development Bank of Southern Africa (DBSA) and the South African National Biodiversity Institute (SANBI)). These funds were used for energy efficiency projects (renewable energy and private and public sector energy efficiency programmes), as well was the Waste Management Flagship Programme (implementation of organic waste treatment solutions). In addition, some of the funds were allocated to SANBI as a Readiness Grant aimed at developing Concept Notes and Funding Proposals for submission to the Green Climate Fund (GCF) amongst other technical activities.

The second largest contribution was from the consortium consisting of the Agence Française de Développement, African Development Bank, Clean Technology Fund and the World Bank International Finance Corporation. These funds were used for the development of 100 MW wind farms to enhance Eskom's renewable energy sources. The contributions committed as grants made up 21% of the multilateral funds received, and these were from the Global Environment Facility (GEF), World Wildlife Fund (WWF) and the Adaptation Fund. The GEF support was for implementing an Energy Management System in South Africa, while the WWF funds were utilised to improve global climate change mitigation outcomes through domestic action, focusing on cities and local businesses.

Figure 4.4:
BREAKDOWN OF MULTILATERAL FUNDING RECEIVED FOR THE PERIOD (2018–2019).



Total:
USD 715 million

4.3.2. Domestic Financial Flow for Climate Change Response Actions

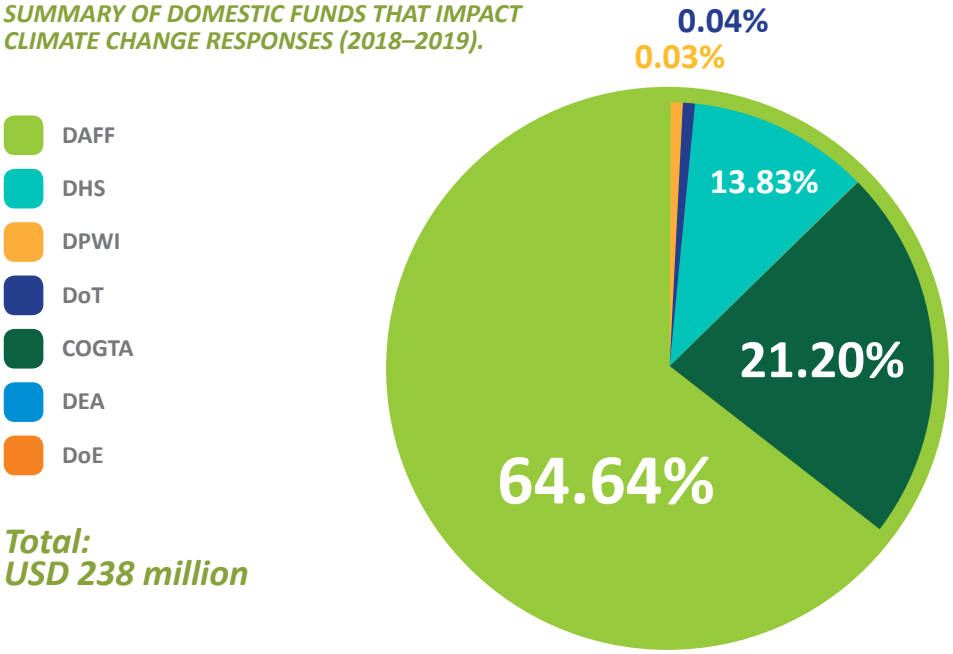
The South Africa Government continues to play a vital role in creating the conditions for inclusive economic growth and development and in establishing the appropriate economic framework to encourage and facilitate the shift to environmentally cleaner technologies and low carbon activities in the country. At national level there are a number of government departments that are integrating and mainstreaming climate change into sector plans. One of the primary strategic objectives set out by the South African Climate Change Policy (DEA, 2011) is to spearhead the "development of comprehensive resource and investment mobilisation strategies, capacities, mechanisms or instruments that support and enable implementation of climate change responses at the scale required; including, but not limited to, public and private financial resources, incentives, non-market and market-based instruments, technical cooperation and partnership agreements, and technology transfers at domestic, sub-regional, regional, and international levels". As a response to this calling, various national government departments are pursuing strategies to integrate and mainstream climate change into their respective sector plans.

The South African government has invested approximately USD 238 million to support climate action at the national level (Figure 4.5). The largest portion of these funds was allocated to the Department of Agriculture, Forestry and Fisheries (DAFF) for forest resource management projects, particularly to provide an enabling framework for the sustainable management of woodlands and indigenous forests, and the efficient development and revitalisation of irrigation schemes and water use.

There are a number of domestic funding sources available in South Africa for climate change projects, and these are discussed in more detail below. Annex B3 provides a detailed list of domestic climate finance flows and projects that aim to enhance support for mitigation and adaption efforts in the country.

"The South Africa Government continues to play a vital role in creating the conditions for inclusive economic growth and development and in establishing the appropriate economic framework to encourage and facilitate the shift to environmentally cleaner technologies and low carbon activities in the country."

Figure 4.5:
SUMMARY OF DOMESTIC FUNDS THAT IMPACT CLIMATE CHANGE RESPONSES (2018–2019).



Total:
USD 238 million

4.3.2.1. National Treasury's Cities Support Programme

This programme works across national departments to facilitate policy shifts that enable sustainable and inclusive urban growth and management in the country's eight large 'metropolitan municipalities' (or 'metros' for short). They also work directly with metro governments (at their request) on a number of topical issues. In 2017 the Programme incorporated 'climate resilience' as a core component and focused on environmental planning, air quality control and mainstreaming climate change actions across urban management sectors. Significantly, a priority has been assisting cities in climate proofing their Integrated Development Plan and Built Environment Performance Plan. A total sum of USD 30 million was disbursed to municipalities as a grant to support sustainable development at sub-national level.

4.3.2.2. Infrastructure Investment Programme for South Africa

The Infrastructure Investment Programme is a USD 182 million fund, jointly established by the Government of South Africa and the European Union. This fund aims to encourage large infrastructure projects by leveraging grants to attract additional loans from participating investment banks. The Development Bank of Southern Africa (DBSA) is the appointed fund manager and solicits proposals from various government levels.

4.3.2.3. The Green Fund

The national government, through the DFFE and managed by the DBSA, established the Green Fund in 2012 with an initial USD 60 million. The fund's objective is to lay the groundwork for the country's transition to a low-carbon, resource efficient and climate resilient development path. The fund responds to market weaknesses, and finances projects that would otherwise not be implemented through thematic calls for proposals and tenders. While 'Green Cities and Towns' is a stated funding priority, relatively little money has flowed to municipalities. Rather, the Fund appears to favour private sector partnerships with civil society to expand investment in a national green economy. The initial (2018) call for proposals focused on waste-water treatment and energy capture.

4.3.2.4. The Expanded Public Works Programme

In response to high unemployment, The Department of Public Works administers grants that create temporary jobs in four priority areas: infrastructure, non-state (non-profit civil society), environment, and culture and social (education and care work). Notably, the programme has created 997 000 jobs in the financial year 2018/19 through rehabilitating ecosystems. Thus, the Programme has great potential to co-finance sustainable infrastructure and highlight the co-benefits of green investment. For the financial year 2018/19, an amount of USD 17 million was spent by government on the programme.

4.3.2.5. Climate Finance Facility

In 2018 the UNFCCC GCF awarded USD 55.6 million to the DBSA to establish the Climate Finance Facility for Southern Africa. The DBSA Climate Finance Facility Programme is a lending facility that aims to address market constraints and catalyse private sector funding for climate-related investments in the Southern African region. The lending facility proposes the use of a blended finance approach and will consist of credit enhancements focused on first loss or subordinated debt and tenor extensions to catalyse private sector climate investments. The Facility will 'crowd in capital' in order to scale up climate finance for sustainable infrastructure and private sector mitigation and adaptation efforts (DEA, 2019b).

4.3.2.6. Green bonds

The Johannesburg Stock Exchange (JSE) launched its Green Bond Segment in late 2017. Its Green Bond platform seeks to unlock the investment potential of green infrastructure, technologies and services and to build trust and assurance around the environmental credentials of the bonds, by developing clear green bond qualification criteria. The proceeds of Green Bonds are exclusively used for the financing or re-financing of new or existing eligible green projects that have a positive environmental and/or climate benefit (JSE, 2017).

The JSE's green bond platform is built on the following framework:

- Research into international best practice.
- Considering local needs and possible pros and cons of various frameworks.
- Stakeholder engagement (issuers, investors, government, auditors, etc.).
- Non-negotiables:
  - o Credibility in terms of "green credentials".
  - o Clarity in respect of practical application of Green Bond principles.
  - o Monitoring and reporting requirements (disclosure).

While the green bond market in South Africa is relatively small in relation to other countries, such as the USA, China and France, green bonds offer a significant opportunity (especially at provincial and municipal level) to mobilise large amounts of private capital earmarked for low-carbon, climate resilient investments. As market actors continue to innovate in this area, the review of green bond regulations and incentives and the harmonisation of standards become critical.

The first local municipality to issue a green bond was the City of Johannesburg, which listed in 2014 (Table 4.2). The City of Cape Town launched its green bond in July 2017, while Growthpoint Properties became the first South African company to issue a green bond during March 2018.

4.3.3. Non-Monetised Support Received

Technical and capacity building support received from developed countries for the period between 2018 and 2019 is summarised in Table 4.2 below and is additional to the support that was reported in Table 37 of BUR2 (DEA, 2017) and Table 4.5 of BUR3 (DEA, 2019a) which included support within the 2015 and 2017 reporting periods.

Table 4.2:
TECHNICAL SUPPORT AND CAPACITY BUILDING SUPPORT RECEIVED FROM DEVELOPED COUNTRIES FOR THE PERIOD 2018-2019.

Type of Support	Activity	Focus	Timeframe	Donor
Capacity Building	Training on the use of the IPPC guidelines to compile national GHG inventories for the AFOLU sector.	Inventory & mitigation	Mar to Oct 2018	United Nations Framework on Climate Change Secretariat
	Training on the national Tracking and Evaluation (T&E) system.	Mitigation & adaptation	Jan to May 2020	GIZ, through the World Resources Institute (WRI)
	Training on the National Greenhouse Gas Inventory System (NGHGIS) and compilation of the 2017 inventory, particularly, the AFOLU sector.	Inventory	Aug to Dec 2019	GIZ, through the Climate Support Programme
	UNFCCC review course for review of Annex 1 GHG inventories for the agriculture sector.	Inventory & mitigation	Mar 2019	United Nations Framework on Climate Change Secretariat
	IPCC basic training of GHG inventories and use of IPCC software in compilation of GHG inventories.	Inventory & mitigation	Oct 2019	IPCC
	2050 Pathways Calculator Conference.	Mitigation & adaptation	Nov 2018	Sponsored by the United Kingdom
	Training in managing Global Governance.	Mitigation & adaptation	3 - 7 Dec 2017 and 9 Aug to 2 Dec 2018	German Development Institute

Table 4.2:

TECHNICAL SUPPORT AND CAPACITY BUILDING SUPPORT RECEIVED FROM DEVELOPED COUNTRIES FOR THE PERIOD 2018-2019.

Type of Support	Activity	Focus	Timeframe	Donor
Capacity Building	Vertical Integration and Learning for Low-Emission Development in Africa and Southeast Asia (V-LED) meeting.	Mitigation	22 - 24 Jan 2019	Vertical Integration and Learning for Low Emission Development
	Renewable Energy Systems in Power Integration.	Mitigation	17 - 28 Jun 2019	Denmark
	Study tour Germany on the implementation of the Sustainable Development Goals.	Mitigation & adaptation	13 - 19 Oct 2019	Germany
	International Symposium and High-level Action for Climate Empowerment Event.	Mitigation & adaptation	13 - 14 Oct 2019	Austria
	Climate Policy for 2050.	Mitigation	14 - 20 Oct 2018	German Government
	IPCC Expert meeting to collect the Emission Factor Database and software users' feedback.	Mitigation	15 - 17 Oct 2019	IPCC Trust Fund
	Climate Opportunity 2019: Co-benefits for just Energy Futures Conference.	Mitigation & adaptation	15 - 16 Oct 2019	The Independent Institute for Environmental Issues
	Steering committee on the Global Environment Outlook.	Mitigation & adaptation	31 Oct to 1 Nov 2019	United Nations Environment Programme (UNEP)
	International 2050 Calculator Conference.	Mitigation	12 - 16 Nov 2019	The Business Energy and Industry Strategy, UK

Table 4.2:
TECHNICAL SUPPORT AND CAPACITY BUILDING SUPPORT RECEIVED FROM DEVELOPED COUNTRIES FOR THE PERIOD 2018-2019.

Type of Support	Activity	Focus	Timeframe	Donor
Technical & Capacity Building	Building the technical capacity of local government officials to develop adaptation responses, undertake climate vulnerability assessments and review existing climate change adaptation strategies and action plans. 40 workshops were held between July and September 2018. A total of 1 236 stakeholders participated, of which 647 were municipal officials, other interested experts from civil society and institutions affiliated with municipalities, such as The National Disaster Management Service. The objectives of the Local Government Climate Change Support Programme were included.	Mitigation & adaptation	Jul to Sep 2018	GIZ, Germany through the Climate Support Programme

4.4. CLIMATE FINANCIAL OUTFLOWS THAT SOUTH AFRICA CONTRIBUTED TO REGIONAL AND INTERNATIONAL ORGANISATIONS THAT BENEFIT CLIMATE CHANGE ACTION

South Africa is not only a recipient of climate finance support from international bodies; the country also commits financial and technical support to a number of regional and international organisations as its 'fair' share of the global climate action. These are contributions made by South Africa to regional and international organisations that benefit climate change action. The South African government contributed an estimated amount of USD 44 million to regional and global organisations which benefit mitigation and adaption action (Table 4.3). Most of the contribution allocations are made to the African Union and the United Nations bodies.

Table 4.3:
SOUTH AFRICA'S CONTRIBUTION TO REGIONAL AND INTERNATIONAL ORGANISATIONS.

Organisation	Total in ZAR	Total in USD	Support Types Provided			Funding Type	
			Mitigation	Adaptation	Capacity Building	Loan	Grant
South African Development Partnership	9 776 000	708 920	X	X	X		X
African Union	227 416 000	16 491 371	X	X	X		X
India, Brazil, South Africa Trust Fund	19 023 000	1 379 478	X	X	X		X
African Peers Review Mechanism	3 243 000	235 170	X	X	X		X
Organisation for Economic Cooperation and Development	305 000	22 117	X	X	X		X
United Nations Environment Programme	7 260 000	526 468	X	X	X		X
African Caribbean & Pacific Group of States	5 122 000	371 429	X	X	X		X
Commonwealth of Nations	22 190 000	1 609 137	X	X	X		X
Southern African Development Community	22 190 000	1 609 137	X	X	X		X
United Nations	180 403 000	13 082 161	X	X	X		X
Indian Ocean Rim Research Centre	189 000	13 706	X	X	X		X
United Nations Development Programme in Southern Africa	1 492 000	108 194	X	X	X		X
United Technical Corporation	150 000	10 877	X	X	X		X
African Union Commission	3 653 000	264 902	X	X	X		X
National Association for Clean Air	14 400 000	1 000 695	X	X	X		X
Global Environmental Fund	23 500 000	1 633 079	X	X	X		X
Environmental Assessment Practitioner Association of South Africa	4 809 000	334 190	X	X	X		X
Kwa-Zulu Natal Conservation Board	1 287 000	89 473	X	X	X		X
Recycling Enterprise Support Programme	69 000 000	4 794 997	X	X	X		X
TOTAL	615 408 000	44 285 465					

4.5. SUPPORT NEEDS

The technical and capacity building needs for South Africa highlighted in the BUR 3, and further identified in the Technical review of the BUR 3, are summarised in Table 4.4. Progress towards addressing these needs over the last two years is also shown, so as to indicate needs that are still outstanding. Section 4.5.2 will discuss future technical and capacity requirements for South Africa.

Table 4.4:
SUMMARY OF SUPPORT NEEDS PREVIOUSLY IDENTIFIED AND PROGRESS TOWARDS ADDRESSING THESE NEEDS.

Focus	Type of Support	Activity Identified in BUR3	Need Indentified in BUR 3 Technical Review	Progress towards addressing the need	Outstanding Needs[7]
Inventory and Mitigation	Capacity Building	Develop training courses covering GHG inventory update process (IPCC guideline methodologies for sectors, quality assurance/ quality control (QA/QC) process and methods, uncertainty analysis, key category analysis, coordination and management of update process).	Enhancing technical capacity for GHG inventory development on a regular and continuous basis.	Gondwana is currently providing training for the DFFE inventory team on the NGHGIS, inventory process, inventory updating, QA/QC process, key category analysis and uncertainty (with all presentations and training material being uploaded onto the NGHGIS), however, specific training courses have not been developed yet.	Training courses still need to be developed, but this is planned and will be funded through the Capacity-Building Initiative for Transparency (CBIT).
			Enhancing technical capacity for the development of the GHG management system, including for: i. Operationalising the system in terms of the personnel capacity to operate and maintain it. ii. Operationalising QA/QC components, processes and plans.	Additional inventory team staff have been appointed at the DFFE to manage the NGHGIS and to compile the inventory. The GHG Inventory team is now responsible for full management of the National GHG management system. Training has been provided on overall functioning of the NGHGIS, and there are currently plans underway to provide operational training on the system management for the NGHGIS. Training on the QA/QC process has also been provided.	Operational training on the system is still required, but this is underway through World Resources Institute (WRI) funding.

[7] These needs are carried through into Table 4.7 on technical and capacity needs going forward.

Table 4.4:

SUMMARY OF SUPPORT NEEDS PREVIOUSLY IDENTIFIED AND PROGRESS TOWARDS ADDRESSING THESE NEEDS.

Focus	Type of Support	Activity Identified in BUR3	Need Indentified in BUR 3 Technical Review	Progress towards addressing the need	Outstanding Needs[7]
Inventory and Mitigation	Technical		Enhancing capacity related to the use of surrogate data or other splicing techniques from the 2006 IPCC Guidelines that can help fill data gaps and generate a consistent time series (including a dedicated project to specifically address the technical capacity and additional personnel needed to ensure that inventories are recalculated in cases where historical data or inventory years are missing).	The inventory team is currently working on extending the time-series back to 1990 for the inventory and filling in data where it is missing. The full time-series has been completed for the AFOLU sector, while for other sectors this should be completed by the 1st BTR.	No further technical capacity is needed.
		Support is needed for the production of updated land use change maps in the AFOLU sector.		The DFFE GIS unit has set up a process to develop land cover maps internally, no external support is needed. The latest Land cover map has successfully been produced for 2018.	No further technical capacity is needed.
			Enhancing technical capacity for tracking land-use changes.	Not started.	Technical capacity is still required for this, but it is planned to be undertaken with CBIT funding.
	Technical and Capacity Building	Support is needed for sector-specific priority data generation processes to improve the GHG inventory. Require information on country specific emission factors in all sectors, with a particular need to improve data in the transport and waste sectors.	Enhancing technical capacity for the development of country-specific Emission Factors for some key categories in the AFOLU sector, namely direct and indirect N_2O emissions from managed soils and land converted to cropland.	A GHG improvement programme was set up in 2011. This is on-going. A fuel consumption survey was done to improve activity data for the period 2000–2018. A model for road transportation has been created. The results of this study have started to be incorporated in the 2017 GHG Inventory, with all results being incorporated by the next inventory. Waste studies are still required, along with studies to develop country specific emission factors for direct and indirect N_2O from managed soils.	The National Greenhouse Gas Improvement Programme (GHGIP) is on-going in that additional projects are continually added. Therefore, technical and capacity support is required to complete these focussed activities.

[7] These needs are carried through into Table 4.7 on technical and capacity needs going forward.

Focus	Type of Support	Activity Identified in BUR3	Need Indentified in BUR 3 Technical Review	Progress towards addressing the need	Outstanding Needs[7]
	Technical and Capacity Building		Enhancing technical capacity for data collection on a regular basis in order to improve the accuracy of the emission estimates for both waterborne navigation and marine bunkers, including improving the capacity to develop modelling tools and estimate GHG emissions for the transport sector in general.	Fuel consumption study for road transport is in progress and should be completed by mid-2020.	Capacity is still required for regular data collection of waterborne navigation and marine bunkers.
Mitigation and Actions	Capacity Building	Build capacity around tracking of mitigation policies and measures and the assessment of mitigation policies and measures. Done through training courses (basic and complex).		No progress.	Support is still needed for this type of capacity building.
			Enhancing the capacity of data providers to estimate emission reductions, track the progress of mitigation actions and share data on emission reductions and progress on a regular and continuous basis.	Two studies are underway by the Council for Scientific and Industrial Research (CSIR) on quantification of actions for the Waste and AFOLU sectors.	No further capacity is required.
	Technical		Enhancing the technical capacity of the DFFE to track the progress of mitigation actions.	The national Tracking & Evaluation (T&E) system has been set up to assist the DFFE in tracking mitigation actions. The system is fully operational, but training of the DFFE staff is currently in progress. Assistance is being provided by Gondwana to populate the system and it should be fully operational by the next BUR.	No further capacity is required.

Table 4.4:

SUMMARY OF SUPPORT NEEDS PREVIOUSLY IDENTIFIED AND PROGRESS TOWARDS ADDRESSING THESE NEEDS.

Focus	Type of Support	Activity Identified in BUR3	Need Indentified in BUR 3 Technical Review	Progress towards addressing the need	Outstanding Needs[7]
Mitigation and Adaptation	Capacity Building	Support for the development of more integrative and systematic approaches to studying climate change which link the land, air and ocean components of climate change.		No progress.	Capacity is still required to complete this activity.
			Building the capacity for undertaking comprehensive technical analyses to identify constraints and gaps at the operational level.cropland.	Complete.	No further support is required for this activity.
	Technical and Capacity Building	Support for technological innovation around social-ecological systems and sustainability. Large scale interdisciplinary, multi-site, multiscale programmes are needed to address integrative research needs.		No progress.	Support is still needed for integrative research.

[7] These needs are carried through into Table 4.7 on technical and capacity needs going forward.

4.5.1. Financial Support Needs

Significant and scaled-up resources are needed in South Africa for mitigation and adaptation actions across all strata of the economy. The South African Government is putting in place an enabling institutional environment that can support a sustainable climate finance model where mitigation and adaptation actions are funded over the long term and where this funding is accessible in a timeous manner to a broad range of stakeholders. Table 4.5 on the following page presents support needed by South Africa for mitigation and adaptation actions by sectors

"Significant and scaled-up resources are needed in South Africa for mitigation and adaptation actions across all strata of the economy. The South African Government is putting in place an enabling institutional environment that can support a sustainable climate finance model."

Table 4.5:
SUPPORT NEEDED FOR MITIGATION AND ADAPTATION.

AGRICULTURE, FORESTRY AND FISHERIES									
Support needed for mitigation and adaptation actions by sector		**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
			Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
AGRICULTURE SECTOR **Support and promote activities related to:** • Conservation agriculture • Climate smart agriculture • Developing water infrastructure and conservation measures • Rangeland and livestock management **FORESTRY SECTOR** **Support and promote activities related to:** • Strengthening community-based forestry and diversification of livelihood skills • Improving inter-departmental collaboration • Identifying key strategic areas of project implementation • Fire mitigation • Implementing disaster management and early warning systems • Integrating climate change into forestry curricula • Supporting ecosystems-based adaptation • Plan and implement multi-objective landscape level planning • Establishing and maintaining quantified baselines	**FISHERIES SECTOR** **Large scale:** • Changing the target species according to changes in species mix, abundance and distribution. • Following the fish over large distances to maximise catch rates, made possible by the size, range and endurance of the vessels. • Improving catching, processing and distribution efficiency through the introduction of new technologies. • Rationalising existing facilities within and between the companies. • Countering lower catches by reducing wastage, improving the value of existing products via product beneficiation, and introducing new and improved marketing strategies. • Stabilising and improving the skills of the labour force through the provision of support infrastructure and education and health facilities. • Selling less economic, less efficient vessels and selling or moving surplus processing machinery to another area or fishery. • Importing fish when production is unable to meet the local demand, thus retaining market share, preserving local markets and retaining the capacity to increase local production should conditions improve. • Coping with the problems of increased bad weather and damage to infrastructure within the companies' existing risk management strategies. **Small Boat Commercial Fisheries:** • Uplift the small-scale fisheries sector by providing support mechanisms, infrastructure, and education and training programmes, and promoting participatory management practices.	Draft Climate Change Adaptation and Mitigation Plan for South African Agriculture, Forestry, and Fisheries Sectors, 2018. Secondary Polices: - Draft Conservation Agriculture Policy, 2017 - Draft Climate Smart Agriculture Strategic Framework, 2018		X	X	X	X	X

Table 4.5:
SUPPORT NEEDED FOR MITIGATION AND ADAPTATION.

COASTAL ZONES SECTOR									
Support needed for mitigation and adaptation actions by sector		**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
			Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
PRIORITY 1: Develop Norms and standards for modelling of sea-level rise projections. **PRIORITY 2:** Develop norms and standards for modelling of storm surge projections. **PRIORITY 3:** Develop guidelines for coastal defence (e.g., environmental engineering approaches). **PRIORITY 4:** Prepare a coastal hazard zone index and demarcate coastal hazard zones (including impacts from climate change). **PRIORITY 5:** Develop effluent emission limits or standards. **PRIORITY 6:** Develop a National Coastal Water Quality Monitoring and Assessment Programme. **PRIORITY 7:** Develop an ocean and coastal information management system with public access. **PRIORITY 8:** Develop a National Strategy for awareness, education and training in the coastal sector. Develop a Strategy to strengthen coastal awareness in school curricula. **PRIORITY 9:** Develop a strategy for engaging coastal traditional councils in management. **PRIORITY 10:** Establish Memorandums of Understanding with other institutions to strengthen research and capacity building for coastal management in South Africa.		National Coastal Management Programme of South Africa, 2014 National Guideline Towards the Establishment of Coastal Management Lines, 2017 Secondary policy: - National Environmental Management Act: Integrated Coastal Management Act 24 of 2008		X	X	X	X	X

Table 4.5:
SUPPORT NEEDED FOR MITIGATION AND ADAPTATION.

HEALTH SECTOR								
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
The South African National Climate Change and Health Adaptation Plan is rooted in the key elements of a public health approach to climate change. The plan's actions are categorised into short-, medium- and long-term actions: • Short-term actions: Review the National Climate Change and Health Steering Committee; Capacity building interventions; Participate in International exchange and collaboration. • Medium-term actions: Review Monitoring and surveillance systems; Create Intersectoral action Health system readiness; Indicator development. • Long-term actions: Conduct National Vulnerability Assessments; Research and development on risks of climate change to health; Conduct Health Impact Assessments; Model and Pilot Climate Change and Health Adaptation Projects; Identify adaptation actions.	National Coastal Management National Climate Change and Health Adaptation Plan, 2020–2024 Secondary policies: - National Heat Health Action Guidelines, 2019 - Department of Health Strategic Plan 2015–2020		X	X	X	X	X

BIODIVERSITY SECTOR								
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
• Evaluate the spatial planning approaches which change the mix of activities which take place in given biomes, including the possibility of abandoning some uses completely and introducing new ones. • Management approaches which adjust the way in which the land uses are executed under a changing climate, for instance by changing the species used or the intensity of use. • Ecosystem-based adaptation, which sets out to support the inherent ability of ecosystems, including their human inhabitants and organisms, to adapt to climate change, principally by reducing the other stresses which might impede that capacity, and restoring ecosystem function where it has been damaged. • Biodiversity stewardship programmes, which, by expanding protected areas on private land and promoting sustainable land management through management agreements, can form corridors that will enhance the adaptive capacity outside of state-owned protected areas.	Climate Change Adaptation Plans for South African Biomes, 2015 Secondary policy: - South African Ecosystem Based Adaptation Strategy 2016–2021		X	X	X	X	X

Table 4.5:
SUPPORT NEEDED FOR MITIGATION AND ADAPTATION.

URBAN AND RURAL SETTLEMENTS SECTOR								
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	Grant
• Environmentally sustainable land use development • Integrated Development Planning • Needs and priorities of people in informal settlements • Environmentally sound low-cost housing and planning for housing development	Environmental Implementation Plan 2015–2020 (Department of Human Settlements). Department of Rural Settlements' Climate Change Adaptation Sector Strategy for Rural Human Settlements, 2013 Supporting policies: Draft National Spatial Development Framework, 2018. Department of Human Settlements Revised Strategic Plan 2015– 2020		X	X	X	X	X

WATER RESOURCES SECTOR								
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	Grant
• Water governance – building adaptive institutions, creating intergovernmental relations, awareness, communication, research and development, stakeholder participation, regional development, and the review of strategy. • Infrastructure development, operation and maintenance – Multi-purpose water storage, water supply and sanitation, groundwater development and management, flood protection measures, infrastructure safety, hydro-geo-meteorological monitoring system. • Monitoring and Management – Data and information gathering, Scenarios and climate modelling, Vulnerability assessments, Planning, Water Allocation and authorisation, Optimisation of dam and groundwater operation, Water Conservation and water demand management, Water quality management, Resource management and protection.	Climate Change Response Strategy for the Water and Sanitation Sector, 2019 Supporting polices: Department of Water and Sanitation Revised Strategic Plan, 2015/16– 2019/20		X	X	X	X	X

Table 4.5:
SUPPORT NEEDED FOR MITIGATION AND ADAPTATION.

ACTIONS IN ENERGY SECTOR: 1A1 ENERGY INDUSTRIES							
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
• 12L tax incentive programme • Appliance Labelling project • Eskom Integrated Demand Management (IDM) programme • Municipal Energy Efficiency and Demand-side Management programme • The National Cleaner Production Centre (NCPC) programme		X		X	X	X	X

ACTIONS IN ENERGY SECTOR: A2 MANUFACTURING INDUSTRIES AND CONSTRUCTION							
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
• Natural gas fuel switch programme		X		X	X	X	X

ACTIONS IN ENERGY SECTOR: 1A3 TRANSPORT							
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
• Bus Rapid Transport System • Electric vehicles • Transnet Road-to-Rail programme		X		X	X	X	X

ACTIONS IN IPPU SECTOR							
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**		
		Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**
• Nitrous oxide emission reductions • Carbon budgets and pollution prevention plans (only process emissions)		X		X	X	X	X

Table 4.5:
SUPPORT NEEDED FOR MITIGATION AND ADAPTATION.

ACTIONS IN WASTE SECTOR								
Support needed for mitigation and adaptation actions by sector	**Reference to Programmes, Policies and Measures**	**Support Types Needed**			**Funding by Preferred Type**			
		Mitigation	**Adaptation**	**Capacity Building**	**Technical Support**	**Technology Support**	**Grant**	
Waste Management **Flagship programme:** • The Climate Change Response Public Works Flagship Programme • The Water Conservation Flagship Programme • The Renewable Energy Flagship Programme • The Energy Efficiency & Management Flagship Programme • The Transport Flagship Programme • The Waste Management Flagship Programme • The Carbon Capture & Sequestration Flagship Programme • Long-term Adaptation Scenarios Flagship Research Programme		X		X	X	X	X	

4.5.2. Technical or Capacity-Building Needs

The technical and capacity building needs for South Africa going forward are identified in Table 4.6.

Table 4.6:
TECHNICAL AND CAPACITY BUILDING NEEDS OF SOUTH AFRICA.

Focus	Type of Support	Activity
Inventory and mitigation	Capacity Building	Enhance the capacity to include mitigation actions and activities into the AFOLU inventory.
		Improve capacity to undertake more complete uncertainty analysis on country inventory data for all sectors.
		Build capacity within the inventory team to complete LULUCF emission estimates.
	Technical	Enhance technical capacity to develop a land mapping system which allows for the integration of various spatial datasets to inform the land cover matrix
		Enhance technical capacity for data collection on a regular basis in order to improve the accuracy of the emission estimates for both waterborne navigation and marine bunkers.
	Technical and capacity building	Support sector-specific priority data generation processes to improve the GHG inventory. Projects to provide information on country specific emission factors in all sectors, particularly: i. Waste sector. ii. Direct and indirect N_2O emission factors for emissions from managed soils and manure management.
Mitigation and actions	Capacity building	Build capacity around tracking of mitigation policies and measures and the assessment of mitigation policies and measures. Done through training courses (basic and complex).
		Enhance the capacity to track mitigation actions and PAMs in all sectors, particularly the AFOLU sector.
Mitigation and daptation	Capacity building	Support the development of more integrative and systematic approaches to studying climate change which link the land, air and ocean components of climate change.
		Enhance capacity to identify and assess co-benefits and wider impacts of actions.
	Technical and capacity building	Support technological innovation around social-ecological systems and sustainability. Large scale interdisciplinary, multi-site, multiscale programmes are needed to address integrative research needs.

4.6 TECHNOLOGY NEEDS AND BARRIERS

The Technological Needs Assessment study was conducted in order to determine key sectors' mitigation and adaptation needs as part of the country's climate change response measures and development goals. The objective of the study was to provide a basis from which to understand the implication of climate change on these development goals and the sectors' climate change mitigation and adaptation needs.

A technology prioritisation process was conducted on a sector-by-sector basis. Through a series of technology prioritisation workshops, technologies were selected based on the country's priorities and ranked within each sector. The workshops were guided by the multi-criteria analysis (MCA) matrix to understand which climate change mitigation and adaptation technologies need to be prioritised in the context of their technological role in supporting the effective implementation of climate change initiatives in the country.

The MCA was described by Dodgson et al. (2009) and was outlined in a guideline for countries conducting a technology needs assessment (Haselip et al., 2015). The MCA approach assisted in determining to what extent each potential technology contributes to national development goals, reduces GHG emissions and/or benefits adaptation, while being cost effective. The MCA approach thus provided a structured framework which allowed the comparison of a number of technologies against multiple criteria and facilitated stakeholder participation relying on the technical expertise of stakeholders.

During the updating of the Technological Needs Assessment synthesis report, an analysis to highlight the key barriers to climate technology innovation, within the key sectors prioritised, was undertaken. This focussed on the identification and analysis of specific barriers to the development, transfer, diffusion and deployment or implementation of technologies for climate change mitigation and adaptation in the country.

A key input into this analysis was stakeholder input from discussions at the sectoral technology prioritisation workshops, as these workshops brought together stakeholders from various science councils, universities, national government departments and the private sector.

Based on a review of the literature and technology prioritisation workshops, a barrier analysis workshop was held with key stakeholders to refine the outcomes of the analysis and to propose interventions to unlock the barriers. The following criteria were used for identifying and assessing barriers to climate technology innovation:

- Cost
- Public policies
- Market structure
- Socio-economic opportunities e.g., social inclusion and creation of new jobs
- Institutional arrangements and readiness
- Technological readiness

4.6.1. Technology Needs

The Technological Needs Assessment prioritised technologies and identified two sectors for mitigation and five sectors for adaptation. These technologies can be implemented in the short-to-medium term.

4.6.1.1. Technology needs for mitigation

In terms of mitigation, the industrial sector has the potential to implement measures to improve its energy efficiency as well as switch from using raw materials to recycled materials (Table 4.7). These measures have significant potential to reduce GHG emissions and also to assist industries in terms of energy savings and job creation. Similarly, in the waste sector, technologies which had the most potential to reduce/avoid greenhouse gas emissions, scored the highest.

Table 4.7:
PRIORITISED TECHNOLOGIES FOR THE MITIGATION SECTOR (CSIR, 2019).

Mitigation Sector	Prioritised Technology	Justification / Motivation
Industry	Aluminium – Energy monitoring and management system	• Sector plays an important role in national economic development. • Largest contributor to GHG emissions in the industrial sector. • Improving energy efficiency could make production of aluminium more competitive.
	Utilise waste material (such as old tyres) as fuel in cement production	• Improves efficiency of cement production while reducing dependence of fossil fuels and GHGs. • Potential to supply waste energy through Combined Heat and Power combustion systems (CHP) and co-generation to neighbouring communities.
	Aluminum – Secondary production and recycling	• Allows for re-use of aluminium scrap. • Environmentally sound process that is more energy efficient than primary production.
Waste	Higher value and marketable by-products from food waste	• Enterprise development and diversion of organic waste from landfill.
	Separation at source and waste recovery services by small businesses	• Increased community participation rates in recycling programs. Sustainable job creation.
	Anaerobic digestion (large scale)	* High mitigation potential. Production of electricity. Solid by-products can be turned into compost and fertiliser.

4.6.1.2. Technology needs for adaptation

Urban forestry, conservation tillage, wetland restoration and protection, and biorefinery were the technologies for the agriculture, biodiversity and forestry sector which scored the highest in addressing climate change and ecosystem benefits. Organic agriculture/farming, multiple land use, and managing and monitoring invasive alien species technologies were other potential technology options to consider in the sector (Table 4.8). The human settlement sector focused on disaster risk reduction in terms of improved storm water drainage and the use of fire-retardant building materials, as well as low elevation engineering which provided coastal protection measures.

Low pour flush toilets, rainwater harvesting, and desalination are currently being implemented across the country as the highest scoring prioritised technologies for the water sector. These technologies also have the potential to contribute to challenges around water pollution and water resource availability (Table 4.8).

Table 4.8:
PRIORITISED TECHNOLOGIES FOR THE ADAPTATION SECTOR (CSIR, 2019).

Adaptation Sector	Prioritised Technology	Justification / Motivation
Agriculture, Biodiversity and Forestry	Urban Forestry	Promote adaptation to heat stress by providing shading and evaporative cooling, rainwater interception, and storage and infiltration for cities. Potential to act as carbon sinks.
	Conservation Tillage	Reduces risk though enhanced soil-moisture retention and minimising soil impaction. High ecosystem benefits through carbon sequestration in organic matter accumulation in the soil from use of residues and cover crops.
	Wetland restoration and protection	High ecosystem benefits. Contributes to water sector priorities. Potential for improved livelihoods.
	Biorefinery	Maximises value-added products obtained from biomass through more efficient, optimised processes. Cross-cutting in agriculture, forestry, fisheries, waste and industry sectors.
Fisheries	Rapid screening tools for imported wild caught, aquaculture products and bait	Supports rapid health assessment of wild and imported fish (and bait) in line with aquaculture requirements.
	Early warning systems for forecasting extreme events	Supports disaster risk management and adaptive responses to extreme weather events and has the potential to save lives.
	Early warning systems to detect changes in algal blooms	Risk reduction in terms of impact on aquatic ecosystems, human health, and the economy.

Table 4.8:
PRIORITISED TECHNOLOGIES FOR THE ADAPTATION SECTOR (CSIR, 2019).

Adaptation Sector	Prioritised Technology	Justification / Motivation
Human Settlements	Disaster risk reduction: Sustainable urban drainage systems	• Improving the resilience of urban built-up environments to flooding. Enterprise development for the production of sustainable urban drainage system technologies. • Job creation. • Reduce the contamination of storm water from pollutants.
	Low elevation engineering	• Job creation in the building and construction sector. • Protection of coastal zones from flooding.
	Disaster risk reduction: Fire-retardant building materials for low cost and informal housing	• Enterprise development for the formulation of fire-retardant materials and the design of fire-resistant houses. • Increase the adaptive capacity of human settlements to natural disasters.
Water	Low pour-flush toilets	• Suitable for areas with low water availability. • Water saving (uses 1–2 L per flush).
	Rainwater harvesting	• Increase diversity and optimisation of mix of water sources. • Improve the reliability of water supply in rural areas and municipalities where services are unreliable.
	Desalination technologies for brackish water, ground water, mine water, and seawater	• Increase ability to make use of more sources of water. • Potential to add jobs to the Blue Economy.

4.6.2. Barriers to Climate Technology

The technologies prioritised above are discussed in this section in terms of barriers to implementation and national actions to support these technologies.

4.6.2.1. Barriers to mitigation technologies

The Department of Science and Technology (DST) and the Department of Environmental Affairs (DEA) identified barriers to the first cluster of mitigation technologies in the following categories: policy and regulatory, access to information, technical, research and development (R&D), cost or financial, and technology transfer barriers. Table 4.9 to Table 4.11 provide an overview of barriers to technology in the energy, IPPU and waste sectors.

Table 4.9:
BARRIERS TO ENERGY-RELATED MITIGATION TECHNOLOGIES PRIORITISED IN THE DEA AND DST MITIGATION TECHNOLOGY PLAN (DEA AND DST, 2015).

Mitigation Technology or Technological System	Description of Barriers
Carbon capture and storage (CCS)	• Lack of policy and regulatory clarity and certainty. • Insufficient knowledge of, and information on, the effectiveness of the technology. • Limited domestic R&D conducted in South Africa. • Weak or limited human skills-base to support CCS development. • Underdeveloped market and private sector interest in CCS are not articulated.
Advanced biofuels	• Lack of policy and regulatory clarity and certainty. • Insufficient knowledge of, and information on, the effectiveness of the technology. • Social resistance (mainly by environmental activists). • Socio-economic and environmental impacts research not well done. • The underdeveloped market for biofuels.
Smart grids	• Insufficient knowledge of, and limited information on, technology (its availability and effectiveness). • Underdeveloped market, and private sector investment is limited. • Poor or underdeveloped physical infrastructure for deploying the technology in rural areas.

Table 4.9:
BARRIERS TO ENERGY-RELATED MITIGATION TECHNOLOGIES PRIORITISED IN THE DEA AND DST MITIGATION TECHNOLOGY PLAN (DEA AND DST, 2015).

Mitigation Technology or Technological System	Description of Barriers
Solar photovoltaics	• Underdeveloped human skills-base (limited number of skilled installers with technical skills). • Lack of proper standards for performance and quality management. • Relatively high installation costs for rural poor households. • Limited public information/awareness of economic and environmental benefits of the technology. • Financing of technology commercialisation is scarce or limited.
Solar water heaters	• Underdeveloped human skills-base (limited number of skilled installers with technical skills). • Lack of proper standards for performance and quality management. • Relatively high installation costs for rural poor households. • Limited public information/awareness of economic and environmental benefits of the technology.
Energy efficient lighting	• Lack of policy and regulatory clarity and certainty. • Inadequate infrastructure and accessibility of technology in rural areas. • Relatively high cost of technology for poor rural households.
Variable speed drives and energy efficient motors	• High-cost large-scale rollout. • Limited public information/awareness of economic and environmental benefits of the technology. • Lack of incentives for private investment in the development of the technology. • Underdeveloped/limited human skills-base (short supply of engineers and system designers).
Energy efficient appliances	• The relatively small market for energy efficient appliances such as refrigerators. • Limited public information/awareness of economic and environmental benefits of the technology. • High costs of acquiring the technology by rural poor households.
Energy storage technologies	• Poor knowledge of and limited information on technology (its availability and effectiveness). • Underdeveloped market, and private sector investment is limited. • Poor coordination and/or linkages between R&D (e.g., CSIR) and industry (e.g. IDC).

Table 4.9:
BARRIERS TO ENERGY-RELATED MITIGATION TECHNOLOGIES PRIORITISED IN THE DEA AND DST MITIGATION TECHNOLOGY PLAN (DEA AND DST, 2015).

Mitigation Technology or Technological System	Description of Barriers
Hybrid electric vehicles	• Limited knowledge and information (awareness) of the technology and its effectiveness and economic as well as environmental benefits. • High upfront costs of purchasing hybrid electric vehicles. • Limited financing for domestic R&D on the technology. • Insufficient coordination between departments of transport, energy, science and technology, and finance undermines efforts to develop a national policy and strategy. • Intellectual property protection (barrier to local manufacturing).
Wind (Onshore)	• Small domestic market and lack of incentives (including financing) for the private sector, particularly SMEs. • Underdeveloped manufacturing base for technology components. • Technological lock-in in coal-generated electricity by Eskom. • Lack of policy and regulatory clarity on nuclear power/energy. • Social resistance and politicisation.
Nuclear pressured water reactor (PWR)	• Lack of incentives to attract domestic private sector investment. • Limited human skills-base to conduct R&D and develop as well as deploy the technology. • High costs of technology.

Table 4.10:
BARRIERS TO IPPU-RELATED MITIGATION TECHNOLOGIES (CSIR, 2019).

Mitigation Technology or Technological System	Description of Barriers
Improving energy efficiency in primary aluminium products	• Limitations of the technologies used in the electrolysis process. • New equipment or changes to processes may also need to be imple mented, these would be industry-site specific and could be costly. • The demand to produce more metal from existing capacity shifts the focus to increasing the electric current in the electrolytic process, rather than reducing it.
Anode technology selection for primary aluminium smelting	• Research and further investigations into the best available tech-nology (based on the existing equipment and design) is required. • International development and testing of these new technologies are occurring, with a limited market in South Africa.
Switch from coal to biomass / residual wood waste in the paper and pulp industry	• The investment costs of new equipment and retrofitting boilers inhibits private sector investment.
Basic Oxygen Furnace in the production of iron and steel	• The use and installation would be subject to limitations associated with the location of existing equipment and plant design. • The cost of the system might also prevent private sector investment.
Waste material as a fuel in cement production	• Scrapped tyres are spread out across the country, so the correct procedures for collection, classification and storage are required. • Public concern about the increase in air pollution emissions and the release of toxic gases, such as dioxins, might reduce interest in such an investment.
Combined heat and power (CHP) in the paper and pulp industry	• High initial capital costs of implementing a CHP system.
Energy Management and Monitoring System	• Limited finances and awareness of the options available might make industries hesitant to invest, especially if the production process is complex. • Unless there are incentives to invest in energy efficiency, capital investment is likely to prioritise areas of the production process that require it more urgently (i.e., investments that can directly improve productivity).
Improvement of process monitoring and control	• The capital costs and the return time on investment would need to be understood to convince industries of the return on investment.
Top Gas Recycling (with CCS)	• The stage of development of such technologies and its track record might make private sector wary of investment.

Table 4.11:
BARRIERS TO WASTE-RELATED MITIGATION TECHNOLOGIES - WASTE SECTOR (CSIR, 2019).

Mitigation Technology or Technological System	Description of Barriers
Recycling - Higher value and marketable by-products from food waste	• Small scale operations not practical. • Contamination of post-consumer food waste usually from packaging, household objects and non-recyclables make extraction costly. • Contamination risks of post-consumer food waste from household hazardous waste. • Lack of enforcement of separation at source of commercial food waste, especially from shopping centers and restaurants.
Recycling - Separation at source and waste recovery services by small businesses	• Enforcement of separation at source in the residential, commercial and industrial sectors is insufficient. • The informal sector, which is recognised, is left largely to operate in its current form. • Lengthy engagements with informal waste pickers to integrate them into co-operatives and small businesses have shown that the loss of revenue for pickers makes participation in the formalisation process unattractive to them. • Infrastructure and resources are lacking for the success of co-operatives, including transport, equipment, premises to work, and electricity supply. • Operational challenges include theft of recyclates, finding markets to sell recyclates, and networking. • Insufficient training of waste pickers to operate small businesses including technical, governance and business management skills. • Underdeveloped relationships between co-operatives and local government. • Lack of start-up and working capital.
Anaerobic digestion: large scale from both industrial and municipal waste	• Capital-intensive. • Source of GHG emissions. • Most organic waste ends up in landfills.
Anaerobic digestion of municipal and industrial waste-water sewage sludge with Combined Heat & Power (CHP)	• Low gas yields due to issues relating to the sludge management component of the plant can result in lower gas production than anticipated. • Human fecal waste which mixes with municipal effluent cannot be used as a feedstock since pathogen reduction by mesophilic anaerobic digestion is insufficient.
In-vessel composting	• Capital intensive. • Requires extensive training of personnel. • High maintenance and operational costs.

4.6.2.2. Barriers to adaptation technologies

The implementation of the technologies listed for climate change adaptation can be impeded or hindered by a range of policy, institutional, social and technical factors. There are policy and institutional issues pertaining to land and resource tenure in general. Ownership of land and land size influences technology choice and implementation. The development and implementation of some of the technologies may be impeded by lack of policy and regulatory clarity as well as social resistance. Scarcity of human resources and limited funding are impediments to R&D. Barriers to implementation of technologies may include lack of information and high costs for small-scale rural farmers (Table 4.12–15).

Table 4.12:
BARRIERS TO AFOLU-RELATED ADAPTATION TECHNOLOGIES (CSIR, 2019).

Type of technology or technological system / field	Barriers to technology development and implementation
Urban forestry and vegetation	• High implementation cost depending on location. • Some municipal laws are an impediment, particularly land tenure restricting farming practices in municipalities.
Biorefinery	• High investment costs and operational expenses. • Need for development of skills to build and operate new technologies. • R&D funding constraints.
Integrated pest management	• Limited technical skills among farmers, particularly in rural areas. • High costs of equipment and other materials for small-scale farmers in rural areas. • Low incentives, particularly for small-scale farmers, due to limited potential to capitalise new investments.
Organic agriculture	• Inadequate incentives for implementation of organic agricultural technologies due to low potential to capitalise further investments. • Weak technical standards for inspection and certification of organic products from small-scale farmers in rural parts of the country.
Monitoring and managing invasive species	• Limited R&D funding. • Poor institutional coordination between provinces and national government departments. • Underdeveloped public-private sector collaboration.

Table 4.13:
BARRIERS TO FISHERIES-RELATED ADAPTATION TECHNOLOGIES (CSIR, 2019).

Type of technology or technological system / field	Barriers to technology development and implementation
Technologies for the rapid health assessment of wild and imported fish (and bait)	• Additional research and development are needed for application in the local context. • Protocols and training of customs/airport staff in aquatic health and hazards. • Training needed in local labs.
Early warning systems for forecasting extreme events	• R&D funding constraints. • User confidence in the degree of uncertainty.
Early warning systems for detecting changes in algal blooms	• R&D funding constraints. • Availability of good quality real-time data may be limited. • User confidence in the degree of uncertainty. • Methods for communication of information to users and ownership of management i.e., who will manage system?

Table 4.14:
BARRIERS TO WATER-RELATED ADAPTATION TECHNOLOGIES (CSIR, 2019).

Type of technology or technological system / field	Barriers to technology development and implementation
Rainwater harvesting	• High cost to install across income groups. • Lack of incentives for broader adoption.
Desalination	• High infrastructure investment. • High financial viability and operational efficiency to be a successful alternative water supply. • High maintenance costs. • Energy-intensive. • Requires skilled personnel.
Protecting and restoring ecological infrastructure	• Need for secure financial flows for restoration and ongoing maintenance of ecological infrastructure. • Need for improved institutional capacity for investment in ecological infrastructure. • Competition for land.
Reducing system leakages	• Need for area-specific assessments and interventions – municipality needs vary depending on the root causes of water losses. • Lack of capital in most municipalities to buy the technology (models/software, and training costs). • Lack of implementation of the policies and regulations which are already in place when it comes to leak detection.
Low pour-flush toilets	• Needs a reliable water supply – assessment of the reliability of water supply must be done prior to implementation. • Local authorities must clarify the responsibilities of operation and maintenance. • Need for plans by municipalities for disposal of leach pits. • Assessment of suitability needed in areas with high water table or sensitive ecosystems.

Table 4.15:
BARRIERS TO SETTLEMENTS-RELATED ADAPTATION (CSIR, 2019).

Type of technology or technological system / field	Barriers to technology development and implementation
Disaster risk reduction - Improved stormwater drainage systems/upgrade	• High investment costs and low availability of expertise required to successfully implement upgrades. • Depending on the level of existing infrastructure in an area, implementation could be expensive, for example, in an area with little existing infrastructure that is compatible with new technology.
Low elevation engineering	• The cost of construction of options such as new groynes or well-designed seawalls may limit the use. • A further barrier may be the availability and cost associated with the specialised equipment and contractors needed for processes such as dredging. • Some dune management options may have a requirement of an Environmental Impact Assessment before commencement resulting in additional cost and lengthier timeframes. • Gaining buy-in from the public and municipal officials for the need for artificial dune creation or dune rehabilitation projects.
Disaster risk reduction - fire-retardant building materials for low cost and informal housing	• Typically undertaken as pilot projects – highlighting the need for innovation and markets for affordable materials to be developed. • Require community-civil society-government-private partnerships to roll out innovative upgrades to existing settlements.
Energy efficiency (e.g. combined heat and power; smart grids, smart cities)	• Capital and operational and maintenance costs are high. • The costs to maintain the system and the availability of existing skills to use the technology could lead to resistance/lack of buy-in. • In cities that are cash-strapped there may be a lack of political support in terms of providing financial support.
Climate adaptive buildings	• Limited low-cost adaptation measures and regulations/codes to enforce implementation of adaptation options. • Limited skilled capacity (engineers, architects and builders, inspectors) to develop standards and to enforce standards. This can increase the difficulty of implementing adaptation measures. • Enforcement procedures of national building regulations and local by-laws are sometimes limited or non-existent within local municipalities. • The availability of suitable materials at an affordable cost.

Table 4.15:
BARRIERS TO SETTLEMENTS-RELATED ADAPTATION (CSIR, 2019).

Type of technology or technological system / field	Barriers to technology development and implementation
Heat resilient surfaces (e.g. warm mix asphalt and engineered cementitious composite	• Capital scarcity for long-term capital-intensive investments. • South Africa's investment in R&D has been in steady decline. • The railway capacity is insufficient to support the transportation of large quantities of raw materials and recycled materials needed to produce new types of concrete and asphalt. • High transport and labour costs. • Volatility and low productivity of the workforce. • Shortage of skilled workers that can support the deployment of new concrete and asphalt technologies. • Slag by-product from manganese alloy production is classified as a hazardous material and cannot be sold in South Africa but could be used in new asphalt mixes

4.6.2.3. Unlocking barriers to climate technology

Table 4.16 provides an overview of recommendations outlined above and identifies the locus of leadership for proposed interventions as well as some of the trade-offs or implications of reforms.

Table 4.16:
PROPOSED INTERVENTIONS TO UNLOCK THE BARRIERS

AREAS WHERE EXISTING BARRIERS EXIST:		
POLICY AND REGULATORY FRAMEWORKS		
INTERVENTIONS TO REMOVE BARRIERS	**LEADERSHIP (PUBLIC / PRIVATE)**	**TRADE-OFFS / IMPLICATIONS**
Review of existing policies, regulations and bylaws to identify specific issues in policies and regulations causing the barriers with the view to policy and regulatory reform. Create an enabling environment for effective policy implementation. This may involve conducting social impact assessments and regulatory impact assessments – this needs to be done for policies before they are submitted. Policy exemption period until implementation and validation of technology (sector specific) (exemptions with conditions) e.g., carbon tax bill (specific sectors exempt because of the validation process, postponed for 5 years if implemented).	Mainly national government departments particularly Department of Science and Innovation (DST), the Department of Trade and Industry (DTI), Department of Environment, Forestry and Fisheries (DFFE), National Treasury and DMRE	Some of the reforms may lead to less public revenue e.g., reduction in fuel tax if using biofuels. Cost of policy making is likely to increase if policy making is evidence-based. To reduce policy-making costs, learning from peers is needed. Multiplicity of stakeholders in policy review and reform may cause delays in decision making, thus slowing the removal of barriers.

AREAS WHERE EXISTING BARRIERS EXIST:

CO-ORDINATION BETWEEN (PUBLIC) R&D (INCLUDING UNIVERSITIES, SCIENCE COUNCILS, GOVERNMENT DEPARTMENTS) AND INDUSTRY

INTERVENTIONS TO REMOVE BARRIERS	LEADERSHIP (PUBLIC / PRIVATE)	TRADE-OFFS / IMPLICATIONS
Establish mandatory coordination requirements and integrate them in regulations and laws. Explicitly make provisions requiring public-private coordination in such legislation as the proposed climate change bill. Establish common technology missions and platforms for climate change, bringing all stakeholders together, including private sector and civil society.	Inter-departmental committee involving DST, DTI, DFFE, and Chamber of Commerce/Business	This will require optimisation of human, Institutional and financial resources.

AREAS WHERE EXISTING BARRIERS EXIST:

DEVELOPMENT OF MARKETS FOR CLIMATE-SMART TECHNOLOGIES

INTERVENTIONS TO REMOVE BARRIERS	LEADERSHIP (PUBLIC / PRIVATE)	TRADE-OFFS / IMPLICATIONS
Create and provide incentives to grow markets (at varying levels), e.g., subsidies for selected technologies. Establish public-sector technology development grants.	Government line departments, particularly, DTI, DST, National Treasury	Evidence-based analysis is required (technology and sector specific) to guide government on specific measures to be taken. This will need expertise and financial resource allocation.

AREAS WHERE EXISTING BARRIERS EXIST:		
PRIVATE SECTOR INVESTMENT IN CLIMATE CHANGE R&D AND INNOVATION		
INTERVENTIONS TO REMOVE BARRIERS	**LEADERSHIP (PUBLIC / PRIVATE)**	**TRADE-OFFS / IMPLICATIONS**
Strengthen private sector intellectual property development and management.	DST, National Intellectual Property Management Office (NIPMO) and DTI	It is assumed that private sector will utilise intellectual property as an incentive to increase investment in climate change R&D and innovation.

AREAS WHERE EXISTING BARRIERS EXIST:		
PUBLIC KNOWLEDGE AND INFORMATION-BASE ON SOME OF THE SMART CLIMATE TECHNOLOGIES IN AGRICULTURE, FORESTRY, WATER, SETTLEMENT, ETC.		
INTERVENTIONS TO REMOVE BARRIERS	**LEADERSHIP (PUBLIC / PRIVATE)**	**TRADE-OFFS / IMPLICATIONS**
Establish public awareness and information provision programmes on specific technologies.	All government departments should provide leadership through coordination by DFFE and DST	This will require budget allocation.

AREAS WHERE EXISTING BARRIERS EXIST:		
SKILLS-BASED TRAINING FOR IMPLEMENTATION AND MAINTENANCE (E.G., ENGINEERING CAPABILITY).		
INTERVENTIONS TO REMOVE BARRIERS	**LEADERSHIP (PUBLIC / PRIVATE)**	**TRADE-OFFS / IMPLICATIONS**
Design and provide accreditation for middle-level programmes for technical training (specialised courses; development of and sustaining scarce skills such as engineering and technology). Integrate technical training into all (or be a core component of) sector roadmaps and be linked to specific technology missions.	Department of Higher Education and Training (DHET), DST and National Treasury	Will require a review of vocational and technical training curriculum.

AREAS WHERE EXISTING BARRIERS EXIST:		
TECHNICAL STANDARDS FOR TECHNOLOGY PERFORMANCE AND QUALITY MANAGEMENT		
INTERVENTIONS TO REMOVE BARRIERS	**LEADERSHIP (PUBLIC / PRIVATE)**	**TRADE-OFFS / IMPLICATIONS**
Institute and enforce specific technical standards in terms of hardware (within the country, imports and exports). Review of existing technical standards.	South African Bureau of Standards (SABS), all standardisation bodies in general, CSIR and DTI	Implications in terms of SABS budget and strengthening infrastructure for technical standards setting and enforcement.

AREAS WHERE EXISTING BARRIERS EXIST:		
COSTS OF TECHNOLOGY PROCUREMENT AND IMPLEMENTATION; HIGH COSTS OF R&D IN CERTAIN SECTORS AND ON CERTAIN TECHNOLOGIES		
INTERVENTIONS TO REMOVE BARRIERS	**LEADERSHIP (PUBLIC / PRIVATE)**	**TRADE-OFFS / IMPLICATIONS**
Conduct/commission a study to review economic costs of research and technology development in priority sectors. Provide subsidies for research and technology development for mitigation and adaptation.	Government departments, particularly DST, DFFE and National Treasury in collaboration with the private sector.	Increased national expenditure on R&D and increased demand on public revenue. Assumption is that subsidies will stimulate procurement and implementation of mitigation and adaptation technologies.

5. SUPPORT RECEIVED FOR THE PREPARATION OF THE BUR4

South Africa received bilateral financial support from the German Government to develop the 4th Biennial Update Report (BUR4). The funding was administered through the Gesellschaft für Internationale Zusammenarbeit (GIZ) as part of the Climate Change Support Programme to South Africa. The GIZ is the implementing agency of the German Federal Ministry for the Environment, Nature Conservation, Buildings and Nuclear Safety (BMUB). The funding was used to contract Gondwana Environmental Solutions International (Gondwana) to assist with data collection as well as integration of the BUR4 and technical editing.

The chapters of BUR4 were drafted internally by the DFFE personnel from the International Climate Change Relations and Reporting as well as the Climate Change Monitoring and Evaluation Chief Directorates. The Council for Scientific and Industrial Research (CSIR) and Promethium Carbon provided additional technical support for the drafting of the 'Mitigation Actions and Effects' chapter. In addition, the CSIR completed a full Technical Needs Assessment. Gondwana provided additional technical support with drafting the 'Support Needed and Received' and the 'Technology Needs Assessment' sections of chapter 4.

In addition, South Africa received further financial support from the GIZ to contract IBIS Consulting to conduct an independent review of BUR4. This is an imperative step for South Africa towards improving the overall quality of the report. South Africa has also benefitted from various capacity building activities of the Consultative Group of Experts (CGE) to compile its BURs, especially in using DFFE personnel who have benefitted from such. Furthermore, South Africa has also benefitted from the capacity building support from the Partnership on Transparency in the Paris Agreement (PATPA) which is co-founded by South Africa, Germany and South Korea.

At the time of completing the BUR4, South Africa was still applying for funding from the Global Environment Facility for the development of the 5th BUR and the 4th National Communication Report using the United Nations Environment as the implementation agency.

6. MEASUREMENT, REPORTING AND VERIFICATION IN SOUTH AFRICA

6.1. CLIMATE CHANGE MONITORING AND EVALUATION

The South African National Climate Change Information System (NCCIS), also referred to as the National Monitoring and Evaluation (M&E) system, is a web-based platform for the tracking, analysis and enhancement of South Africa's progress towards the country's transition to a low-carbon economy and climate-resilient society as put forward in the National Climate Change Policy (DEA, 2011). The platform collates climate related data and information from a range of sources (Figure 6.1) for the purposes of providing insights into the country's progress in responding to climate change and achieving national and international goals, commitments and targets including the National Determined Contributions (NDC). The NCCIS offers a series of decision support tools to inform policy and decision-making, as well as showcasing information for South Africa's domestic and international reporting. It informs national decision makers, including Parliament and Cabinet as well as presenting South Africa's position in various negotiating platforms such as the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC).

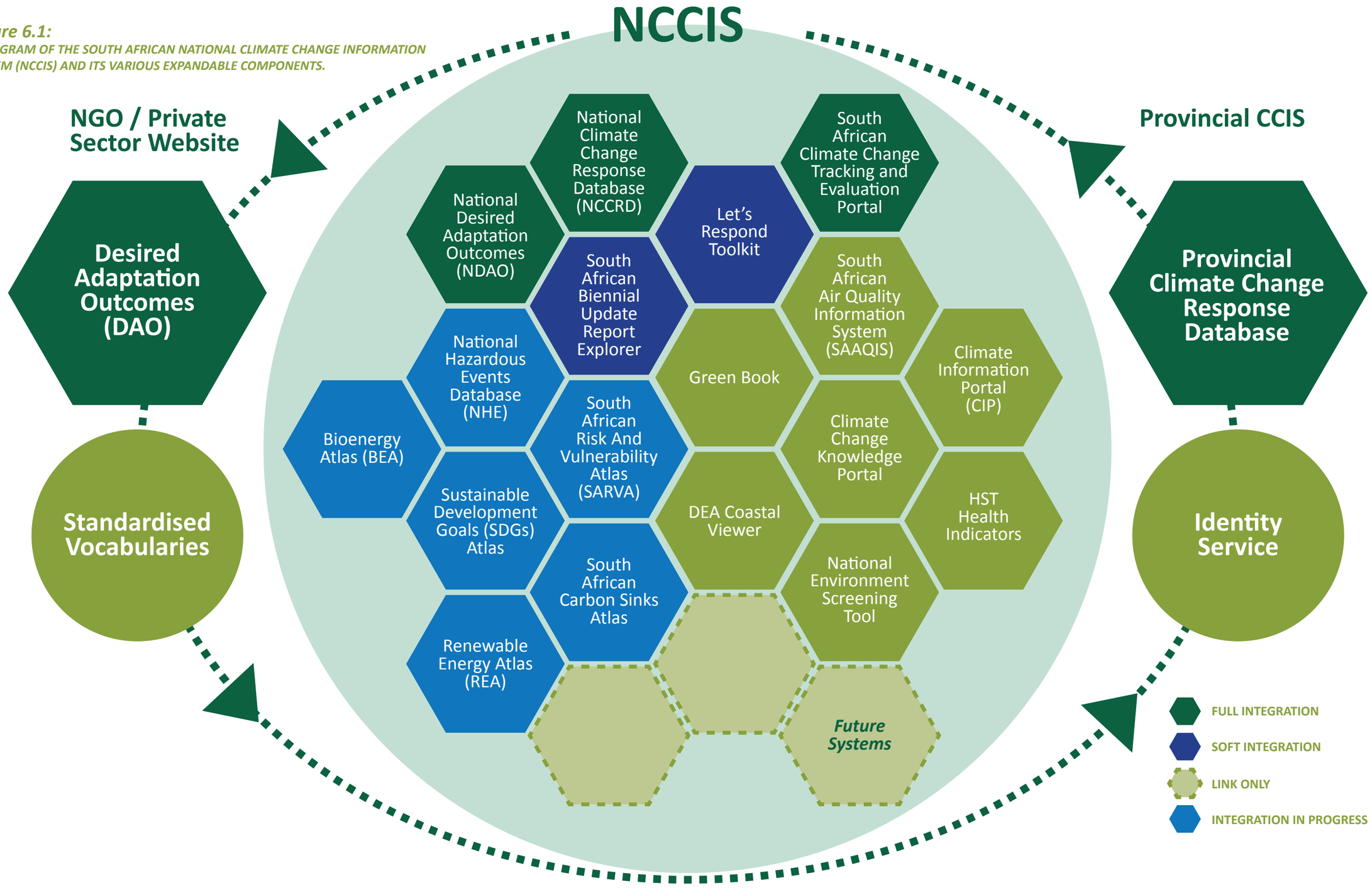
The NCCIS is supported by national, provincial, and local scale systems of data-collection to provide detailed, complete, accurate and up to date data on:

- Greenhouse gas (GHG) emission reductions achieved through projects, policies and other related instruments/measures.
- Observed and projected climate change.
- Current, and future, risks, impacts and vulnerabilities.
- Climate resilience response measures.
- Analysis of the impact of adaptation and mitigation measures.
- Information on climate change financial flows.
- Tracking of technology transfer activities related to climate change initiatives.
- Climate change related tracking indicators.

It showcases vital climate action to inform domestic and international reporting. The NCCIS collects data and information from data custodians that use internationally recognised methodology to collect and analyse data/information (including quality assurance and control). One such example is the work that is led by the South African Weather Service on climate indices, which has adopted the methodology and guidelines from the World Meteorological Organisation. Future work for the NCCIS includes the creation of subnational systems and sector specific systems, building on the work that has already been done on the NCCIS.

The South African M&E system encompasses all three functional aspects of the measurement, reporting and verification (MRV) system, namely, MRV of GHG emissions, MRV of mitigation actions and MRV of Support. South Africa has adopted the approach of developing a climate change M&E system, which integrates the analysis of all aspects of climate change MRV at multiple scales, and also incorporates a national system for the compilation of GHG inventories, making the M&E system the national central depository and portal for climate change information in South Africa.

Figure 6.1:
A DIAGRAM OF THE SOUTH AFRICAN NATIONAL CLIMATE CHANGE INFORMATION SYSTEM (NCCIS) AND ITS VARIOUS EXPANDABLE COMPONENTS.



6.2. PROGRESS SINCE BUR3

The NCCIS was launched in August 2019 and is composed of the following modules or subsystems to facilitate access to data and information on tracking South Africa's transition to a lower carbon and climate resilient society:

- National Climate Change Response Database: a portal for capturing and reporting climate change projects and their details.
- National Desired Adaptation Outcomes: designed as a monitoring and evaluation framework for climate change resilience through progress towards a series of adaptation goals.
- Climate Information Centre: a collection of actionable data sets and information relevant to the South African climate change field, distributed as required by data providers and formal sources.
- Tracking & Evaluation (T&E) Portal: a system which stores the data and information on the details of actions, indicators, impacts and related challenges, targets, and investments in climate change. This system also provides data visualisation, and provides outputs in formats required by the BUR. It will, therefore, assist the DFFE in producing BURs timeously.
- Portfolio of online Atlases, decision support systems and tools.
- Services, tools, static content, documentation including reports, policies and guidelines, and other digital objects developed by external partners and stakeholders.
- Standardised vocabularies serving as a common frame of reference for climate change reporting and monitoring.
- Search and discovery capabilities.

The current update provides progress made in terms of 'system refinement' and enhancement as outlined in the 3rd National Biennial Update Report (BUR3) (DEA, 2019) under Phase 3 of the system development. The system enhancements and refinements that were planned to be implemented in the 2019/2020 fiscal year encompassed the following system upgrades:

i. Expanded system integration and upgrades that incorporate additional domestic sub-systems.

ii. Enhanced user reporting, analytics and data visualisation capabilities.

iii. Setting up a fully operational system.

iv. Improved domestic reporting.

6.2.1. Milestones Reached Since the BUR3

A considerable amount of work has been done in terms of institutional arrangements, data flows and quality assurance since BUR3. The institutional arrangements for the NCCIS have been designed to facilitate ownership and buy-in by national sector departments and provinces. This includes the creation of sectoral and provincial specific sub-systems that integrate into the NCCIS. The national sector departments and provinces assume the role of focal points for data collection and provision of data into the system.

The Gauteng Climate Change Response Database (https://ccis.environment.gov.za/gccrd) is one such example, with the Gauteng Department of Agriculture and Rural Development playing a major role in coordinating projects from key provincial stakeholders, verifying the projects and ensuring quality assurance and control. It is planned that further work will be done to include all components of the NCCIS in the Gauteng subsystem of the NCCIS.

Provincial enhancements and coverage engagements are also underway for the following provincial governments: KwaZulu-Natal; Mpumalanga; Eastern Cape and Northern Cape. The information resources included in the NCCIS which integrates a series of existing national domestic systems and tools is accessible at https://ccis.environment.gov.za/#/info-tools. These tools complement the data and information in the NCCIS by providing information and data that is not currently therein.

6.3. INSTITUTIONAL ARRANGEMENTS FOR MRV

The UNFCCC focal point sits within the International Climate Change Relations and Reporting (ICCRR) unit of the DFFE and they are responsible for submitting documents (National Inventory Reports (NIRs), BURs, National Communications (NCs)) to the UNFCCC. This unit is responsible for compiling the BUR and NC reports. The overall institutional arrangements and data flows for the MRV of GHG emissions, mitigation, adaptation and support are shown in Figure 6.2.

The compilation of the GHG emissions inventory and the NIRs are managed through the NGHGIS and are the responsibility of the Climate Change Monitoring and Evaluation (CCM&E) unit in the DFFE. The DFFE has been responsible for collecting all the data from various data providers for all sectors of the inventory, but this will change in the next inventory due to the introduction of the National Greenhouse Gas Emission Reporting Regulations (NGERs) and the South African Greenhouse Gas Emissions Reporting System (SAGERS). The DFFE CCM&E is responsible for managing SAGERS. The CCM&E is responsible for drawing some information from the NCCIS to the inventory, for example, the terrestrial carbon stock data is obtained from the tools on the NCCIS. It should also be mentioned that the GIS unit at the DFFE also provides information on land cover for the AFOLU sector estimates. In the next inventory they will also provide burnt area data. The DFFE CCM&E unit is also responsible for initiating projects to update the tools on the NCCIS. This should be done every few years and will require financial support to complete.

The NCCIS is managed by the DFFE CCM&E unit, which has the responsibility of ensuring that various tools on the system are updated and that the data providers update their information on the system. 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 the DFFE CCM&E. In the future, a system can be set up 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 provincial DFFE to update the Provincial Climate Change Response Databases. In the future, a system could be set up whereby data can be collected at the local municipality level and filtered through to the Provincial Climate Change Response Databases and then to the National Climate Change Response Database.

The DFFE CCM&E unit is responsible for updating mitigation, adaptation and finance data to the Tracking & Evaluation (T&E) system (Figure 6.3). 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 by donor organisations from the DFFE CCM&E, which is also responsible for uploading the data to the T&E system. Not all components of the NCCIS are fully functional, and these issues will be discussed on the following page.

Figure 6.2:
DIAGRAM OF THE INSTITUTIONAL ARRANGEMENTS AND DATA FLOWS FOR MRV IN SOUTH AFRICA.

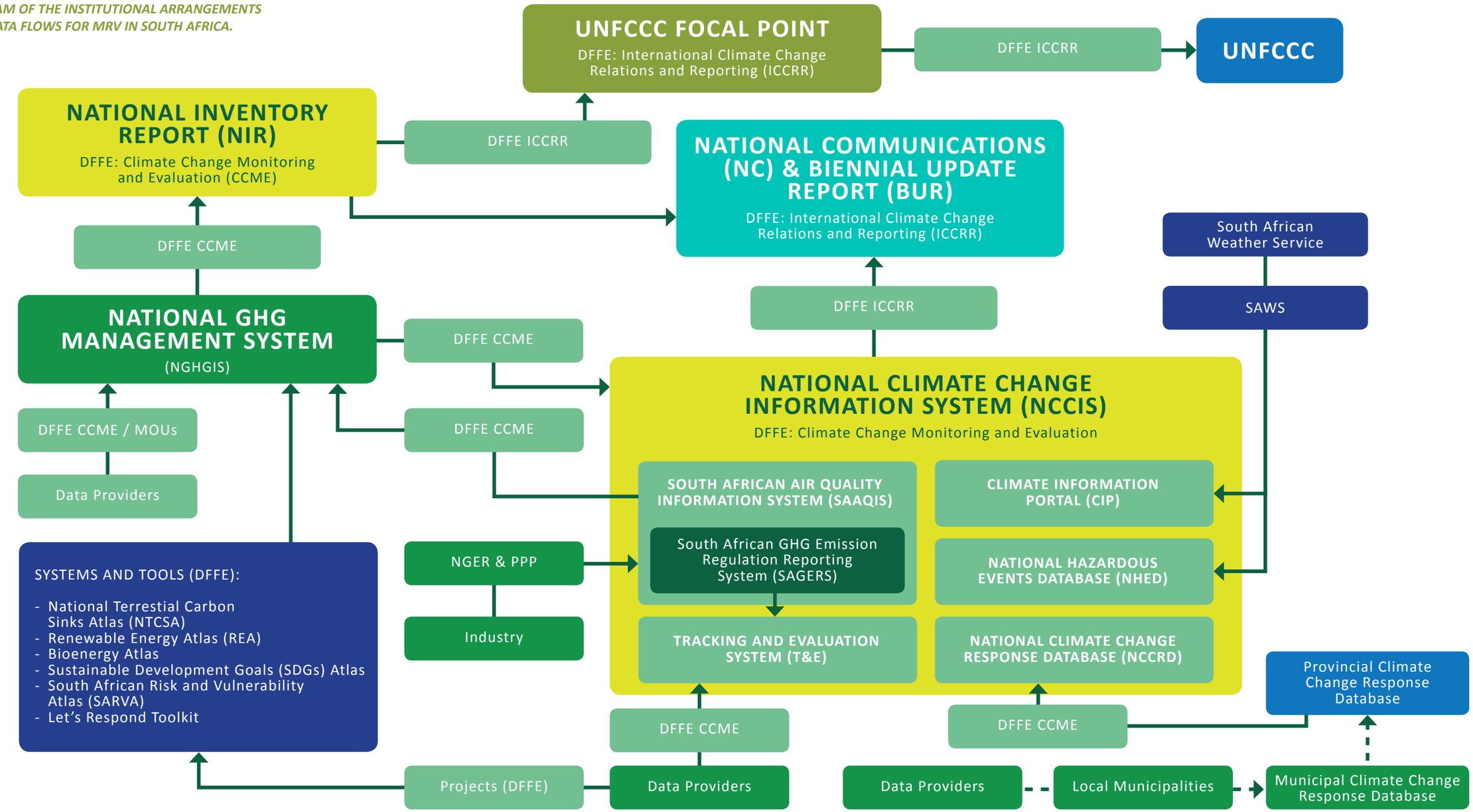


Figure 6.3:
COMPONENTS OF SOUTH AFRICA'S TRACKING AND EVALUATION (T&S) SYSTEM.

Administration

- Institutional arrangements
- Documents and data sets
- Stakeholders
- Workplan
- Funds and supporters
- Improvements plan
- Quality objectives

T & E Climate Actions

- Targets and objectives
- Climate challenges
- Climate actions
- Action indicators
- Constraints and gaps
- Wider impacts

Why are we taking action?

Challenges

To understand risks, vunerabilities, GHG trends and projections

- Energy, transport, economic models
- Climate scenario
- GHG projections
- Vulnerability assessments
- GHG inventory
- Climate data

What actions will contribute?

Targets

To record national targets and international obligations

- Commitments
- Plans
- Area wide, sectoral and emissions reduction targets

Actions

Information on mitigation and adaptation actions

- Timelines
- Location
- Costs
- Stakeholders
- Sectors and categories affected
- Action impacts (ex-ante and ex-poste)

Who is investing in actions?

Implementation

Tracking support for investments, capacity and technology

- Private investment
- Bilateral
- Public investment
- Multinational
- Technology transfer

Are actions working and sufficient?

Indicators

Quantitative information for tracking all elements

- National statistics
- Climate events
- Action monitoring
- GHG inventory

What are the wider benefits and possible conflicts of the action?

Wider impacts

Linking wider impacts to national strategies and SDGs

- National strategies
- SDGs
- Wider impacts evidence

6.3.1. GHG Inventory MRV

The compilation of the GHG emissions inventory and the NIRs are managed through the NGHGIS and are the responsibility of the Climate Change Monitoring and Evaluation (CCM&E) unit in the DFFE. The NGHGIS is a secure web-based SharePoint platform that allows document management, sharing and storage. It serves as a GHG Inventory process management tool in order to facilitate inventory planning, preparation and management. The DFFE CCM&E manage this system, and each of the inventory sector leads have access to the system and are responsible for uploading sector-relevant information to the system. The DFFE CCM&E unit is responsible for the energy, IPPU and waste sectors, while an external consultant, Gondwana Environmental Solutions International (Gondwana) is responsible for the AFOLU sector.

The main data providers for the inventory are shown in Figure 2.1 in Chapter 2. In the 2017 and previous inventories, there was a lack of legal and formal procedures for obtaining data and compiling the GHG emission inventory (GHGI). Data collection was mostly done through a voluntary data collection process. It has been the responsibility of the inventory compilers (the DFFE and Gondwana) to obtain the input data from various data providers (Table 6.1). Gondwana is responsible for compiling the overall inventory estimates and the NIR which goes through an external review and public consultation process (see section 2.5.2) before being approved by the DFFE. The NIR is then reviewed by the steering committee and is presented to parliament before being approved for submission to the UNFCCC.

“The compilation of the GHG emissions inventory and the NIRs are managed through the NGHGIS and are the responsibility of the Climate Change Monitoring and Evaluation (CCM&E) unit in the DFFE.”

Table 6.1:
ROLES AND RESPONSIBILITIES OF THE TEAM INVOLVED IN THE GHG INVENTORY COMPILATION PROCESS.

Role	Responsible organisation	Main responsibilties
Single National Entity	**DFFE CCM&E**	• Responsible for submissions and their consistency with other, related submissions. • Define the National System (determine who is involved and manage agreements/contracts). • Develop legal and contractual infrastructure. • Executive engagement with stakeholders (including data providers and users). • Ensure participation of relevant stakeholders. • Manage contracts and delivery of GHGI. • Prioritise and facilitate improvements.
National inventory co-ordinator	**DFFE CCM&E**	• Manage and support the National GHG Inventory team, schedule, and budget in order to develop the inventory in a timely and efficient manner. • Identify, assign, and oversee national inventory sector leads. • Assign cross-cutting roles and responsibilities. • Manage quality assurance (QA) processes and inventory review periods (if applicable). • Provide technical support to single national entity with stakeholder engagement and setting up data supply agreements (designing specifications and timetables). • Manage NGHGIS. • Maintain and implement a national GHG inventory improvement plan. • Prepare the submission. • Obtain all necessary government approvals for the NIR before submission. • Submit the NIR to the UNFCCC. • Foster and establish links with related national projects, and other regional, international programmes as appropriate.
Steering committee	**Intergovernmental Committee on Climate Change and the National Climate Change Committee**	• Provide input to improvement planning. • Respond to requests to review high level data and assumptions.

Table 6.1:
ROLES AND RESPONSIBILITIES OF THE TEAM INVOLVED IN THE GHG INVENTORY COMPILATION PROCESS.

Role	Responsible organisation	Main responsibilties
Sector leads	**Energy, IPPU and Waste (DFFE CCM&E)** **AFOLU (Gondwana)**	• Collaborate with the national inventory co-ordinator to manage the sector budget and develop a sector-specific work plan. • Gather data and conduct technical engagements with data providers. • Compile the sector inventory estimates and the sector report. • Develop and implement a sector-specific plan for archiving. • Consider potential improvements identified in the previous inventory for the sector and assess whether to implement improvements. • Coordinate the response to comments received from QA (external) reviews of the sector GHG estimates and update the inventory if necessary. • Review the final sector GHG estimates and the narrative describing the assumptions, methodologies, and results. • Ensure consistency of data. • Coordinate with lead compilers of other sectors to ensure no double counting. • Oversee the development of the uncertainty analysis for the sector. • Identify and document any improvements needed. • Ensure all documents are submitted to the NIC. • Ensure all relevant information is incorporated into the NGHGIS.
QA / QC co-ordinator	**Limited resources for coordinator. Sector leads responsible for sector QA / QC**	• Ensure the timely and accurate completion of QA / QC checklists. • Ensure all uncertainty analysis has been completed and included in QA / QC lists. • Deliver documentation of QA/ quality control (QC) activities to the NIC and archive coordinator. • Coordinate external reviews of the inventory document and ensure that comments are incorporated into the inventory.
Document manager	**Gondwana**	• Obtain all sector reports from lead compilers and compile the overall NIR. • Complete the overall key category analysis. • Incorporate all the introductory information by liaising and obtaining information from the various section managers. • Complete all the overall trends (graphs, tables and text). • Complete all the appendices. • Collect uncertainty data from sector leads and complete overall uncertainty analysis. • Perform document QA/QC checks.

Table 6.1:
ROLES AND RESPONSIBILITIES OF THE TEAM INVOLVED IN THE GHG INVENTORY COMPILATION PROCESS.

Role	Responsible organisation	Main responsibilties
Archive manager	**Gondwana**	• Ensure inventory compilation sheet are archived on the NGHGIS. • Serve as the keeper of the permanent archive and respond to future requests to view archive materials.

6.3.1.1. Challenges, gaps and constraints

A limitation of resources has been a challenge for inventory compilation; however, the DFFE CCM&E unit has recently employed more staff to ensure there is expertise in each sector in-house. In addition, system managers have been brought into the team, so the inventory team is well placed to fully utilise the NGHGIS and compile the inventory in the next inventory cycle. The new team members may require inventory compilation training, but additional training courses are expected to be developed through the Capacity-Building Initiative for Transparency (CBIT) funding.

6.3.2. Mitigation MRV

In this BUR cycle, the DFFE was responsible for collecting all the information required for the BUR. The DFFE contracted Promethium Carbon to collate mitigation reduction data for the energy and IPPU sectors. In addition, they were tasked with estimating reductions from Cleaner Development Mechanism (CDM), Verified Carbon Standard (VCS), and Gold Standard projects, identifying co-benefits and also outlining institutional arrangements for mitigation action MRV. The Council for Scientific and Industrial Research (CSIR) were contracted to collect data on the emission reductions in the AFOLU and Waste sectors, and for compiling the overall emission reductions. The consultants contacted the various data providers in order to obtain the information (Table 6.2). Until now, there has been no formal data collection system, however, with the NGERs and an increase in the inclusion of climate change actions and targets in government strategies and plans, greater formality will be brought into the reporting process. Emission reductions were determined by the consultants, and these were reviewed and approved by the DFFE before being incorporated into the BUR. The BUR is subjected to an external review process prior to submission. The DFFE International Climate Change Relations and Reporting unit is responsible for co-ordinating this review process and for submitting to the UNFCCC via the focal point.

Table 6.2:
DATA PROVIDERS FOR THE EMISSION REDUCTION ANALYSIS (PROMETHIUM CARBON, 2020).

Measures	Data providers
12L tax incentive programme	South African National Energy Development Institute (SANEDI)
Energy Efficiency Standards and Appliance Labelling project	Green House (2016) report
Eskom Integrated Demand Management (IDM) programme	Eskom IDM team
Municipal Energy Efficiency and Demand-side Management programme	DMRE
National Cleaner Production Centre (NCPC) Industrial Energy Efficiency programme	NCPC
Private sector energy-efficiency (PSEE) programme	National Business Initiative – PSEE programme report (PSEE, 2015)
Private sector embedded solar generation	Association of Renewable Energy Practitioners
Landfill Gas to Energy Activities	CDM project design documents
Renewable Energy Independent Power Producer Procurement programme	Independent Power Producers Office
Switch to natural gas	Department of Mineral Resources and Energy
Bus Rapid Transport System	Ex ante emission reductions from VCS-registered Rea Vaya project
Transnet Road-to-Rail programme	Transnet
Nitrous oxide emission reductions	Chemical Allied Industries Association
Carbon budget and pollution prevention plans	DFFE
Afforestation	DFFE
Grassland rehabilitation	DFFE
Waste management flagship programme	DFFE

6.3.2.1. Challenges, gaps and constraints

Uptake of the T&E system has been slow and the reasons for this are limited capacity, timing and awareness. The DFFE CCM&E unit increased its capacity at the beginning of the year to address this issue, but not all staff were trained on the T&E system before the BUR data collection process began. In addition, consultants, with limited access and system awareness, were brought in to complete the mitigation chapter. Due to these issues the T&E system was not fully utilised for the current BUR. Subsequent to this, additional training on the T&E system has been undertaken and offline data input templates were created to assist in the data collection process. All the information for this BUR will be uploaded onto the system once the BUR is complete and will be ready for use in the next BUR cycle. In future, the data can be updated annually on the T&E system so that information is readily available for the compilation of the next BUR. This will improve the consistency and transparency of the information going forward.

Data collection is always a challenge as resources are limited and it is time consuming obtaining each individual data set. The reporting for NGERs will improve this process, however, these Regulations are focussed on energy and IPPU. There is still a gap in the AFOLU and waste data collection process. Currently, the DFFE is responsible for incorporating the data into the T&E system. Developing online data submission templates that are accessible to data providers could improve the data collection process. Often, the issue, particularly in the AFOLU sector, is that programmes are not collecting appropriate indicator data as the projects are not designed specifically for mitigation. If templates are created, this could guide data providers as to what is required. In addition, increased stakeholder engagement (activities and workshops) around the various systems (what they can do and what data is required) would increase awareness and also contribute to improving the data collection process.

“All the information for this BUR will be uploaded onto the system once the BUR is complete and will be ready for use in the next BUR cycle. In future, the data can be updated annually on the T&E system so that information is readily available for the compilation of the next BUR.”

6.3.3. Future Reporting and Data Flows

With the introduction of the National Greenhouse Gas Emission Reporting Regulations (NGERs) that took effect on the 3rd of April 2017, the SAGERS data collection system has been put in place. This will formalise the data collection process for the energy and IPPU sectors (Figure 6.4). GHG data collected through SAGERS will be utilised for inventory estimates for the next inventory cycle. SAGERS reporting will also have implications for the monitoring and reporting of mitigation actions.

6.3.3.1. SAGERS

The SAGERS portal has been developed as part of the National Atmospheric Emissions Inventory System (NAEIS) and is currently able to serve as a tool for the implementation of the online registration and reporting by data providers/industry in fulfilment of mandatory NGERs.

SAGERS allows the DFFE to support South Africa in meeting its reporting obligations under the UNFCCC, and the reporting provisions in the NC and the BUR; as well as for tracking progress of the NDC commitments and the associated transparency of action. Domestically, the system assists South Africa to:

- Fulfil section 6.7 of the National Climate Change Response that requires GHG emissions inventories that are accurate, complete and up to date.
- Inform government policy formulation and the South African general public.
- Avoid duplication of similar reporting requirements in South Africa.
- Evaluate mitigation options.
- Assess the effectiveness of policies and mitigation measures.
- Develop long term emissions projections.

Monitor and evaluate the performance of South Africa in the reduction of GHG emissions.

- Inform policy makers on the country's progress in transitioning to a climate resilient society and lower carbon economy.
- Assess performance of the carbon budget and the Pollution Prevention Plans (PPPs).
- Strengthen the DFFE's capacity to implement and administer the national greenhouse gas data management system, and to standardise and improve accuracy and coverage of emissions reporting.
- Support the implementation and institutionalisation of the mandatory NGERs by industry through the NAIES, including facilitating user registration and submissions for the reporting of emissions.
- Strengthen the institutionalisation, validation and verification of GHG emissions for the administration of carbon tax (the carbon tax became effective as of June 2019 in South Africa).
- Enhance coordination among sectors in the verification of climate change information and data.
- Improve the archiving of GHG inventory datasets, methodologies, and assumptions for transparency in reporting.

The SAGERS portal is implemented and coordinated by the DFFE. The reporting platform is based on the 2006 International Panel on Climate Change (IPCC) reporting methodology. The portal (Figure 6.5) facilitates the efficient administration of, and the implementation of South Africa's QA/QC Plan for consistent compilation of National GHG Inventories.

Figure 6.4:
DATA FLOWS FOR DATA TO BE USED IN THE INVENTORY COMPILATION.

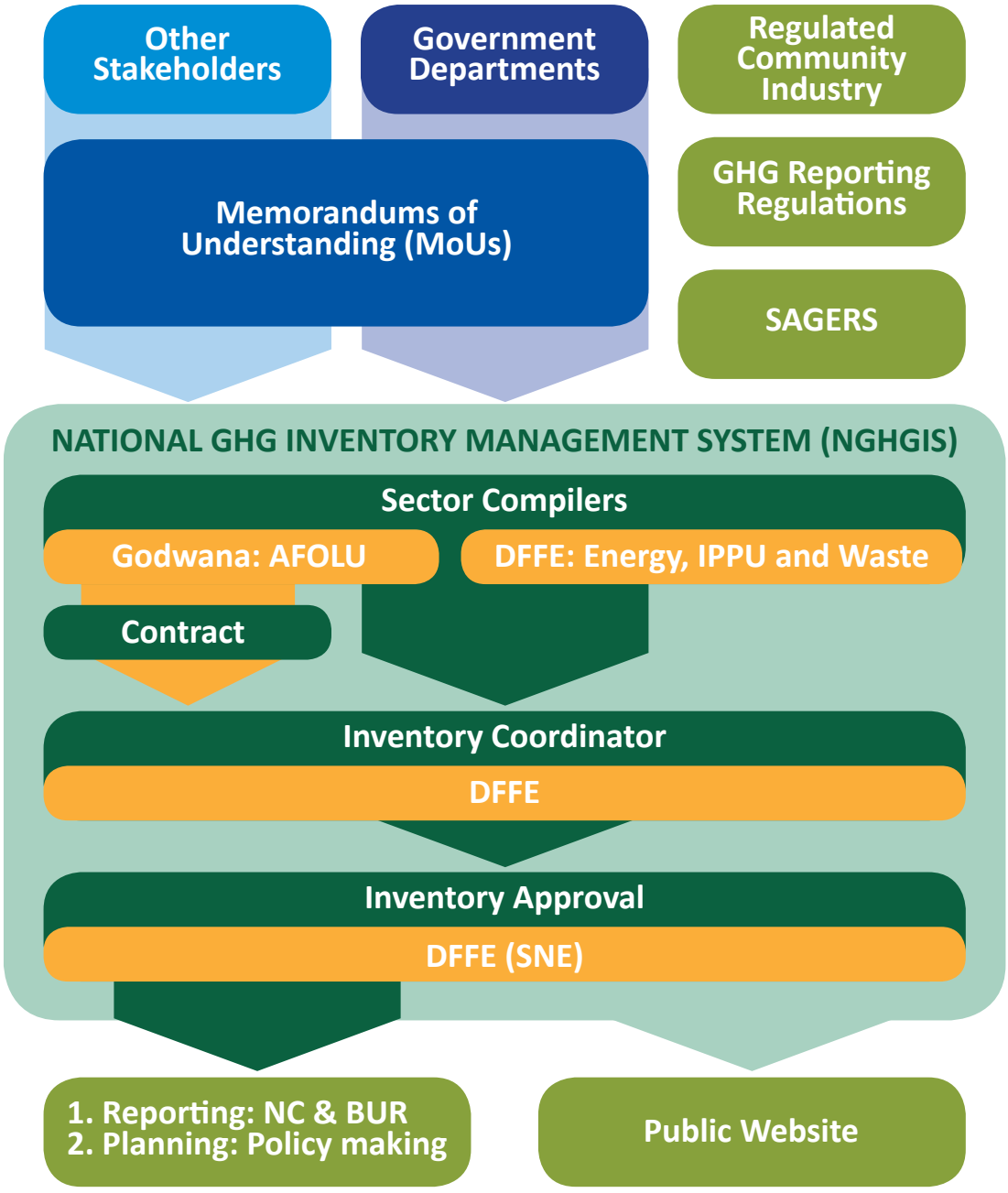


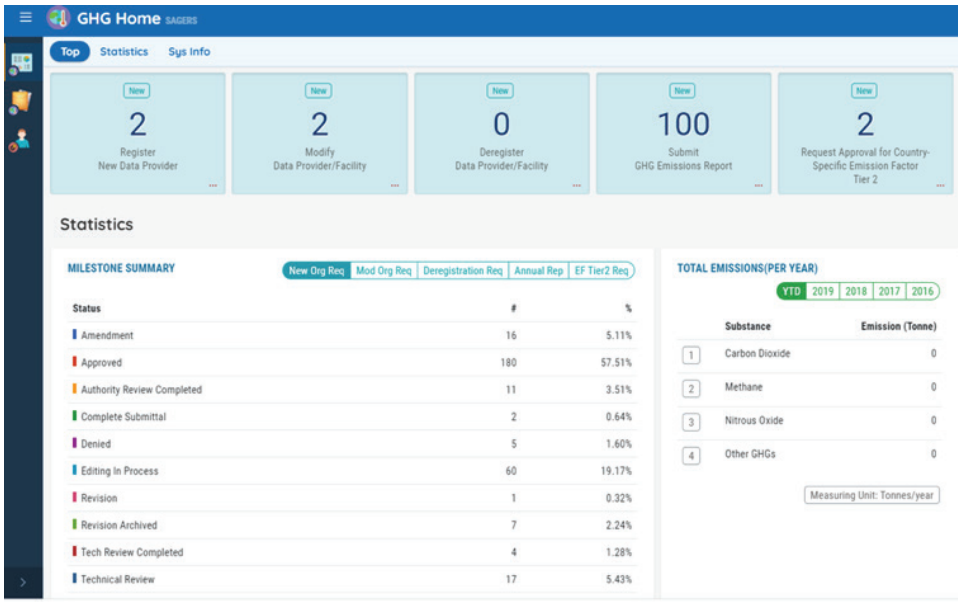
Figure 6.4 GHG data collected through SAGERS will be utilised for inventory estimates for the next inventory cycle. SAGERS reporting will also have implications for the monitoring and reporting of mitigation actions.

It also enables Industry to meet its GHG reporting requirements in a web-based, secure environment. It makes the estimation of the GHG emissions much simpler for industry role-players and relieves industry from the need to outsource such work to third parties which can often be burdensome and costly. The system provides an array of benefits to South Africa which include:

- The provision of a user-tailored platform for data providers to register and report their annual GHG emissions data and the associated activity data.
- The provision of methodological guidance on the quantification of GHG emissions and the embedded parameters for assessing annual GHG emissions.
- The facilitation of easy access to the parameters and GHG emissions factors database embedded into the system.
- Serving as an information hub for data providers for accessing information relevant to registration and reporting under the NGERs 2016.
- The provision of relevant templates, guidelines and information relating to compliance under the NGERs 2016, published under Government Notice 275 in Government Gazette No. 40762 of 03 April 2017, promulgated under the National Environmental Management: Air Quality Act No.39 of 2004.

In relation to the last point, the DFFE, in consultation with industry, has developed "Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry" (DEA, 2017). The Technical Guidelines provide detailed methodological guidance on how emissions are to be reported to the DFFE. Data providers are required to aggregate emissions at company level, whilst maintaining IPCC activity disaggregation.

Figure 6.5:
AN EXAMPLE OF A SAGERS PORTAL DASHBOARD.



6.3.3.2. Carbon Offset Administration System

The Carbon Offset Administration System has been developed as part of the Carbon Offset Regulations (DoE, 2016). This system allows for the approval of projects, listing of projects, transfer of ownership and retirement of credits (Figure 6.6). This system will allow for the tracking of carbon credit projects in South Africa.

6.4. VERIFICATION

Verification is incorporated into the inventory process, however, to date there has not been a formal verification process for the GHG inventory emission estimates or mitigation action emission reductions. Individual compilers have been responsible for verifying data inputs, emission outputs and emission reductions with available data. South Africa is currently (in line with the requirements of the NGERs) developing a fully-fledged verification scheme (DFFE, 2020) [178][179][180] in order to ensure transparency, accuracy, consistency and completenessof submissions made in terms of the NGERs (Figure 6.7). The Verification Programme will use a combination of system checks, reviews and on-site inspections by the Competent Authority (DFFE) and independent verification to obtain the required level of confidence over the Emissions Reports submitted to the Competent Authority. The Verification Programme aims to ensure that the GHG emissions and removals computed and submitted by Data Providers are complete, transparent and accurate. The Verification Programme is aligned to the reporting process described in the NGERs and the Methodological Guidelines.

To provide the modalities of the verification scheme, the DFFE has prepared a set of Verification Guidelines, and their primary purpose is to support the implementation of the mandatory GHG reporting regime in South Africa. The Verification Guideline provides direction to the Competent Authority, Data Providers and Independent Verifiers on the verification process for the NGERs and details the responsibilities of these role players. This Verification Guideline is applicable to all anthropogenic emissions by sources and removals by sinks as outlined in Annexure 1 of the NGERs.

In order to ensure alignment with existing verification schemes domestically and internationally, the DFFE has designed its verification programme in line with the South African National Accreditation System (SANAS). SANAS recently launched its latest accreditation programme for the accreditation of GHG validation and verification bodies for use in related forms of GHG recognition against the requirements of SANS ISO 14065. However, taking into account both the challenges and opportunities associated with the accreditation process and the availability of accredited bodies under SANAS, the DFFE has designed a verification programme that follows a phased approached in order to enable flexibility and to enable domestic experts in the field to prepare themselves for the accreditation process under SANAS.

The phased verification approach is structured, from a timing perspective, to be aligned with the phases of the Carbon Tax and the proposed Carbon Budgets. Phase 1 will start on approval of the Verification Guideline and run until December 2022, and Phase 2 will start from January 2023.

One of the most important differences between Phase 1 and Phase 2 relates to the requirements of the Independent Verification process. In Phase 1, Independent Verifiers that meet specific competence requirements will be allowed to conduct independent verification. Additional detail on this is outlined in the verification guidelines. In Phase 2, only Independent Verifiers accredited in terms of ISO 14065 by the South African National Accreditation System (SANAS) will be allowed to conduct independent verification from January 2023. The rationale behind this is to allow time for Independent Verifiers to become accredited with SANAS, while at the same time initiating a process to ensure that the data reported to the Competent Authority is complete, accurate and transparent.

Figure 6.6:
DESCRIPTION OF THE FLOW OF INFORMATION THROUGH THE CARBON OFFSET ADMINISTRATION SYSTEM (DOE, 2016).

Registration of Projects

- Project Owner will register a project under one of the approved international standards (VCS and GS).
- Credits are issued to the Project Owner in the registry of the approved international standards (VCS and GS).
- The Project Owner cancels the credits from the registry of the approved standard to enable listing in the South African registry.
- The approved standard will issue an Attestation of Voluntary Cancellation when credits are being cancelled on their register.

Application for Letter of Extended Approval

- The Project Owner applies for an Extended Letter of Approval by completing an online form and uploading supporting documentation (project design document and validation report).
- The Carbon Offset Administrator assesses the request mainly against the Eligibility Criteria.
- The Director General issues the Extended Letter of Approval on recommendation of the Carbon Offset Administrator.

Listing of Carbon Credits

- The listing application requires the Project Owner to complete an online form and submit supporting documentation.
- The Carbon Offset Administrator evaluates the request against the validity of the supplied documents.
- The credits are listed in the Ownership Repository which forms part of the South African Registry.

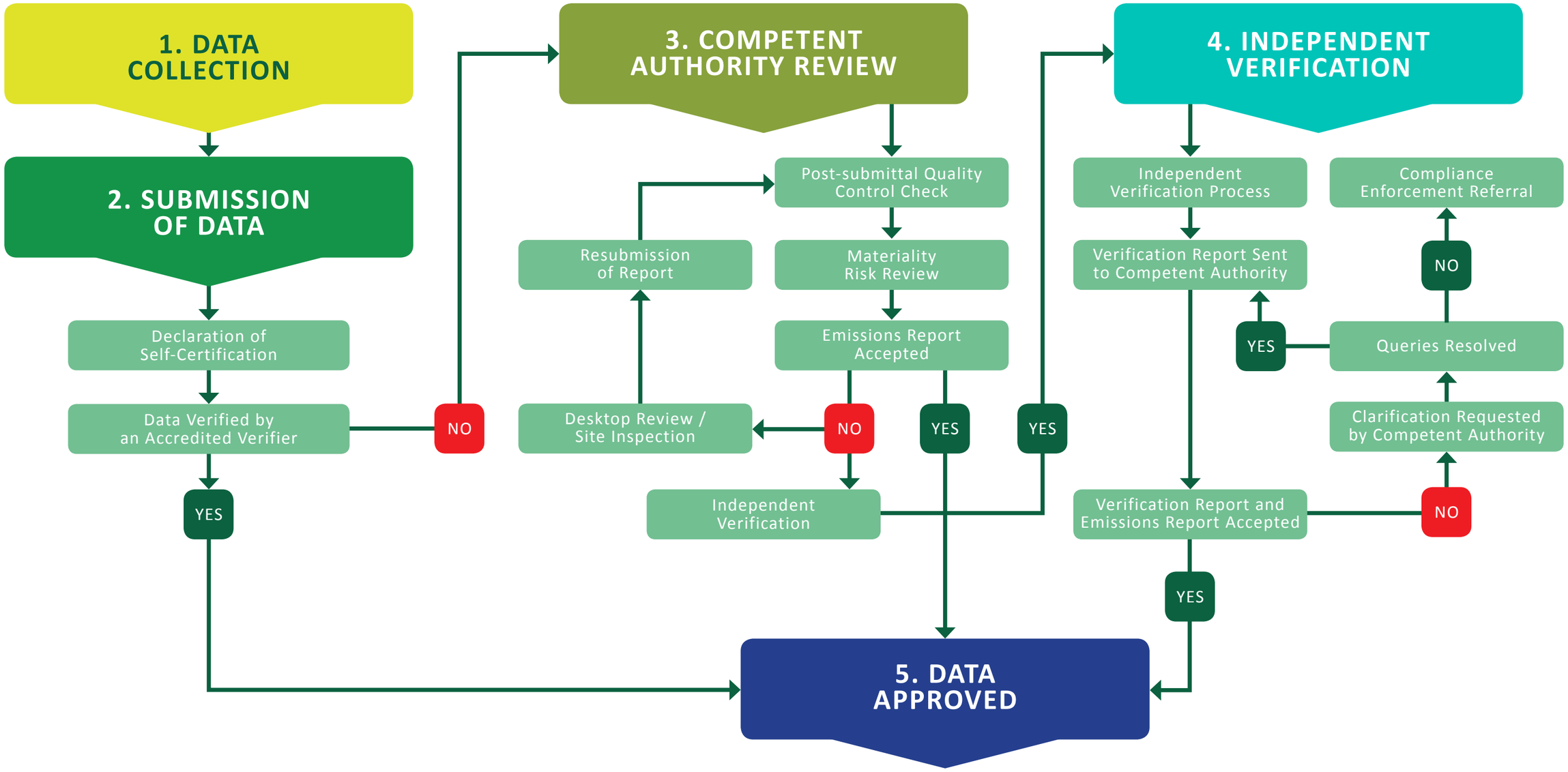
Transfer of Carbon Credits

- Listed carbon credits may be transferred to participants in the system through a transfer request.
- Carbon credit may only be transferred to participants registered on the Carbon Offset Administration System.

Retirement of Carbon Credits

- The South African Revenue Service (SARS) will require the submission of a retirement certificate for carbon tax offset purposes.
- Only carbon credits listed on the Carbon Offset Administration System can be retired and generate a retirement certificate.
- Carbon credits can be retired through a retirement request on the Carbon Offset Administation System.
- If carbon credits are not retired, they do not expire.

Figure 6.7:
PROCESS FLOW SUMMARY FOR THE NGERS VERIFICATION PROGRAMME.



REFERENCES

Act 108 of 1996. Constitution of the Republic of South Africa.

Act 39 of 2004. National Environmental Management: Air Quality Act. Republic of South Africa.

Act 13 of 2005. Intergovernmental Relations Framework Act. Republic of South Africa.

CSIR. (2019). Update of South Africa's Technology Needs for climate change adaptation and mitigation. TNA Synthesis report. CSIR Smart Places Cluster, Pretoria, South Africa.

DAFF. (2012). Agriculture, Forestry and Fisheries Integrated Growth and Development Plan 2012. ISBN 978-1-86871-349-3. Department of Agriculture, Forestry and Fisheries. Pretoria, South Africa.

DAFF. (2015). Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries. Government Gazette No. 38851. Notice No. 500. Department of Agriculture, Forestry and Fisheries. Government Printer, Pretoria, South Africa.

DAFF. (2018). Draft Conservation Agriculture Policy for public comment. Government Gazette No. 41432. Department of Agriculture, Forestry and Fisheries. Government Printer, Pretoria, South Africa.

DAFF. (2018a). Draft Climate Smart Agriculture Strategic Framework for Agriculture, Forestry and Fisheries. Government Gazette No. 41811. Department of Agriculture, Forestry and Fisheries. Government Printer, Pretoria, South Africa.

DEA. (2011). National Climate Change Response Policy. Department of Environmental Affairs, Government Printer, Pretoria, South Africa.

DEA. (2011a). Defining South Africa's peak, plateau and decline greenhouse gas emissions trajectory. Explanatory note. Department of Environmental Affairs, Pretoria, South Africa.

DEA. (2011b). National Waste Management Strategy. Department of Environmental Affairs. Pretoria, South Africa.

DEA. (2014). South Africa's Greenhouse Gas Mitigation Potential Analysis. Department of Environmental Affairs, Pretoria, South Africa. Retrieved from **https://www.environment.gov.za/sites/default/files/docs/mitigationreport.pdf**

DEA. (2015). South Africa's Intended Nationally Determined Contribution: Discussion document. Department of Environmental Affairs, Pretoria, South Africa. Retrieved from **https://www.environment.gov.za/sites/default/files/docs/sanational_determinedcontribution.pdf**

DEA. (2016). Piloting the climate change M&E Guidelines – Assessing the impact of the Public Transport Strategy on climate change indicators. Department of Environmental Affairs. Pretoria, South Africa.

DEA. (2017). South Africa's 2nd Biennial Update Report (2014-2016). Department of Environmental Affairs, Pretoria, South Africa.

DEA. (2017a). Carbon Budgets Final Report. Department of Environmental Affairs, Pretoria, South Africa. Retrieved from **https://agbiz.co.za/uploads/AgbizNews17/170713_Carbon-Budgets-South-Africa%20_Final-Report.pdf**

DEA. (2017b). National Greenhouse Gas Emission Reporting Regulations. National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). Government gazette No. 40762. Notice No. 275. Department of Environmental Affairs. Government Printer, Pretoria, South Africa.

DEA. (2017c). National Pollution Prevention Plan Regulations. National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). Government Gazette No. 40996. Notice No. 712. Department of Environmental Affairs. Government Printer, Pretoria, South Africa.

DEA. (2017d). Technical Guidelines for Monitoring, reporting and Verification of Greenhouse Gas Emissions by Industry: A companion to the South African National GHG Emission Reporting Regulations. Department of Environmental Affairs, Pretoria, South Africa. Retrieved from **https://www.environment.gov.za/sites/default/files/legislations/technicalguidelinesformrvofemissionsbyindustry_0.pdf**

DEA. (2018a): South Africa State of Waste Report. Second draft report. Department of Environmental Affairs, Pretoria, South Africa.

DEA. (2018b). South Africa's Third National Communication. Department of Environmental Affairs, Government Printer, Pretoria, South Africa.

DEA. (2018c). Pollution prevention plans. Department of Environmental Affairs. Pretoria, South Africa. Retrieved from **https://www.environment.gov.za/sites/default/files/legislations/pollutionpreventionplans_ghg_guidelines2018.pdf**

DEA. (2018d). South Africa: Final country report of the LDN Target Setting Programme. Department of Environmental Affairs. Pretoria, South Africa. Retrieved from **https://knowledge.unccd.int/sites/default/files/ldn_targets/South%20Africa%20LDN%20TSP%20Country%20Report.pdf**

DEA. (2018e). Regulations regarding the exclusion of a waste stream or a portion of a waste stream from the definition of waste. National Environmental Management: Waste Act, 2008 (Act No 59 of 2008). Government Gazette No. 41777. Department of Environmental Affairs. Government Printer, Pretoria, South Africa.

DEA. (2018f). Draft Climate Change Bill. Published for public comment. Government Gazette No. 41689. Notice No. 580. Department of Environmental Affairs. Government Printer, Pretoria, South Africa.

DEA. (2019a). South Africa's 3rd Biennial Update Report to the United Nations Framework Convention on Climate Change. Department of Environmental Affairs, Pretoria, South Africa.

DEA. (2019b). Development of a National Climate Finance Strategy for the Republic of South Africa. Climate Finance Landscape Study: Incomplete draft submitted as part of termination agreement. Unpublished document for the Department of Environmental Affairs, Pretoria, South Africa.

DEA and DST. (2015). Mitigation Technology Plan Report: Development of the climate change mitigation technology implementation plan for South Africa. Department of Environmental Affairs and Department of Science and Technology, South Africa.

DEFF. (2020). Department of Environment, Forestry, Fisheries 2019/20 – 2023/24 Strategic Plan and 2020/21 Annual Performance Plan. Department of Environment, Forestry and Fisheries, Pretoria, South Africa. Retrieved from **https://www.environment.gov.za/sites/default/files/docs/strategicplan202021to202324.pdf**

DEFF. (2020b). National Environmental Management: Air Quality Act, 2004 (Act No.39 of 2004) Proposed Amendment of the National Greenhouse Gas Emission Reporting Regulations, 2016 published under Government Notice 275 in the Government Gazette 40762 of 3 April 2017 (Government Gazette 43712; Government Notice 994 of 11 September 2020), Government Printer, Pretoria.

DEFF. (2020c). Technical Guidelines for Validation and Verification of Greenhouse Gas Emissions- A companion to the South African National Greenhouse Gas Emission Reporting Regulations

DEFF. (2021). National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 6 National Waste Management Strategy 2020 (Government Gazette no 44116; Notice 56 of 28 January 2021), Government Printer, Pretoria.

Dodgson, J.S., Spackman, M., Pearman, A. and Phillips, L.D. (2009). Multi-criteria analysis: a manual. Department for Communities and Local Government: London. Retrieved from **http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf**

DoE. (2015). Energy Balance for 2015. Department of Energy, Pretoria, South Africa. Retrieved from **http://www.energy.gov.za/files/media/Energy_Balances.html**

DoE. (2016). South African Carbon Offset Administrative and Reporting System: Monitoring, Reporting and Verification Tools Report. Department of Energy, Pretoria, South Africa.

DoE. (2017). Energy Balance for 2017. Department of Energy, Pretoria, South Africa. Retrieved from **http://www.energy.gov.za/files/media/Energy_Balances.html**

DoE. (2019). The South African Energy Sector Report 2019. Department of Energy, Pretoria, South Africa. Retrieved from **http://www.energy.gov.za/files/media/explained/2019-South-African-Energy-Sector-Report.pdf**

DoE. (2019a). Integrated Resource Plan (IRP2019). Electricity Regulation Act (Act No. 4 of 2006). Government Gazette No. 42784. Department of Energy. Government Printer, Pretoria, South Africa.

DoT. (2000). National Land Transport Transition Act, Pretoria, Republic of South Africa.

DoT. (2007). Public Transport Strategy. Pretoria, Republic of South Africa.

DoT. (2009). National Land Transport Act, Pretoria, Republic of South Africa.

DoT. (2017). Draft Green Transport Strategy (2017-2050). Government Gazette No. 41064. Notice No. 886. Department of Transport. Government Printer, Pretoria, South Africa.

DoT. (2018). Green Transport Strategy (2018-2050). Department of Transport, Pretoria, South Africa. Retrieved from **https://www.transport.gov.za/documents/11623/89294/Green_Transport_Strategy_2018_2050_onlineversion.pdf/71e19f1d-259e-4c55-9b27-30db418f105a**

DoT. (2019). Annual Performance Plan for 2019/20. National Department of Transport, Pretoria, Republic of South Africa.

Du Toit, B., Dovey, S., Seifert, T., Muyambo, P. and Malherbe, D. (2016). Carbon sequestration in South African plantation forests. Progress Report 1. PAMSA, South Africa.

Du Toit, C.J.L., Meissner, H.H. and van Niekerk, W.A. (2013a). Direct methane and nitrous oxide emissions of South African dairy and beef cattle. South African Journal of Animal Science, 43 (3): 320 – 339.

Du Toit, C.J.L., van Niekerk, W.A. and Meissner, H.H. (2013b). Direct greenhouse gas emissions of the South African small stock sectors. South African Journal of Animal Science, 43 (3): 340 – 361.

Du Toit, C.J.L., van Niekerk, W.A. and Meissner, H.H. (2013c). Direct methane and nitrous oxide emissions of monogastric livestock in South Africa. South African Journal of Animal Science, 43 (3): 362 – 375.

Du Toit, C.J.L., Meissner, H.H. and van Niekerk, W.A. (2013d). Direct greenhouse gas emissions of the game industry in South Africa. South African Journal of Animal Science, 43 (3): 376 – 393.

DTI. (2012). Technology Study on Consumer Energy Devices. Department of Trade and Industry. Retrieved from **http://www.thedtic.gov.za/wp-content/uploads/Consumer_Energy_Saving.pdf**

DWAF. (1997). Dept. of Water Affairs and Forestry (1990-2010). NFAP: South Africa's National Forestry Action Programme, 1 September 1997. Pretoria: NFAP Secretariat, Pretoria, Republic of South Africa.

DWAF. (2005). Framework for the National Forestry Programme (NFP) in South Africa (On-line). **https://www.environment.gov.za/sites/default/files/legislations/frameworkfornationalforestryprogramme.pdf**

EMIS. (2019). School Realities 2019, ISBN: 978-1-4315-3280-3, Department of Basic Education, Pretoria, South Africa. Retrieved from **https://www.education.gov.za/Portals/0/Documents/Reports/School%20Realities%202019%20Final%20.pdf?ver=2020-02-07-101051-330**

Eskom. (2018). Eskom Integrated Demand Management: The Way Forward (On-line). **https://www.savingenergy.org.za/wp-content/uploads/2018/11/Eskom-IDM-The-Way-Forward.pdf**

Findlater, K.M., Kandlikar, M., & Satterfield, T. (2019). Misunderstanding conservation agriculture: Challenges in promoting, monitoring and evaluating sustainable farming. Environmental Science & Policy, 100:47-54. doi:10.1016/j.envsci.2019.05.027.

FSA. (2018). Forestry and forest products industry facts: 1980 to 2018. Forestry South Africa, Pietermaritzburg, South Africa. Retrieved from **https://www.forestrysouthafrica.co.za/wp-content/uploads/2019/12/Forestry-FP-Industry-Facts-1980-2018.pdf**

GCIS. (2019). Official Guide to South Africa 2018/19. Twenty-sixth (26th) edition. Government Communication and Information Systems, Pretoria, South Africa. Retrieved from **https://www.gcis.gov.za/sites/default/files/docs/resourcecentre/yearbook/yb1919-24-cover.pdf**

GTI. (2014). 2013–2014 South African National Land-Cover Dataset. GeoTerraImage Pty Ltd., Pretoria, South Africa.

GTI. (2015). 1990 – 2013-14 South African National Land-cover change. GeoTerraImage Pty Ltd. Department of Environmental Affairs, Pretoria, South Africa.

Haselip, J., Narkevičiūtė, R. and Rogat, J. (2015). A step-by-step guide for countries conducting a Technology Needs Assessment. UNEP DTU Partnership. Retrieved from: **http://www.tech-action.org/-/media/Sites/TNA_project/TNA-guide-note-Sept-2015_Final**

H. Plecher. (2020). South Africa: Population growth from 2009 to 2019.Statista. Retrieved from **https://www.statista.com/statistics/578928/population-growth-in-south-africa**

IPCC. (1996). Climate Change 1995: The Science of Climate Change, Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J.T., Meira Filho, L.G., Callander, B.A., Harris, N., Kattenberg, A., Maskell, K., (eds). Cambridge University Press.

IPCC. (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The National Greenhouse Gas Inventories Programme, Eggleston, H.S., Buenida, L., Miwa, K., Ngara, T. and Tanabe, K., (eds). Institute for Global Environmental Strategies (IGES). Hayama, Kanagawa, Japan.

IPCC. (2014). 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol. Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland.

JSE. (2017). Tomorrow's legacy, grown today. Retrieved from **https://www.jse.co.za/trade/debt-market/bonds/green-bonds**

Moeletsi, M.E. and Tongwane, M.I. (2015). Methane and Nitrous Oxide Emissions from Manure Management in South Africa. Animals, 5, 193–205.

Moeletsi, M.E., Tongwane, M.I., Mdlambuzi, T., Grootboom, L., Mliswa, V.K., Nape, K.M. and Mazibuko, S. (2015). Improvement of the Greenhouse Gas Emissions Inventory for the Agricultural Sector. DFID: Pretoria, Southern Africa.

National Committee on Agriculture, Land Reform and Rural Development. (2019). TC191023: Budgetary Review and Recommendation Report of the Portfolio Committee on Agriculture, Land Reform and Rural Development: Agriculture (Vote 24), dated 16 October 2019. Retrieved from **https://pmg.org.za/tabled-committee-report/3955/**

National Committee on Environment, Forestry and Fisheries. (2019a). Industry waste plans; Department 2019/20 Quarter 1 & 2 performance, with Minister & Deputy Minister Meeting Summary. Retrieved from **https://pmg.org.za/committee-meeting/29310/**

National Committee on Environment, Forestry and Fisheries. (2019b). Audit Outcomes: Auditor General of South Africa briefing; DEA, Forestry and Fisheries (Marine Living Resources Fund) 2018/19 Annual Report; with Minister Meeting Summary. Retrieved from **https://pmg.org.za/committee-meeting/28970/**

National Committee on Environment, Forestry and Fisheries. (2019c). Waste Bureau service provider appointments; operational effectiveness; with Minister and Deputy Minister Meeting Summary. Retrieved from **https://pmg.org.za/committee-meeting/27902/**

National Committee on Transport. (2019a). Department of Transport Quarterly Reports, Capacity Building Session with Auditor General of South Africa; with Deputy Minister Meeting Summary. Retrieved from **https://pmg.org.za/committee-meeting/28713/**

National Treasury. (2013). Regulations in terms of Section 12L of the Income Tax Act, 1962, on the Allowance for Energy Efficiency Savings. Government Gazette No. 37136. Notice No. R. 971. Government Printer, Pretoria, South Africa.

National Treasury. (2015). Carbon Tax Bill (published for Public Comment). Pretoria, South Africa. (2014). Budget 2014 Estimates of National Expenditure Vote 37 Transport (On-line). **http://www.treasury.gov.za/documents/national%20budget/2014/enebooklets/Vote%2037%20Transport.pdf**

National Treasury. (2016). Budget 2016 Estimates of National Expenditure Vote 35Transport (On-line). **http://www.treasury.gov.za/documents/national%20budget/2016/enebooklets/Vote%2035%20Transport.pdf**

National Treasury. (2018). Budget 2018 Estimates of National Expenditure Vote 35 Transport (On-line). **http://www.treasury.gov.za/documents/national%20budget/2018/ene/Vote%2035%20Transport.pdf**

National Treasury. (2019). The 2019 Budget Review. Pretoria, Republic of South Africa. Retrieved from **www.treasury.gov.za**

National Treasury. (2019a). Draft Regulations Trade Exposure Allowance (published for Public Comment). Pretoria, South Africa. Retrieved from **http://www.treasury.gov.za/public%20comments/CarbonTaxAct2019/Draft%20Trade%20Exposure%20Regulations%202%20Dec%202019.pdf**

National Treasury. (2019b). Draft Regulations Trade Exposure and GHG Emissions Intensity Benchmark Regulations (published for Public Comment). Pretoria, South Africa. Retrieved from **http://www.treasury.gov.za/public%20comments/CarbonTaxAct2019/Summary%20of%20Trade%20Exposure%20and%20Benchmark%20Regulations%202%20Dec%202019.pdf**

National Treasury. (2019c). Carbon Offset Regulations. Carbon Tax Act, 2019. Government Gazette No. 42873. Notice No. 1556. Government Printer, Pretoria, South Africa.

National Treasury. (2020). Budget Review 2020 (Annex D), National Treasury, Pretoria, Republic of South Africa. Retrieved from **http://www.treasury.gov.za/documents/National%20Budget/2020/review/Prelims.pdf**

National Treasury. (2020a). Regulations in terms of Section 19(b) for purposes of Section 10 for the Trade Exposure Allowance. Carbon Tax Act, 2019. Government Gazette No. 43451. Notice No. 690. Government Printer, Pretoria, South Africa.

National Treasury. (2020b). Regulations in terms of section 19(a) on the Greenhouse Gas Emission Intensity Benchmarks for purposes of Section 11 for the performance allowance. Carbon Tax Act, 2019. Government Gazette No. 43452. Notice No. 691. Government Printer, Pretoria, South Africa.

National Treasury. (2020c). Notice in terms of Section 6(2)(c) for the Renewable Energy Premium. Carbon Tax Act, 2019. Government Gazette No. 43453. Notice No. 692. Government Printer, Pretoria, South Africa.

National Treasury. (2021). Budget 2020 Highlights. National Treasury, Pretoria, South Africa.
Retrieved from **http://www.treasury.gov.za/documents/National%20Budget/2020/sars/Budget%202020%20Highlights.pdf**

NDMC. (2017). Annual Report 2016 – 2017. National Disaster Management Centre.
Department of Cooperative Governance, Pretoria, South Africa.
Retrieved from **http://www.ndmc.gov.za/AnnualReports/NDMC%20Annual%20Report%202016%20-17.pdf**

NDMC. (2018). Annual Report 2017 – 2018. National Disaster Management Centre.
Department of Cooperative Governance, Pretoria, South Africa. Retrieved from
http://www.ndmc.gov.za/AnnualReports/NDMC%20Annual%20Report%202017-18.pdf

NPC. (2011). National Development Plan: Vision 2030. National Planning Commission, Pretoria, South Africa.
Otter, L. and Scholes, M. (2000). Methane Sources and Sinks in a Periodically Flooded South African Savanna.
Global Biogeochemical Cycles. 14, 97–111. 10.1029/1999GB900068.

Parmar, H (2020). State of electric vehicle uptake in South Africa – Energize (On-line).
https://www.crediblecarbon.com/news-and-info/news/evstate-of-electric-vehicle-uptake-in-south-africa-energize/

Promethium Carbon. (2020). Draft report: Quantification of Climate Change Mitigation Actions.
Report for Department of Environmental Affairs. Promethium Carbon, Johannesburg, South Africa.

PSEE. (2015). Guide to energy efficiency finance in South Africa. Private Sector Energy Efficiency Programme.
Johannesburg, South Africa.
Retrieved from **http://www.psee.org.za/downloads/publications/FPP9315_NBI_PSEE_Finance_Publication.pdf**

PSEE. (2015a). The Private Sector Energy-Efficiency Programme: Two years of focused energy-efficiency
interventions in the private sector. Private Sector Energy Efficiency Programme, Johannesburg, South Africa.
Retrieved from **http://psee.org.za/downloads/PSEE%20brochure_final_HI-RES.pdf**

SAWS. (2019). Annual Climate Summary for South Africa 2018. South African Weather Service. Pretoria, South Africa.

Shackleton, C.M. (1993). Are communal grazing lands in need of saving? Development Southern Africa 10, (1), 65-78.

Singh, N., Damassa, T., Alarcon-Diaz, S. and Sotos, M. (2014). Exploring Linkages Between National and Corporate /
Facility Greenhouse Gas Inventories. World Resources Institute Working paper. Working Paper. Washington, DC:
World Resources. Retrieved from **https://files.wri.org/s3fs-public/wri_ghg_inventories_final.pdf**

StatsSA. (2017a). South Africa's Mid-Year Population Estimate for 2017. Statistics South Africa.

StatsSA. (2017b). Poverty trends in South Africa: An examination of absolute poverty between 2006 and 2015.
Statistics South Africa.

StatsSA. (2017c). Education Series Volume III: Educational Enrolment and Achievement, 2016. Report No 92-01-03,
Statistics South Africa. Retrieved from **https://www.statssa.gov.za/publications/Report%2092-01-03/Report%2092-01-032016.pdf**

StatsSA. (2018a). Capital expenditure by the public sector for 2017. Statistics South Africa.
Retrieved from **http://www.statssa.gov.za/publications/P9101/P91012017.pdf**

StatsSA. (2018b). Mortality and causes of death in South Africa: Findings from death notifications, 2016. Statistics South Africa. Retrieved from **https://www.statssa.gov.za/publications/P03093/P030932016.pdf**

StatsSA. (2018c). Quarterly Labour Force Survey (QLFS) Q4:2017. Statistics South Africa. Retrieved from **http://www.statssa.gov.za/?p=10884**

StatsSA. (2019a). Mid-year population estimate: Statistical Release P0302. Statistics South Africa.

StatsSA. (2019c). General Household Survey, May 2019, Statistical release P0318. Statistics South Africa.

StatsSA. (2020a). Gross domestic product, Fourth quarter of 2019. Statistics South Africa. Retrieved from **http://www.statssa.gov.za/publications/P0441/P04414thQuarter2019.pdf**

StatsSA. (2020b). Stats SA releases Census of Commercial Agriculture 2017 Report. Statistics South Africa. Retrieved from **http://www.statssa.gov.za/?p=13144**

StatsSA. (2020c). Quarterly Labour Force Survey (QLFS) Q4:2019. Statistics South Africa. Retrieved from **http://www.statssa.gov.za/?p=12948**

StatsSA. (2021a). GDP: Quantifying SA's economic performance in 2020. Downloaded on 14/03/2021 from **http://www.statssa.gov.za/?p=14074**

StatsSA. (2021b). Gross domestic product, Fourth quarter 2020. Statistics South Africa. Retrieved from **http://www.statssa.gov.za/publications/P0441/P04414thQuarter2020.pdf**

UN Millennium Summit. (2000). United Nations Millennium Declaration. New York, United Nations, Dept. of Public Information.

UNDP. (2019). Human Development Report 2019: Inequalities in Human Development in the 21st Century-Briefing note for countries on the 2019 Human Development Report: South Africa. United Nations Development Programme. Retrieved from **http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/ZAF.pdf**

Von Maltitz, G. P., Gambizo, J., Kellner, K., Rambau, T., Lindeque, L. and Kgope, B. (2019). Experiences from the South African land degradation neutrality target setting process. Environmental Science & Policy, 101, 54-62.

World Bank. (2019a). Retrieved from **https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=ZA**

World Bank. (2019b). Retrieved from **https://data.worldbank.org/country/south-africa**

ANNEXURE A: LULUCF SECTOR GHG SUMMARY TABLE

Land-use category		Annual change in carbon stocks (Gg CO_2)		Annual change in carbon stocks (Gg CO_2)		CH_4	N_2O	NOx	CO
Initial land use	Final land use	Living biomass	Dead organic matter	Soils	CO_2 Emmissions / Removals	(Gg)			
Forest land	Forest land	22 255.6	-5.9	0.0	-22 249.8	IE	IE	IE	IE
Cropland	Forest land	1 161.1	59.4	750.0	-1 970.6	IE	IE	IE	IE
Grassland	Forest land	2 984.1	67.0	124.3	-3 175.4	IE	IE	IE	IE
Wetlands	Forest land	97.5	13.9	0.0	-111.4	IE	IE	IE	IE
Settlements	Forest land	291.4	39.9	117.3	-448.6	IE	IE	IE	IE
Other lands	Forest land	545.9	73.8	1 041.3	-1 661.0	IE	IE	IE	IE
Sub-total	**Forest land**	**27 335.7**	**248.2**	**2 033.0**	**-29 616.9**	**IE**	**IE**	**IE**	**IE**
Cropland	Cropland	965.5	221.4	-11.7	-1 175.2	IE	IE	IE	IE
Forest land	Cropland	-1 870.6	302.8	-855.4	2 423.2	IE	IE	IE	IE
Grassland	Cropland	32.5	568.5	-953.5	352.5	IE	IE	IE	IE
Wetlands	Cropland	3.7	2.6	-7.0	0.7	IE	IE	IE	IE
Settlements	Cropland	-8.6	13.2	-22.0	17.3	IE	IE	IE	IE
Other lands	Cropland	6.1	7.1	24.5	-37.7	IE	IE	IE	IE
Sub-total	**Cropland**	**-871.4**	**1 115.6**	**-1 825.0**	**1 580.8**	**IE**	**IE**	**IE**	**IE**
Grassland	Grassland	-827.4	-462.9	-2 015.9	3 306.2	IE	IE	IE	IE
Forest land	Grassland	-257.5	34.9	-0.9	223.5	IE	IE	IE	IE
Cropland	Grassland	16.4	-51.7	1 027.4	-992.0	IE	IE	IE	IE
Wetlands	Grassland	32.0	16.3	-21.6	-26.7	IE	IE	IE	IE
ttlements	Grassland	38.4	18.9	76.2	-133.5	IE	IE	IE	IE
Other lands	Grassland	1 262.4	1 453.7	15 275.3	-17 991.4				
Sub-total	**Grassland**	**264.2**	**1 009.1**	**14 340.5**	**-15 613.8**	**IE**	**IE**	**IE**	**IE**
Wetlands	Wetlands	NE	NE	NE	NE	31.7	IE	IE	IE
Forest land	Wetlands	NE	NE	NE	NE	IE	IE	IE	IE
Cropland									
Wetlands									
Grassland	Wetlands	NE	NE	NE	NE	IE	IE	IE	IE
Settlements	Wetlands	NE	NE	NE	NE	IE	IE	IE	IE
Other land	Wetlands	NE	NE	NE	NE	IE	IE	IE	IE
Sub-total	**Wetlands**	**NE**	**NE**	**NE**	**NE**	**31.7**	**IE**	**IE**	**IE**
Settlements	Settlements	687.2	0.4	-0.2	-687.5	IE	IE	IE	IE
Forest land	Settlements	-169.4	26.1	-131.4	274.6	IE	IE	IE	IE
Cropland	Settlements	-21.3	-4.0	13.7	11.7	IE	IE	IE	IE
Grassland	Settlements	11.7	65.0	-113.5	36.9	IE	IE	IE	IE
Wetlands	Settlements	0.2	0.3	-1.1	0.6	IE	IE	IE	IE
Other land	Settlements	1.0	1.4	30.8	-33.3	IE	IE	IE	IE
Sub-total	**Settlements**	**509.5**	**89.3**	**-201.7**	**-397.0**	**IE**	**IE**	**IE**	**IE**
Other land	Other land			0.0	0.0	IE	IE	IE	IE
Forest land	Other land	-206.8	-38.6	-699.0	944.4	IE	IE	IE	IE
Cropland	Other land	-9.2	-6.4	-54.2	69.8	IE	IE	IE	IE
Grassland	Other land	-1 073.4	-1 000.9	-9 969.1	12 043.3	IE	IE	IE	IE
Wetlands	Other land	0.0	0.0	-446.6	446.6	IE	IE	IE	IE
Settlements	Other land	-2.1	-1.2	-5.4	8.8	IE	IE	IE	IE
Sub-total	**Other land**	**-1 291.5**	**-1 047.1**	**-11 174.4**	**13 512.9**	**IE**	**IE**	**IE**	**IE**
Total Land	**25 946.5**	**1 415.1**	**3 172.4**	**-30 534.0**	**31.7**	**IE**	**IE**	**IE**	**IE**

Non-CO_2 gas emissions from fires are included under 3C1 Biomass burning; N_2O emissions from fertilisers and those associated with changes in land use and management are included under 3C4 Direct N_2O from managed soils and 3C5 Indirect N_2O from managed soils.

ANNEXURE B: FINANCIAL SUPPORT DETAILS

ANNEXURE B1: BILATERAL FINANCIAL SUPPORT
TABLE B1.1: ADDITIONAL INFORMATION ON BILATERAL FINANCIAL SUPPORT COMMITTED BETWEEN 2018 AND 2019

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Type of Funding: Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
Grant	Belgium - Government of Flanders	64 079 071	4 858 155		X							Department of Environmental Affairs (DEA) Adaptive Capacity Facility.
Grant	Belgium - Government of Flanders	137 770	10 444		X							Formulation of a project proposal for the DEA on Climate Change Adaptation.
Grant	Belgium - Government of Flanders	641 446	48 631		X							Harnessing Climate Change Adaptation for SMME Development in SA: Experiences from the Water Sector (in partnership with Trade and Industrial Policy Strategies (TIPS)).
Grant	Belgium - Government of Flanders	6 406	118 347		X							Support to the DFFE for the hosting of the 2019 Partnership for Action on the Green Economy (PAGE) Ministerial Conference.
Grant	Belgium - Government of Flanders	15 188 436	1 151 511		X X							Towards an inclusive green economy by showcasing sustainable land use management projects in the Kruger to Canyons Biosphere Region (in partnership with the Kruger to Canyons National Planning Commission).
Grant	Belgium - Government of Flanders	12 510 619	948 493									Communal Agricultural Transformation (CAT) Empowering People - Restoring Land (in partnership with the Olive Leaf Foundation).
Grant	Belgium - Government of Flanders	14 426 419	1 093 739		X							Micro Aquaponics Lappies – Proof of concept of community embedding (in partnership with Belgium Campus).
Grant	Belgium - Government of Flanders	16 593 414	1 258 030		X							Towards Enhanced Climate Change Adaptation and an Inclusive Adaptive Green Economy in South Africa (in partnership with Idalo Inclusive).
Grant	Belgium - Government of Flanders	12 846 640	973 968		X							Enabling community-based adaptation in the Mkhuze River Ecosystem, KwaZulu-Natal (in partnership with Wildlands).
Grant	Belgium - Government of Flanders	508 747	38 571		X							Consultancy services: call for proposal – Climate Change Adaptation and the Inclusive Adaptive Green Economy.

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Grant	Belgium - Government of Flanders	468 300	35 504		X							Consultancy services: gender mainstreaming.
Grant	Belgium - Government of Flanders	26 225	1 988		X							Facilitation of strategic planning workshop in the framework of Country Strategy III (Government of Flanders–Government of South Africa).
Grant	Belgium - Government of Flanders	1 560 539 505	86 889 727		X							Building climate resilience of coastal communities, ecosystems and small-scale fishers through implementing community and ecosystem-based adaptation activities (in partnership with the World Wildlife Fund (WWF)).
Grant	Belgium - Government of Flanders	1 559 231 387	114 456		X							Women for Climate Justice (GenderCC SA): building resilience and reducing vulnerability of smallholder farmers by focusing on mango farming enterprises, water and ecosystem-based services to reduce negative impacts of climate change.
Grant	Belgium - Government of Flanders	1 560 539 505	118 312 320		X							Support to the DFFE for the hosting of the 2019 Partnership for Action on Green Economy (PAGE) Ministerial Conference.
Grant	Belgium - Government of Flanders	1 559 231 387	118 213 145		X							Street Art Meets Climate Change competition (in partnership with WTG Media House): formulation of a project proposal for the DFFE on Climate Change Adaptation.
Grant	Denmark	8 840 000	641 044	X		X						Danish–South African Energy Partnership Program: decoupling economic growth in the Republic of South Africa from the growth in the overall Greenhouse Gas (GHG) emissions. The intermediate objective is to increase the deployment of low carbon technologies in the energy sector.
Grant	Denmark	8 840 000	641 044	X		X						Strategic Water Sector Programme: the purpose of the programme is to support the South African government agencies and other relevant stakeholders in developing and implementing strategy, management and regulatory frameworks to contribute to the National Water Resource Strategy (2013), namely that “water is efficiently and effectively managed for equitable and sustainable growth and development.”

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
Grant	Denmark	8 840 000	641 044	X		X						Strategic Smart and Sustainable Cities Sector Cooperation Programme with the City of Tshwane: the programme focuses on solutions to create smart and sustainable cities by exchanging know-how on regulatory frameworks between the two cities and extending networks of competences within the private sector. More specifically, the programme focuses on activities around: • City planning and development • Growth – business, workplaces and livelihood • Water and energy.
Grant	Denmark	2 684 394	203 517	X								Implementation of 'Smart Metering' in South Africa: the Danish Renewable Energy and Energy Efficiency Programme Advisory Board, approved that the remaining unspent funds will be transferred to the Wind Atlas for South Africa (WASA) to support the WASA 1 masts until December 2018. An Addendum to the WASA 2 Agreement was made to extend the WASA 2 Agreement, as well as the operation of the WASA 1 masts by the CSIR to December 2018, and to raise funds in support of WASA 1 masts between April 2018 to December 2018.
Grant	European Union	789 408	59 849	X	X	X						Sustainable use of natural resources to improve resilience in South Africa: A grassroots women's initiative – implemented from 2013 to 2018 by OXFAM Great Britain.
Grant	European Union	1 796 293	136 186	X	X				X			Natural Resource Conservation and Management for the Generation of Water-linked Green Economy in the Eastern Cape and Southern KwaZulu-Natal, South Africa – implemented from 2013 to 2018 by EWT.

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Grant	European Union	26 380 000	2 000 000	X	X	X	X					SWITCH Africa Green I - a programme supporting small and medium-sized enterprises (SMEs) in the area of sustainable consumption and production (SCP)– dedicated South African call implemented from 2013 to 2018 by United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP) and DEA.
Grant	European Union	16 548 000	1 200 000	X	X	X						PAGE – implemented from 2015 to 2020 by the UNEP, International Labour Organisation (ILO), UNDP, United Nations Industrial Development Organisation (UNIDO), and the United Nations Institute for Training and Research (UNITAR)in 17 countries, South Africa being one of them.
Grant	European Union	105 520 000	8 000 000	X	X		X					Green Economy Coalition (to support knowledge platforms and dialogue hubs)– implemented from 2016 to 2020. Implementing agencies in South Africa are: TIPS and African Centre for a Green Economy.
Grant	European Union	7 195 000	500 000		X	X						Inclusive Green Economy Policy Making for Sustainable Development Goals: from Implementation to Evaluation – implemented from 2016 to 2019 by UNEP in three countries, South Africa being one of them.
Grant	European Union	4 730 497	328 735	X		X	X	X				H2020 - AfriAlliance: Africa-EU Innovation Alliance for Water and Climate – implemented from 2016 to 2021. Implementation partners in South Africa: Council for Scientific and Industrial Research (CSIR), Water Research Commission and Local Governments for Sustainability (ICLEI).
Grant	European Union	22 304 500	1 550 000	X	X	X						Promoting market-based deployment of clean energy technology solutions in municipal waterworks: pilot Initiative in South Africa – implemented from 2017 to 2019 by UNIDO and the Renewable Energy and Energy Efficiency Partnership (REEEP).

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Grant	European Union	3 358 444	243 542	X			X					Entrepreneurial and Environmental Empowerment for South Africa's Youth – implemented from 2017 to 2020 by Teach A Man to Fish, Wildlife & Environment Society of South Africa (WESSA) and BWDT.
Grant	European Union	10 552 000	800 000	X	X	X						Urban Low Emissions Development Strategy (LEDS) II: Promoting Urban Low-Emissions Development Strategies in Emerging Economy Countries – implemented from 2017 to 2021 by United Nations Human Settlements Programme (UN-HABITAT) and ICLEI in eight countries, South Africa being one of them.
Grant	European Union	2 516 408	174 872	X	X	X	X					Climate Reality Project: Promoting Broader and Effective Participation of South African Civil Society in Environmental Governance – implemented from 2017 to 2021 by Foods and Trees for Africa.
Grant	European Union	5 845 412	322 483	X	X	X	X					SWITCH Africa Green II - Smallholder access to high value horticultural markets – implemented from 2018 to 2020 by Solidaridad.
Grant	European Union	3 676 633	248 016	X	X	X	X					SWITCH Africa Green II - Promoting Inclusive Sustainable Practices in the South African Clay Brick Sector – implemented from 2018 to 2020 by Clay Brick Association.
Grant	European Union	4 814 864	1 200 000	X		X		X				SWITCH Africa Green II - Waste to Wing – Greening African Aviation – implemented from 2018 to 2020 by Waste to Wing (currently suspended).
Grant	European Union	40 031 650	3 035 000	X	X		X					H2020 - PreMa: Energy efficient, primary production of manganese ferroalloys through the application of novel energy systems in the drying and pre-heating of furnace feed materials – implemented from 2018 to 2022. Implementation Partners in South Africa: MINTEK, Transalloys Pty Ltd, and Stellenbosch University (SU).

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Grant	European Union	2 677 570	165 000	X			X					Strategic partnerships for the implementation of the Paris Agreement (SPIPA) – implemented from 2019 to 2021 by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)-South Africa Bilateral Component, noting that South Africa is also benefitting from SPIPA multi-country actions with additional funding.
Grant	European Union	10 552 000	800 000	X		X	X					Transition towards the circular economy - economic and policy analysis – implemented from 2018 to 2021 by the Organisation for Economic Co-operation and Development (OECD) in their member countries, South Africa being one of them.
Grant	European Union	1 079 250	75 000	X		X						Dialogue Facility: South Africa's Science, Technology and Innovation Circular Economy Agenda – implemented in 2019 by the Department of Science and Innovation.
Grant	European Union	3 057 875	212 500	X			X					H2020 - Southern Ocean Carbon and Heat Impact on Climate – implemented from 2019 to 2023. Implementing partner in South Africa: CSIR.
Grant	European Union	60 674 000	4 600 000	X		X	X					Partnership for Market Readiness – implemented by the World Bank and the South African National Treasury from 2017 to 2020.
Grant	European Union	57 560 000	4 000 000	X	X		X	X				CfP Climate Change champions: Support to civil society organisations (CSOs) – to be committed in 2020. Implementation from 2021 to 2025.
Grant	European Union	120 000 000	909 780	X		X						The overall objective of the programme is to achieve a net zero energy and emissions reduction through improving and optimising energy consumption of the municipality's wastewater treatment plants and the government buildings energy ratings. The project will be implemented from 2020-2022.

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Loan	**France: Agence Française de Développement**	**1 453 140 000**	**110 169 826**	**X**								Energy transmission - Renewables.
Grant	**France: Agence Française de Développement**	**5 166 730**	**374 672**	**X**					**X**			Energy Research Centre (in partnership with the University of Cape Town) - modelling energy consumption. Assignment of an international expert.
Grant	**France: Agence Française de Développement**	**5 489 000**	**416 149**	**X**	**X**							Studies about climate risk and vulnerability, and alternative energy.
Grant	**France: Agence Française de Développement**	**2 421 000**	**183 548**	**X**					**X**			Consumer Price Index study - Understanding the impact of a low carbon transition on South Africa.
Loan	**France: Agence Française de Développement**	**2 155 200 000**	**156 287 165**	**X**								SUNREF II Energy Efficiency / Renewable Energy Credit Line.
Grant	**France: Agence Française de Développement**	**53 880 000**	**4 023 898**	**X**								Energy Efficiency / Renewable Energy Technical Assistance.
Grant	**France: Agence Française de Développement**	**3 771 600**	**273 503**	**X**								Transport_Passenger Rail Agency of South Africa (PRASA) / SNCF partnership.
Grant	**Germany: German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMUB)**	**249 760 000**	**18 935 557**	**X**	**X**							Climate Support Programme. The project supports the South-African DEA in implementing the National Climate Change Response Policy in the areas of mitigation, adaptation and monitoring, reporting and verification (MRV). In addition, the DEA will be strengthened in its catalytic role to induce other departments and the private sector to implement concrete, climate-relevant projects. Implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ).

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Grant	**Germany: German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMUB)**	**67 513 250**	**5 118 518**	**X**								Energy Efficiency in Public Buildings and Infrastructure Programme within the framework of the Nationally Appropriate Mitigation Actions Facility. Implemented by the GIZ.
Grant	**Germany: German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMUB)**	**5 164 850**	**358 267**	**X**	**X**	**X**	**X**		**X**			Project name: Low Carbon Development Frameworks in South Africa. The project builds on the DEA's programme under the White Paper and supports its further rollout across government and uptake by non-governmental role players in business and civil society. It does this through driving highest realistic mitigation ambition at sectoral level, based on evidence and deeper analysis than has been possible to date in the DEA process, and through providing knowledge and perspectives independent of government and business, both of which can be perceived as partisan to their special interests. Implemented over the period 2015 to 2018.
Grant	**Germany: German Federal Ministry for Economic Cooperation and Development (BMZ).**	**62 440 000**	**4 733 889**									Promotion of Innovation in procurement of Renewable Energy and Preparation of Regional Transmission Lines. Implemented by KfW.
Grant	**Germany: German Federal Ministry for Economic Affairs and Energy (BMWi).**	**187 320 000**	**14 201 668**	**X**								South African-German Energy Partnership. Supports the development of a sustainable energy infrastructure (in particular low-carbon electricity production through the use of renewable energies) and increasing energy efficiency in South Africa. Implemented by GIZ.
Grant	**Germany: BMZ**	**156 100 000**	**11 834 723**	**X**	**X**							Green Goal – Non-Motorised Transport: Johannesburg, eThekwini, Polokwane. Implemented by KfW.

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Grant	**Germany: BMZ**	**280 980 000**	**21 302 502**	X								Renewable Energy in South African Municipalities (RESAM), Municipality of Nelson Mandela Bay. Implemented by KfW.
Grant	**Germany: BMZ**	**577 570 000**	**43 788 476**	X								Small IPP Support Programme / FIRST. Implemented by KfW.
Loan	**Germany: BMZ and Industrial Development Corporation (IDC).**	**1 170 750 000**	**88 760 425**		X							South African Facility for Green Growth. Implemented by KfW.
Loan	**Germany: BMZ and Development Bank of South Africa (DBSA).**	**2 965 900 000**	**224 859 742**	X								Programme for Renewable Energies and Energy Efficiency in the Southern African Power Pool. Implemented by KfW.
Loan	**Germany: BMZ and HIS.**	**388 610 950**	**29 462 543**	X	X							Energy Efficient Housing/International Housing Solutions Fund II. Implemented by KfW.
Loan	**Germany: BMZ**	**1 334 188 027**	**101 151 480**	X		X						Renewable Grid Integration and Strengthening Programme with ESKOM. Implemented by KfW.
Loan	**Germany: BMZ**	**702 450 000**	**53 256 255**	X								Mooi–Mgeni Transfer Scheme II, City of eThekwini. Implemented by KfW.
Loan	**Germany: BMZ**	**3 122 000 000**	**236 694 466**	X								Financing of Electric Locomotives with Transnet. Implemented by KfW.
Loan	**Germany: BMZ**	**1 267 532 000**	**96 097 953**		X							Climate Initiative Urban Wastewater Management, Cape Town. Implemented by KfW.
Loan	**Germany: BMZ**	**1 561 000 000**	**118 347 233**	X	X							Climate Friendly Urban Mobility, eThekwini Metropolitan Municipality. Implemented by KfW.
Loan	**Germany: BMZ**	**4 683 000 000**	**355 041 698**	X								Eskom Renewable Grid Integration/Transmission. Implemented by KfW.
Loan	**Germany: BMZ**	**7 851 830 000**	**595 286 581**	X								Green Energy Efficiency Fund Phase I. Implemented by KfW.

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
Grant	**German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMUB).**	**1 763 069**	**132 764**	**X**			**X**	**X**				Tracking and Strengthening Climate Action (TASCA):TASCA provides governments with tools and resources to track the implementation and effects of their Nationally Determined Contributions, and the underlying policies that support them and strengthen climate action. The project works in five countries to strengthen systems and capacities to track progress toward tackling climate change: Colombia, Ethiopia, India, Indonesia, and South Africa. In addition to work in the project countries, TASCA advances global research and organises convenings to advance critical issues related to transparency and ambition. Project implemented by World Resources Institute (WRI).
Grant	**Germany: BMZ**	**6 275 650**	**455 087**	**X**				**X**				Support South Africa's climate change mitigation and monitoring and evaluation activities, including: • Support the development and operationalisation of the Climate Change Tracking and Evaluation System. • Development of climate change tracking, data visualisation and communication tools. • Development of guidelines and capacity building to support implementation of the Climate Change Tracking and Evaluation System. • Assessment of mitigation actions and policies to evaluate their impact in reducing greenhouse gas emissions and achieving other benefits. • Support South Africa's biennial update report.
Grant	**Italy: Ministry for Environment, Land and Sea Protection of the Italian Republic.**	**615 000**	**46 500**	**X**		**X**					**118 000**	In the context of the Executive Programme on Scientific and Technological Co-operation between the Italian Republic and the Republic of South Africa for the years 2018-2020, the Ministry for Environment, Land and Sea Protection of the Italian Republic has financed the research project "Integration of High Power Energy Storage Systems for Sustainable Water and Renewable Sources Management", a collaboration between the University of Bologna and the University of Pretoria. The amount shown was financed for 2018.

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
Grant	Italy: Ministry for Environment, Land and Sea Protection of the Italian Republic.	809 000	56 000	X		X					112 000	In the context of the Executive Programme on Scientific and Technological Co-operation between the Italian Republic and the Republic of South Africa for the years 2018-2020, the Ministry for Environment, Land and Sea Protection of the Italian Republic has financed the research project "Integration of High Power Energy Storage Systems for Sustainable Water and Renewable Sources Management", a collaboration between the University of Bologna and the University of Pretoria. The amount shown was financed for 2019.
Investment	Italy: Enel Green Power	3 200 000	222 000	X								Training activities financed by the company in South Africa.
Investment	Italy: Enel Green Power	76 600 000	5 300 000	X	X							In the framework of the Renewable Energy Independent Power Producers Procurement Programme, Enel Green Power has devolved the amount indicated to projects of Economic Development and Socio-Economic Development in favour of the communities around the seven, already active, renewable energy plants.
Investment	Italy: Enel Green Power	18 742 320 000	1 417 200 000	X		X						In the framework of the Round 4 Renewable Energy Independent Power Producers Procurement Programme, Enel Green Power has been awarded the implementation of 5 140 MW wind farms projects. The wind farms are under construction and they will represent a unique contribution to the South African economy in consideration of the advanced technologies which are being used.
Grant	Italy: RES4AFRICA Foundation	242 600	16 800	X	X							RES4AFRICA Foundation financed the full scholarships and travel expenses for three South African officials to take part in the Advanced Training Course "Deployment of renewable energy solutions: challenges and opportunities" which took place in Milan in November 2019.

				Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General			
Financial Flows / Support	**Donor**	**Amount in ZAR**	**Amount in USD**	**Type of Funding**						**Principal Focus official Development Assistance**	**Co-Financing (USD)**	**Main responsibilties**
Grant	**Italy: Ministry for Environment, Land and Sea Protection of the Italian Republic.**	**615 000**	**46 500**	**X**		**X**					**118 000**	In the context of the Executive Programme on Scientific and Technological Co-operation between the Italian Republic and the Republic of South Africa for the years 2018-2020, the Ministry for Environment, Land and Sea Protection of the Italian Republic has financed the research project “Genomics for a Blue Economy”, a collaboration between the “Stazione Zoologica Anton Dohrn” and the University of the Western Cape. The amount shown was financed for 2018.
Grant	**Italy: RES4AFRICA Foundation.**	**3 273 000**	**218 000**		**X**							RES4AFRICA Foundation be carrying out four studies on the energy sector in South Africa in collaboration with various South African institutions (e.g., CSIR).
Grant	**Italy: Ministry for Environment, Land and Sea Protection of the Italian Republic.**	**809 000**	**56 000**	**X**		**X**						Just Energy Transition Study.
Grant	**Japan: The Government of Japan (GoJ)**	**About 25m**	**1 805 650 in total for three years (2019-2022)**	**X**	**X**	**X**	**X**					In order to reduce the amount of plastic leaking into the environment (including the marine environment) in South Africa, the GoJ and the UNIDO signed an agreement for grant funding of US$1 805 650 for a project to support a transition from conventional plastics to more environmentally sustainable alternatives in South Africa. The project will be implemented by UNIDO, in collaboration with the CSIR over a period of three years. The project has the potential to reduce plastic leakage to the environment and unlock new economic opportunities - both of which are urgently needed for South Africa.
Grant	**Norway: Norwegian Ministry of Foreign Affairs Agreement Partner: Department of Science & Technology**	**2 510 760**	**190 353**				**X**					The goal of the Programme is: Enhanced knowledge-based policies by government institutions and decisions for sustainable development in the areas of oceans and ocean space (blue economy), environment, climate change and sustainable energy in South Africa and Norway (SANOCEAN). Implementing agency: the National Research Foundation (NRF).

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
				Type of Funding								
Grant	**Norway: Norwegian Ministry of Foreign Affairs**	**1 864 425**	**231 236**				X				**118 000**	The objective of the project was to build capacity within the South African National Inventory Unit to develop a system for national greenhouse gas inventories in South Africa, including the reporting to the UN Framework Convention on Climate Change (UNFCCC) through national communications. The project was implemented in partnership with KLIF (the Norwegian Climate and Pollution Agency).
Grant	**Switzerland**	**152 660 000**	**11 070 341**	X								Energy Efficient Street Lighting Retrofit Project (implemented under the South-African German Energy Programme (SAGEN)).
Grant	**Switzerland**	**42 206 000**	**3 060 624**	X								Provision of Technical assistance for Sustainable Use of Natural Resources and Energy Finance (SUNREF) II Energy Efficiency/Renewable Energy Credit Line.
Grant	**Switzerland**	**31 699 400**	**2 298 724**	X								Agri-Processing Resource Efficiency.
Grant	**Switzerland**	**23 707 200**	**1 719 159**	X								Partnership for Action on Green Economy.
Grant	**Switzerland**	**53 880 000**	**3 907 179**	X								ElectriFI: Solarise Africa Ltd.
Loan	**United Kingdom**	**754 320 000**	**54 700 508**	X								The objective of the project is to consolidate renewable energy sources in South Africa through a financing agreement that will support the development of 254 MW of clean energy projects across South Africa.
Grant	**United States of America: United States Agency for International Development (USAID)**	**35 963 475**	**1 449 828**	X		X	X			**Low emissions development (climate change mitigation).**		South Africa's Low Emissions Development (SA-LED) is strengthening public sector capacity, focusing on the provincial and local governments, through technical assistance, engaging with private sector developers to enhance the quality of LED project pipelines, and facilitating LED investment in line with DEA's National Flagship Programs: Renewable Energy; Energy Efficiency and Demand-Side Management; Waste Management; and Sustainable Transport. The programme helps municipalities plan, finance, and implement LED projects.

ANNEXURE B: FINANCIAL SUPPORT DETAILS

ANNEXURE B2: MULTILATERAL FINANCIAL SUPPORT
TABLE B2.1: ADDITIONAL INFORMATION ON MULTILATERAL FINANCIAL SUPPORT COMMITTED BETWEEN 2018 AND 2019

Financial Flows / Support	Donor	Imple-menting Organisation	Amount in ZAR	Amount in USD	Type of Funding: Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
Grant	World Wide Fund for Nature South Africa funded by WWF US	World Wide Fund for Nature South Africa (USAID)	333 425	25 000	X				X				Project name: Alliance for Climate Action: South Africa Pilot. The intent is to improve global climate change mitigation outcomes through domestic actions, the impact of which can then be multiplied by bringing them onto an international stage. In South Africa, we will focus the initiative most on cities and business, as holding the greatest potential impact in relation to the theory of change and leveraging off existing relationships. The global partnerships will be picked up nationally with the National Business Initiative (local arm of both We Mean Business and Carbon Disclosure Project), C40 and the Southern African Climate Action Network (SA-CAN).
Grant	World Wide Fund for Nature South Africa funded by WWF US	World Wide Fund for Nature South Africa (USAID)	700 500	50 000	X	X		X					Project name: Alliance for Climate Action South Africa – Phase II.
Grant	WWF International Switzerland	World Wide Fund for Nature South Africa (USAID)	419 480	29 098	X	X				X		124 439 330	Project name: Science Based Targets initiative Science-based GHG emission reduction target setting will become standard business practice and corporations will be contributing to close the emissions gap left by country commitments. Contributing to Science Based Targets for companies to reduce their greenhouse gas emissions in line with the requirements of climate science for keeping global warming below 2 degrees Celsius.
WWF Mexico	World Wide Fund for Nature South Africa		550 230	38 656	X	X		X					Project name: Science Based Targets initiative Science-based GHG emission reduction target setting will become standard business practice and corporations will be contributing to close the emissions gap left by country commitments. Contributing to Science Based Targets for companies to reduce their greenhouse gas emissions in line with the requirements of climate science for keeping global warming below 2 degrees Celsius.

Financial Flows / Support	Donor	Imple-menting Organisation	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
					Type of Funding								
Grant	**World Wide Fund for Nature South Africa funded by WWF Sweden**		**780 000**	**54 602**		X	X	X		X			Project name: One Planet Cities South Africa 2019-2020 WWF's vision for the One Planet Cities (OPC) programme is that cities transform their development pathways in line with the Paris Agreement, where global warming is limited to 1.5°C and cities' resilience is enhanced – cities that enable people to thrive and prosper, while respecting the ecological limits of our only planet. To reach this, there must be a critical mass of cities that have commitments and actions in line with 1.5°C global warming that also enhance national climate policy ambitions in priority countries. The OPC includes: technical support to cities; policy and communications work; and engagement with key stakeholders within cities to build a deeper understanding of the need to limit global warming to 1.5 °C, as well as support and support to cities engagement to support more inclusive, sustainable cities.
Loan	**Agence Française de Développe-ment, African Development Bank, Clean Technology Fund and World Bank**	**Eskom**	**2 110 400 000**	**160 000 000**	X								To enhance Eskom's renewable energy sources through financing the development of 100 MW wind farms.
Grant	**Global Environment Facility**		**1 521 510**	**104 931**	X			X				**416 000**	To accelerate and expand the introduction of Energy Management Systems, Industrial Energy Systems Optimisation, and the Energy Management Standard ISO 50001 within the South African industrial (and selected commercial) context. The aim is to realise increased investment in industrial energy efficiency through the wide-scale adoption of the two methodologies and ISO 50001 under: (i) enhanced institutional frameworks and regulatory environments, (ii) technical and implementation assistance to industry and multi-level engineer, technician and operator capacity building programmes.

Financial Flows / Support	Donor	Imple-menting Organisation	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
					Type of Funding								
Grant	Global Environment Facility		626 421	9 083 113	X			X				2 400 000	To accelerate and expand the introduction of Energy Management Systems, Industrial Energy Systems Optimisation, and the Energy Management Standard ISO 50001 within the South African industrial (and selected commercial) context. The aim is to realise increased investment in industrial energy efficiency through the wide-scale adoption of the two methodologies and ISO 50001 under: (i) enhanced institutional frameworks and regulatory environments, (ii) technical and implementation assistance to industry, and (iii) multi-level engineer, technician and operator capacity building programmes.
Grant	Adaptation Fund	SANBI	33 452 667	5 402 225		X						38 439 000	The South African National Biodiversity Institute (SANBI) is implementing two projects which are both funded by the Adaptation Fund. Both projects are in their 4th year of implementation. The first project is being implemented in KwaZulu Natal titled "Building resilience in the Greater uMngeni Catchment, South Africa". The second project is a small grants project titled "Taking adaptation to the ground: A Small Grants Facility for enabling local level responses to climate change in South Africa" which is being implemented in Northern Cape and Limpopo.
Loan	Green Climate Fund (GCF)		8 055 000 000	537 000 000	X								The GCF- Development Bank of Southern Africa (DBSA) Embedded Generation Investment Programme will support the implementation of renewable energy projects with a capacity of 330 MW, which is comprised of 280 MW Solar PV and 50 MW Wind. 2019–2043.
Loan	GCF		195 000	2 386 220		X	X						SANBI is also an accredited entity of the Green Climate Fund. To date, SANBI has received a Readiness Grant from the GCF aimed at developing Concept Notes and Funding Proposals for submission to the GCF amongst other technical activities. 2018.

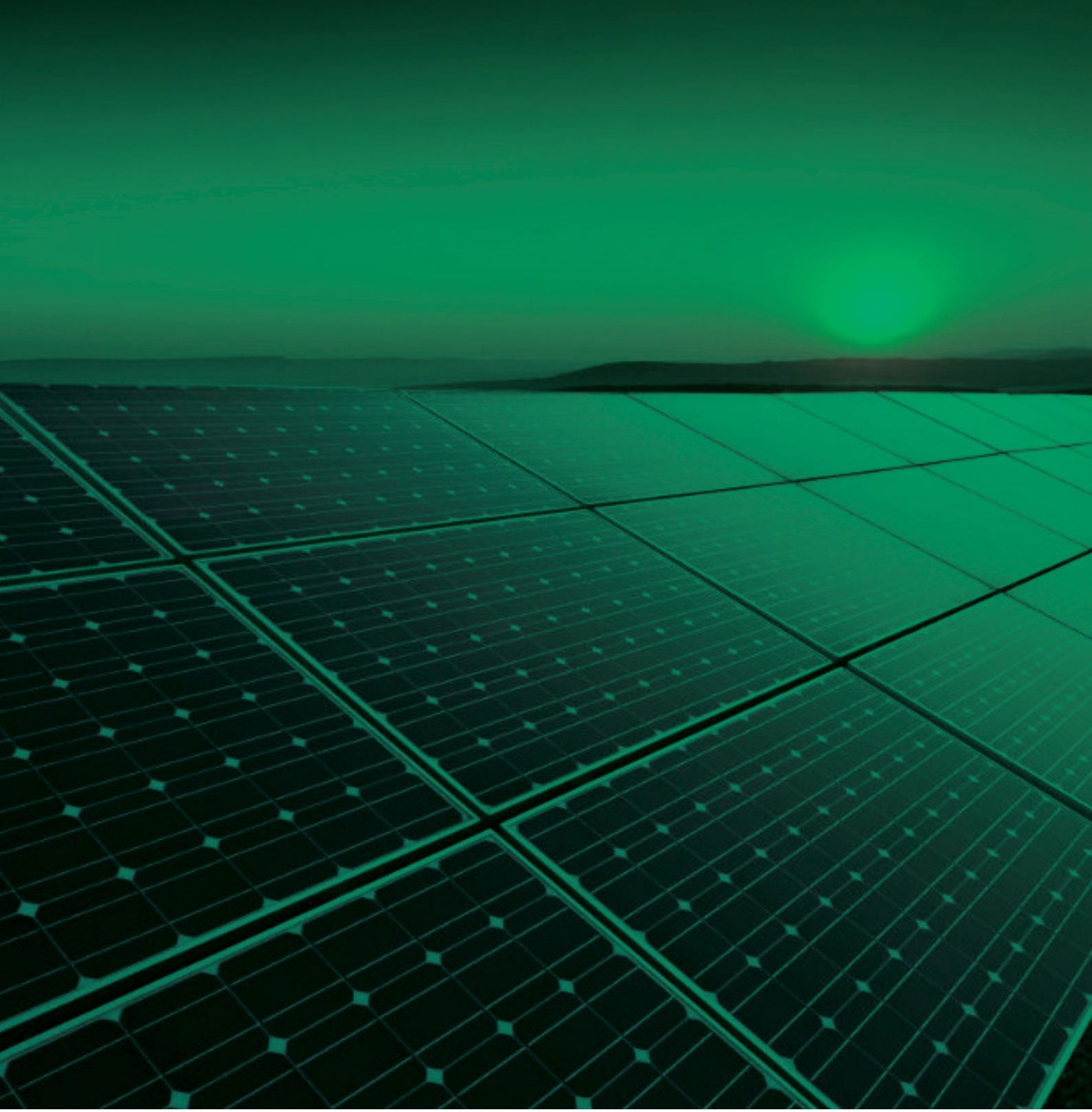
Financial Flows / Support	Donor	Imple-menting Organisation	Amount in ZAR	Amount in USD	Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	Principal Focus official Development Assistance	Co-Financing (USD)	Main responsibilties
					Type of Funding								
Loan	GCF		18 690 929	1 417 053	X		X					2 400 000	Waste Management Flagship Programme: The purpose of the Programme would be to implement the organic waste treatment solutions identified in the 6 pilot municipalities and thereafter, upscale implementation to 24 additional municipalities through a programmatic approach. The programmatic approach will allow subsequent 24+ subprojects to learn from the first 6 fore-runners and replicate the solutions in a streamlined, cost-efficient manner.
Loan	GCF		4 195 211	318 060	X		X						Project preparation funding is being requested to conduct a detailed feasibility study to evaluate the optimal financial & institutional model for a Public & Private Sector Energy Efficiency Programme in South Africa. Additionally, funding will be used to prepare the full concept feasibility study and application to the GCF, and to conduct both gender impact, and Environmental and Social Safeguards (ESS) studies. The estimated budget is $ 318 060, to complete the studies within 9 months.
Loan	GCF		195 000	2 386 220			X						SANBI is an accredited entity of the Green Climate Fund. To date, SANBI has received a Readiness Grant from the GCF aimed at developing Concept Notes and Funding Proposals for submission to the GCF amongst other technical activities. 2018.

ANNEXURE B: FINANCIAL SUPPORT DETAILS

ANNEXURE B3: DOMESTIC FINANCIAL FLOWS
TABLE B3.1: DOMESTIC FINANCIAL FLOW FOR CLIMATE CHANGE ACTIONS BETWEEN 2018 AND 2019

Financial Flows / Support	Donor	Amount in ZAR	Amount in USD	Type of Funding						Specific Purpose of Funding
				Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	
Grant	**The Department of Agriculture, Forestry and Fisheries (DAFF)**	**2 121 100 000**	**153 814 358**	**X**	**X**					Programme 5: Forestry and Natural Resources Management: Natural Resources Management. Facilitates the development of infrastructure and the sustainable use of natural resources through an enabling framework for the sustainable management of woodlands and indigenous forests, and the efficient development and revitalisation of irrigation schemes and water use. This sub programme also facilitates climate change mitigation and adaptation, and risk and disaster management; and promotes, regulates and coordinates the sustainable use of natural resources, particularly land and water.
Grant	**DAFF**	**1 650 400**	**119 681**	**X**	**X**					Programme 6: Climate Change and Designated National Authority. Ensures that climate change and environment response measures, in terms of mitigation and adaptation, are implemented within the energy sector. It also ensures the fulfilment of international energy commitments and obligations under the United Nations Framework Convention on Climate Change.
Grant	**The Department of Energy**	**937 758**	**68 003**	**X**		**X**				Programme 6: Clean Energy. Manages and facilitates the development and implementation of clean and renewable energy initiatives, as well as energy efficiency and demand-side management initiatives.
Grant	**The Department of Environmental Affairs**	**63 902**	**4 634**	**X**	**X**	**X**				Climate Change Management, Mitigation and Adaptation.
Grant	**The Department of Environmental Affairs**	**2 827 971**	**205 074**	**X**	**X**	**X**				Environmental Protection and Infrastructure Programme.
Grant	**The Department of Environmental Affairs**	**206 000**	**14 938**	**X**	**X**	**X**				Information Management and Sector Coordination.
Grant	**The Department of Environmental Affairs**	**206 000**	**14 938**	**X**	**X**	**X**				Green Fund.
Grant	**The Department of Environmental Affairs**	**4 429 185**	**321 188**	**X**	**X**	**X**				Natural Resource Management.
Grant	**Cooperative Governance and Traditional Affairs**	**696 000 000**	**50 471 356**		**X**	**X**				National Disaster Management Centre.

				Mitigation	Adaptation	Capacity Building	Technical Support	Technology Support	General	
Financial Flows / Support	**Donor**	**Amount in ZAR**	**Amount in USD**	**Type of Funding**						**Specific Purpose of Funding**
Grant	**Cooperative Governance and Traditional Affairs**	**99 000**	**7 506**		**X**	**X**				Disaster Management Institute.
Grant	**Cooperative Governance and Traditional Affairs**	**220 100**	**15 961**		**X**	**X**				Municipal disaster recovery grant.
Grant	**The Department of Agriculture, Forestry and Fisheries**	**295 006**	**21 393**		**X**	**X**				Comprehensive agricultural support programme grant: Disasters: flood damaged infrastructure.
Grant	**The Department of Agriculture, Forestry and Fisheries**	**266 500**	**19 326**		**X**	**X**				Comprehensive agricultural support programme grant: Disasters Drought relief.
Grant	**The Department of Transport**	**1 008 152**	**73 107**		**X**	**X**				Provincial Maintenance roads maintenance Grant: Disaster Relief component.
Grant	**The Department of Human Settlements**	**194 000 000**	**14 488 424**		**X**	**X**				Municipal disaster recovery grant.
Grant	**The Department of Human Settlements**	**247 000 000**	**18 446 602**		**X**	**X**				Human settlements development grant: Kwazulu-Natal disaster recovery funding.
Grant	**The Department of Public Works**	**1 421 493**	**103 081**		**X**	**X**				Expanded public works programme.



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