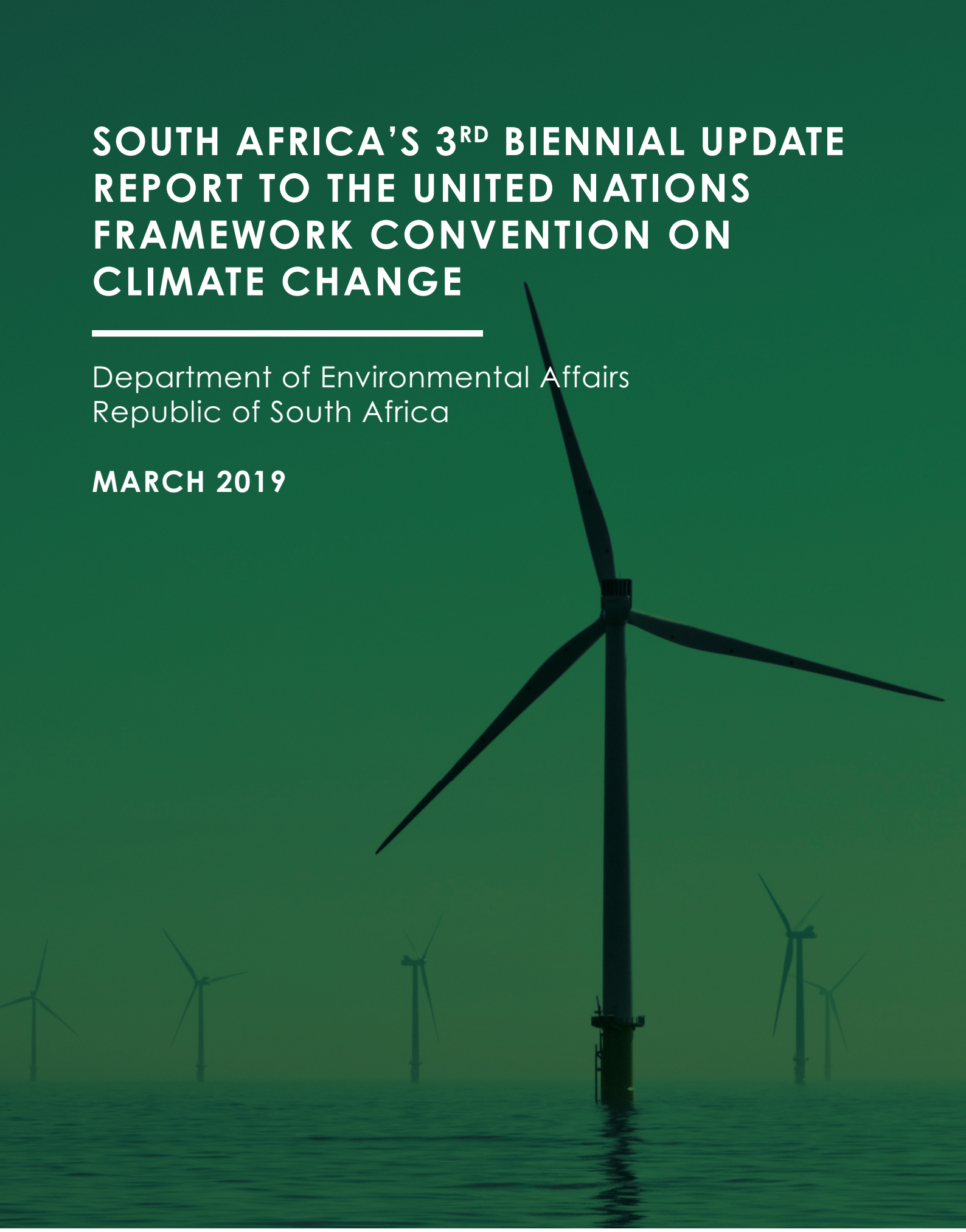
SOUTH AFRICA'S 3RD BIENNIAL UPDATE REPORT TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Department of Environmental Affairs
Republic of South Africa

MARCH 2019



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2030 NDP

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PREFACE

The Department of Environmental Affairs (DEA) on behalf of the government of South Africa publishes the 3rd Biennial Update Report of South Africa to the United Nations Framework Convention on Climate Change (UNFCCC) in line with articles 4 and 12 of the Convention. It is an update of the Third National Communication of South Africa to the UNFCCC which was submitted in August 2018. South Africa strives to comply with all the provisions in the "UNFCCC Biennial Update Reporting Guidelines for Parties not included in Annex I to the Convention." It is worth noting that the extent to which South Africa will be able to do this depends on the support that will be provided based on the reported support needs of South Africa in this report as well as other previous reports to the international community.

South Africa was able to develop the 3rd BUR through funding from the Global Environment Facility (GEF) using the United Nations (UN) Environment as the implementing agency. This report was developed through a collaborative effort between the DEA and the Council for Scientific and Industrial Research (CSIR). Selected chapters were drafted internally by the DEA climate change team and other chapters were drafted by the CSIR with strategic guidance from the DEA.

Suggested citation is as follows:
DEA. (2019). South Africa's 3rd Biennial Update Report to the United Nations Framework Convention on Climate Change. Pretoria. South Africa.

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CSIR

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ACKNOWLEDGEMENTS

The DEA and the CSIR worked with several stakeholders in developing the 3rd Biennial Update Report of South Africa. In this regard, the DEA as the coordinating entity would like to thank all the stakeholders who worked with DEA and CSIR teams to ensure that the country can report transparently on:

- the 2000-2015 emissions inventory,
- progress on mitigation policies, measures and actions for the same period, including quantification of emission reductions to the extent possible, and
- support received including reporting needs related to finance, capacity and technology.

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 3rd BUR:

South African Government:
Departments of Environmental Affairs, Energy, Transport, Agriculture Forestry & Fisheries, Mineral Resources, Basic & Higher Education, Human Settlements, Economic Development, Public Enterprises, National Treasury, Health, Rural Development, Water Affairs, Cooperative Governance, Science & Technology, Trade and Industry as well as International Relations and Cooperation. Provincial Departments of Gauteng Economic Development and Environmental Affairs; KwaZulu-Natal Agriculture and Rural Development; Limpopo Economic Development, Tourism and Environmental Affairs; Mpumalanga Agriculture, Rural Development, Land and Environmental Affairs; Northern Cape Environmental Affairs and Nature Conservation; North West Rural, Environmental and Agricultural Development; Eastern Cape Economic Development, Environmental Affairs and Tourism; Western Cape Local Government, Environmental Affairs and Development Planning; Free State Economic, Small Business Development, Tourism and Environmental Affairs, City of Johannesburg, City of Cape Town. In addition we would like to thank the South African Local Government Association (SALGA) on behalf of the municipalities of South Africa.

State Owned Entities:
South African National Energy Development Institute, Industrial Development Corporation, Transnet, South African Petroleum Industry Association, ESKOM, Passenger Rail Agency of South Africa and Gautrain Management Agency.

Non-Government Organisations
Business Unity South Africa (BUSA), National Business Initiative (NBI), National Disaster Management Centre (NDMC), SASOL, United Nations Environment Programme (UNEP), Global Environment Facility (GEF), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Carbon Disclosure Project (CDP).

MINISTERIAL FOREWORD

In December 2018, in Katowice, Poland, South Africa along with other signatories to the Paris Agreement finalised the comprehensive Paris Agreement rulebook which outlines the details of implementing the Paris Agreement. The 24th session of the Conference of the Parties (COP 24) to the UNFCCC, the 14th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP) and the third part of the first session of the Conference of the Parties serving as the 1st meeting of the Parties to the Paris Agreement (CMA 1-3), adopted modalities, procedures and guidelines on mitigation; adaptation; support (finance, capacity building, technology development and transfer) transparency; global stocktake; compliance as well as other necessary guidelines that are important to fully operationalise the Paris Agreement. South Africa is particularly pleased to have co-facilitated with the Government of Spain, the Modalities, Procedures and Guidelines (MPG) for the Transparency Framework for Action and Support referred to in Article 13 of the Paris Agreement.

Of particular importance is that these Transparency MPGs build upon the existing MPGs for Biennial Reporting by Annex I parties as well as Biennial Update Reporting by Non Annex I Parties. Whilst upholding the principle of no backsliding by all parties, they also take into account the flexibility needed by those developing country parties in light of their capacities. Within this context, South Africa views its 3rd BUR as a milestone, not only in providing progress that South Africa has made towards mitigating climate change but also as an important report to help South Africa assess its readiness for the preparation of its first Biennial Transparency Report (BTR) which will be submitted in 2024.

In this 3rd BUR, South Africa presents its climate change policy on mitigation planning, action and progress achieved to date. South Africa reiterates its commitment to making a fair contribution towards holding the increase in the global average temperature to 2°C above pre-industrial levels and pursuing efforts to limit the global average temperature increase to 1.5°C.

As indicated in the NDC, South Africa's mitigation component of its NDC has moved from a "deviation from business-as-usual" form of commitment and takes the form of a "peak, plateau and decline" GHG emissions trajectory. South Africa's emissions by 2025 and 2030 are forecast to be in a range between 398 and 614 $MtCO_2$ equivalent as communicated in the Nationally Determined Contribution (NDC) and National Climate Change Response Policy. The 2021-2025 and 2026-2030 phases will focus on achieving the pledges made in the NDC. Tracking progress towards achieving this target will be effectively reported, beginning with our first BTR.

Policy instruments to aid in achieving these targets are under development or currently implemented including but not limited to the carbon tax policy, sectoral emission targets for sectors, company-level carbon budgets, as well as regulatory standards and controls for greenhouse gases declared as criteria pollutants and key emitting sectors. These policies and measures will be implemented at national level over five-year periods. Specifically, the 2016 and 2020 phase is focusing on developing and demonstrating the mix of policies and measures in order to meet South Africa's Cancun pledge. South Africa has reported in this 3rd Biennial Update Report its GHG emissions inventory from 2000 to 2015 including the GHG mitigation achieved between the years 2000 and 2015.

It is in this context, that I am pleased to present to you the 3rd Biennial Update Report of South Africa to the United Nations Framework Convention on Climate Change.

Mrs N Mokonyane
Minister of Environmental Affairs (South Africa)

EXECUTIVE SUMMARY

The Republic of South Africa submits its 3rd BUR under the United Nations Framework Convention on Climate Change (UNFCCC). This report follows the Biennial Reporting Guidelines for Parties not included in Annex I to the Convention and therefore comprises of the following seven chapters:

1. National Circumstances
2. National Greenhouse Gas Inventory
3. Mitigation Actions and their Effects
4. Finance, Technology and Capacity Building Needs and Support Received
5. Support Received for the Preparation of the BUR
6. Measurement, Reporting and Verification
7. Additional Information

Each chapter is summarised below and highlights the progress made in South Africa's response to climate change, since reporting in the 2nd BUR and TNC.

ES1 NATIONAL CIRCUMSTANCES

South Africa is certainly 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 stabilizing greenhouse gas (GHG) concentrations in the atmosphere, hence reducing carbon footprints and preventing harmful human activity interference in the climate system. In Accordance with the National Climate Change Response Policy (NCCRP) White Paper (DEA, 2011), climate change remains a threat to sustainable development and livelihoods. South Africa continues to transition to a low carbon and climate resilient economy. This is evident through the many programmes and projects targeted at addressing climate change, mainstreaming of climate change into development policies as well as the effective monitoring and reporting on GHG emissions, mitigation and adaptation actions (DEA, 2018). Information reported in BUR-3 on national circumstances builds on the work reported and included in the BUR-2 and TNC. Information on the geographic profile and general climatic conditions for South Africa is updated to include current efforts and measures that South Africa has undertaken to address climate change.

The Department of Environmental Affairs (DEA) plays a central coordinating and policymaking role and is responsible for providing guidance and ensuring that there is a clear alignment of policies and international obligations when it comes to climate change. There is a need to align the Sustainable Development Goals (SDG), Sendai Framework for Disaster Risk Reduction and the Paris Agreement. Frameworks and policies play a significant role in the current efforts required for developing countries to become low carbon and climate resilient economies.

The Department coordinates the work on the ongoing preparation of National Communications (NCs) and Biennial Update Reports (BURs) under the Chief Directorate:

International Climate Change Relations and Negotiations. 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 DEA continues to support contributing authors and 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 correctly reflect the national circumstances.

ES2 NATIONAL GHG EMISSIONS INVENTORY

The national greenhouse gas (GHG) inventory for South Africa is presented for the period of 2000 to 2015. 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 aggregated gross GHG emissions (i.e. excluding FOLU) were 439 238 Gg CO_2e in 2000 and these increased by 101 616 Gg CO_2e (or 23.1%) by 2015 (**Table ES2.1**). South Africa's aggregated net GHG emissions, including Forestry and Other Land Uses (FOLU), were 426 214 Gg CO_2e in 2000 and these increased to 512 383 Gg CO_2e by 2015 (Table ES2.1). Between 2000 and 2015 the average annual growth was 1.43%, with the Energy sector being the main contributor to this increase.

Table ES2.1: Changes in South Africa's gross and net emissions between 2000 and 2015 by sector

Greenhouse gas source and sink sector	Emissions (Gg CO_2e)		Difference (Gg CO_2e)	Change (%)
	2000	2015	2000-2015	2000-2015
Total net emissions (incl. FOLU)	**426 214**	**512 383**	**86 169**	**20.2**
Total gross emissions (excl. FOLU)	439 238	540 854	101 616	23.1
1. ENERGY	343 790	429 907	86 117	25.0
2. IPPU	34 071	41 882	7 811	22.9
3. AFOLU (excl. FOLU)	50 539	49 531	-1 008	-2.0
3. AFOLU (incl. FOLU)	37 515	21 060	-16 455	-43.9
4. WASTE	10 838	19 533	8 695	80.2

Gross emissions increased by 1.2% between 2012 and 2015. The increase was due to a 0.05% (195 Gg CO_2e), 9.3% (1 667 Gg CO_2e) and a 7.5% (2 927 Gg CO_2e) increase in the emissions from the Energy, Waste and IPPU sectors respectively. CO_2 gas is the largest contributor to South Africa's gross and net emissions, thereby contributing 91.9% of gross emissions between 2000 and 2015 and 92% in 2015. This is followed by CH_4 contributing 9.4% in 2015 and then N_2O contributing 4.5% in 2015. The contribution from CH_4 and N_2O to the gross emmisions decreases between 2000 and 2015, while CO_2 and F-gases increased over the same period.

An uncertainty analysis was further completed for the Energy and IPPU sectors, with the analysis for the AFOLU and waste sectors planned for the next inventory. The uncertainty on the 2015 Energy estimates was determined to be 6.6%, while the uncertainty on the trend was 6.13%. For the IPPU sector the uncertainty was determined to be 9.56% on the 2015 estimates. A further improvement in the inventory since the BUR-2 is the development of the National GHG Inventory Management System (NGHGIS). Through this system South Africa aims to manage and simplify its climate change obligations to the UNFCCC process. The system has been designed to ensure transparency, consistency, comparability, completeness and accuracy (TCCCA) of inventories as defined in the guidelines for preparation of inventories. It will ensure the quality of the inventory through planning, preparation and management of inventory activities in accordance with Article 5 of the Kyoto Protocol.

ES3 MITIGATION ACTIONS AND THEIR EFFECTS

An update to the information on mitigation actions with quantified effects that were presented in BUR-1, BUR-2 and the 2nd Climate Change Report are presented in BUR-3 for the period 2000-2015. The annual greenhouse gas emission reductions were estimated at 96 MtCO_2e/year, 101 MtCO_2e/year, 112 MtCO_2e/year and 119 Mt CO_2e/year for 2012, 2013, 2014 and 2015 respectively (**Figure ES3.1**). The emission reductions are related to the progress made by government and parastatals. Emission reductions mainly occurred in the energy sector, 93% for the period 2000-2015. It is estimated that the private sector has reduced its greenhouse gas emissions by 7.5 Mt CO_2e in 2016 and 6.8 Mt CO_2e in 2017. Cumulative greenhouse gas emission reductions in 2015 of the private sector were not reported in Carbon Disclosure Project reports.

An update on policies and programmes that contribute toward giving effect to the country's climate change mitigation goals is also provided in the chapter. The Near-term Priority Flagship Programmes, for example, have provided a focal point for attracting and leveraging investment from both the private and public sectors. This investment in climate change response has been used to integrate the actions of different spheres of government and other key stakeholders in the private sector and civil society to achieve collective climate impact.

The Carbon Tax Bill, Greenhouse Gas Emissions reporting, Climate Change Bill and Pollution Prevention Plan regulations are substantial policy steps undertaken by the country to curb greenhouse gas emissions. This has been achieved by government, in collaboration with the private sector, through extensive engagements since 2011 to meet the country's climate change commitments. The carbon offsets regulations were introduced to supplement these regulations to incentivise actions and measures that reduce, avoid or sequester greenhouse gas emissions.

One key component of the Post 2020 South African mitigation system will be the use of Sectoral Emission Targets (SETs) as an instrument that places quantitative limits on future greenhouse gas emissions to allow South Africa to fulfil its climate change

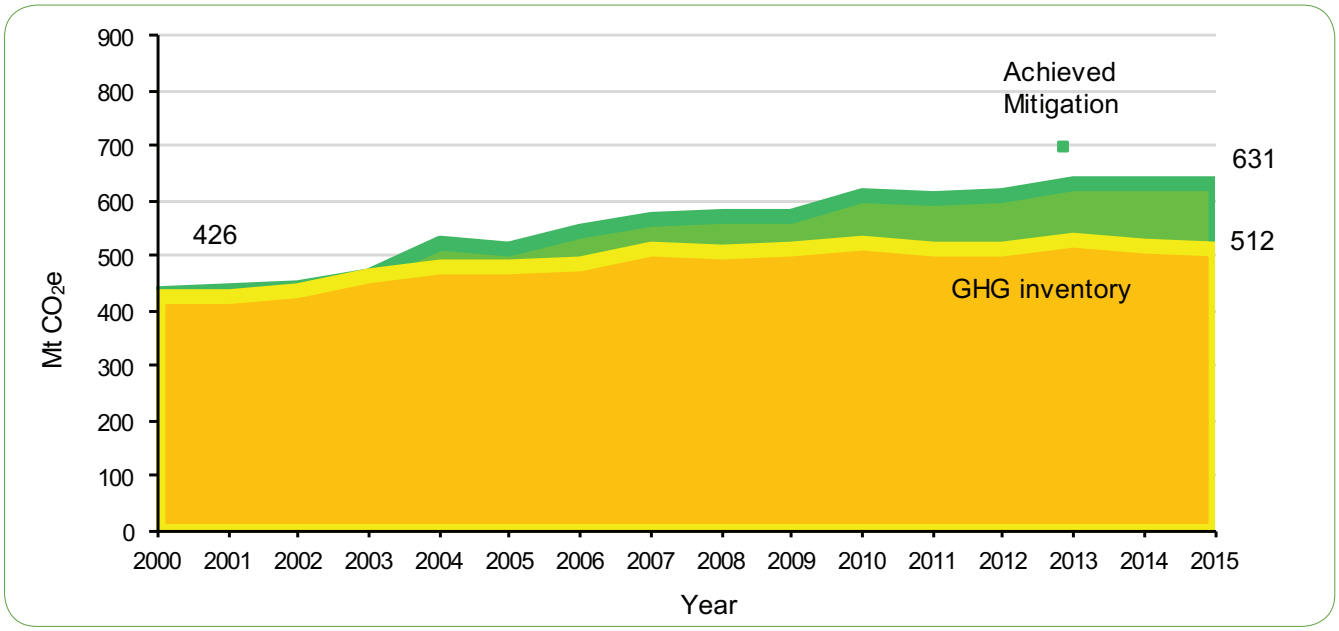

Figure ES3.1: South Africa's annual emissions reduction for period 2000-2015

mitigation ambition. The targets will be a set of emission reduction goals for the short (2016-2020), medium (2020-2030) and long term (2030-2050). To set up SETs for individual government departments and the electricity generation sector, the targets will based on an assessment of the mitigation potential, best available mitigation options, science, evidence and a full assessment of the costs and benefits. Two research studies were undertaken to inform the SETs development and were based on the Mitigation Potential Analysis study including the Greenhouse Gas Pathways Project and the Policies and Measures project (PAMS). Both the studies considered the greenhouse gas effects of mitigation policies and measures on the projected greenhouse emissions of the country.

The monitoring and evaluation system for the Energy; Waste; Agriculture, Forestry and Other Land Use, and Industrial Processes and Product Use Sectors goes beyond a monitoring function to evaluate climate change impacts and the effectiveness of responses in South Africa to support the improvement of mitigation policy. The information could be useful to indicate whether the country's social, economic and environmental systems are becoming more resilient to climate change over time. The generation of lessons learned will enhance stakeholders' understanding of the country's climate change impacts, risks and vulnerabilities, which in turn could help to identify approaches that are effective in reducing those impacts, risks and vulnerabilities. The country has achieved remarkable success in setting policy direction for mitigation in each of the emission sectors.

Important mitigation policies in the Energy sector include the Integrated Resource Plan 2018, the post 2015 National Energy Efficiency Strategy and the Integrated Demand-side Management Programme. The Integrated Resource Plan 2018 proposes South Africa's electricity generation mix until 2050 and is unique to previous plan updates due to the increased capacities of renewable energy sources included in the energy supply mix. Sector specific energy efficiency targets have been set in the post 2015 National Energy Efficiency Strategy for industry; transport; public and commercial and agriculture to be achieved by 2030. The Energy Efficiency Target Monitoring System ensures that energy efficiency policies are supported by adequate end-use information, by substantially increasing the effort to collect energy data and information across all sectors.

This monitoring system will enable the Department to track energy savings and to report greenhouse gas emission reductions in each sector as a result of achieved energy reductions. The Integrated Demand-side Management Programme covers a range of funding and awareness programmes, which promote energy efficiency and load management. The programme is a concerted drive to measurably impact energy consumption in response to the projected supply shortfall while building a sustainable, energy efficient society in the longer term.

The National Waste Management Strategy and the Waste Management Flagship Programme frame the mitigation options in the waste sector including waste-to-energy, re-use, recycling or recovery, waste reduction and access to basic waste disposal services. The National Waste Management Strategy provides the overall approach to national waste management during the lifecycle of waste. Additionally the strategy supports job and business enterprise creation in the waste sector, awareness campaigns about the impact of waste on their health, well-being and the environment and the integration of Integrated Waste Management Plans into local government Integrated Development Plans. The Waste Management Flagship Programme prioritises the research of waste-to-energy opportunities available within the solid-, semi-solid and liquid-waste management sectors, especially the generation, capture, conversion and or use of methane emissions.

The Department of Agriculture, Forestry and Fisheries has introduced the Climate Change Sector Plan, the Climate Change Adaptation and Mitigation Plan and the Smart Agriculture Strategic Framework which collectively serve to prioritise climate-smart technologies within the Agriculture, Forestry and Other Land Uses sector. The Department of Environmental Affairs have undertaken a number of studies to quantify the greenhouse gas emissions in the sector and to evaluate the emission reduction potentials of climate-smart technologies including the development of a Greenhouse Gas Emissions Baseline for the Agriculture, Forestry and Other Land Use sector in South Africa, the improvement of the Greenhouse Gas Emissions Inventory for the Agricultural Sector and the National Terrestrial Carbon Sinks Assessment. Monitoring and evaluation requirements linked to the national greenhouse gas emission inventory to support the reporting of progress of implementation of policy, actions and measures in the sector are indicated in the report National Climate Change Monitoring and Evaluation system of the Agriculture, Forestry and Other Land Use Sector.

The analysis of industrial sector responses on emission reduction activities indicate that industries are in a continuous process of improvement to report on their mitigation activities. Industries reported difficulties in terms of centralising the collection of data, capturing of information and the collation of data to derive meaningful emission reduction results. Emission reductions are most often estimated from predicted activity data without monitoring and evaluation systems being implemented to estimate emissions reductions from measured activity data. The co-benefits of the mitigation actions also are proposed but no monitoring and evaluation occurs to track the developmental benefits. Currently only those industries undertaking projects as part of the Clean Development Mechanism are required to monitor emission reductions after the implementation of the mitigation intervention. Industries reporting to the Carbon Disclosure Project or National Cleaner Production Centre Industrial Energy Efficiency programme do not need to monitor and evaluate the emission reductions of the reported mitigation interventions. The present challenge to reporting the progress and impact of policies and measures in industry will be addressed by the implementation of the Pollution Prevention Plan regulations, Climate Change Bill and Carbon Tax Bill. The implementation of the National Climate Change Response monitoring and evaluation system will contribute toward addressing the shortfalls of current international systems to centralise information about mitigation interventions in the country.

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

Financial, capacity-building and technical support received and further needed to finance the cost of South Africa's transition to a lower-carbon and climate resilient economy and society is outlined in this chapter in terms of international and domestic climate-related finance flows, as well as non-monetised support received between January 2015 and December 2017- providing an update on projects since BUR-2 as well as providing information on approved proposals/ concept notes submitted where relevant.

An analysis of bilateral and multilateral support received showed that close to 55% of bilateral grants received were from Germany and the majority of multilateral support received was through multilateral grants of the Global Environment Facility (95%) which were implemented through the Development Bank of South Africa (55%), United Nations Industrial Development Organisation (27%), United Nations Environment Programme (12%), and United Nations Development Programme (6%). The South African 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. The domestic funding sources available in South Africa for climate change projects include, for example, the Green Fund managed by the Department of Environmental Affairs (DEA) and the Development Bank of Southern Africa (DBSA) as well as the Energy Efficiency and Demand-side Management Fund managed by the Department of Energy. An analysis of the domestic finance flows showed that the South African government has invested approximately $ 643.9 million in the form of grants and $ 45.4 million in the form of loans to support climate change-related programmes and research from 2015 to 2017.

Technical support and capacity building support received from developed countries included support for activities related to mitigation methodology, GHG expert reviewer training, and training on an energy and emissions model (the 2050 Pathways Calculator), as well as courses on energy efficiency and green industrial development. An overview of progress in updating the country's Technology Needs Assessment was provided in terms of the sector prioritisation, technology prioritisation and barrier analysis components of the assessment.

ES5 SUPPORT RECEIVED FOR PREPARATION OF BUR

South Africa, as a signatory to the UNFCCC, received financial support from the Global Environment Facility (GEF) to compile and publish its BUR-2 and BUR-3, as well as the TNC. The United Nations Environment Programme (UNEP) is the implementing entity responsible for the management of these funds for the GEF.

South Africa received additional financial support from the German Federal Ministry for the Environment, Nature Conservation, Buildings and Nuclear Safety (BMUB) through its International Climate Initiative. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) is the implementing agency through its Climate Support Programme to South Africa. The financial support provided by the GIZ enabled South Africa to appoint an independent external reviewer to review South Africa's 6th NIR as well as the BUR-3. The South African personnel have also attended various capacity building trainings in relation to the reporting to the Convention. In addition, the CGE training material has been very helpful in building capacities for the South African personnel in compiling BURs, NCs and NIRs.

The key challenges that South Africa faces in the preparation of BURs relates to the insufficient number of personnel responsible for compiling the NIR as well as the BUR. South Africa's Climate Change Monitoring and Evaluation System has not fully been operationalized so data relating to mitigation actions and support received is still collected to a large extent on manual basis. Institutional arrangements for data provision have not yet been fully formalised and data is provided based on informal arrangements between the DEA and the data providers. This has resulted in some data gaps and often causes delays in the finalisation of the reports.

ES6 MEASUREMENT, REPORTING AND VERIFICATION IN SOUTH AFRICA

South Africa is developing a comprehensive, integrated National Climate Change Response Monitoring and Evaluation System which includes the current National Climate Change Response Database (NCCRD) and the National Greenhouse Gas Inventory System (NGHGIS) and will serve as a data and information coordination network. The climate change M&E system enables South Africa to assess, analyse and understand progress made on achieving the country's climate commitments. The South African M&E system encompasses all the three functional aspects of the MRV; namely, MRV of GHG emissions, MRV of mitigation actions and MRV of Support; and is taking a phased approach to the rollout of the system with full-implementation of the M&E system envisaged in 2020.

An update of milestones reached in the development of this system is provided. Progress in terms of the development of the M&E system includes the completion of the M&E guidelines for assessment of mitigation policies and actions, development and testing of eight overarching and 75 sector-specific Desired Adaptation Outcomes (DAOs), testing of approaches for assessing the effectiveness of adaptation responses with case studies, and operationalizing the web-based M&E system platform prototype. In terms of the greenhouse gas inventory, regulations on National Pollution Prevention Plans and mandatory National Greenhouse Gas Emissions Reporting Regulations (Gazette No. 40054) have been promulgated and implemented.

The development of a national data visualisation platform, initiated in June 2017, aimed to enhance the data visualisation capacity within the development of the M&E system. This platform will provide a visualisation capability for the various outputs and products of the M&E system and enhance DEA's capacity to communicate national information on climate change to a wide range of audiences by making reports and other M&E products visually appealing and easy to explore by audiences.

ES7 ADDITIONAL INFORMATION

South Africa has reported voluntarily in its additional information on the detailed progress of the national climate change near-term priority flagship projects. These include the Renewable Energy Near-term Priority Flagship Programme; Energy Efficiency and Energy Demand Management Near-term Priority Flagship Programme; Waste Management Near-term Priority Flagship Programme; Transport Near-term Priority Flagship Programme; Carbon Capture and Storage (CCS) Flagship Programme, as well as the Adaptation Research Flagship Programme.

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ACED	African Clean Energy Developments
AD	Anaerobic Digestion
AEL	African Explosives Limited
AFOLU	Agriculture, Forestry and Other Land Use
AGB	Above-ground biomass
BCEF	Biomass conversion and expansion factor
BEF	Biomass expansion factor
BMU	German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety
BNF	Biological nitrogen fixing
BOD	Biological oxygen demand
BRT	Bus Rapid Transit
BUR	Biennial Update Report
C	Carbon
C_2F_6	Carbon hexafluoroethane
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CDP	Carbon Disclosure Project
CF_4	Carbon tetrafluoromethane
CFC	Chlorofluorocarbons
CGE	Consultative Group of Experts
CGS	Council for Geosciences
CH_4	Methane
CNG	Compressed Natural Gas
CO	Carbon monoxide
CO_2	Carbon Dioxide
CO_2eq	Carbon dioxide equivalent
CSP	Concentrating Solar Power
DAFF	Department of Agriculture, Forestry and Fisheries.
DAO	Desired Adaptation Outcomes
DBSA	Development Bank of Southern Africa

DEA	Department of Environmental Affairs
DFID	Department for International Development
DMR	Department of Mineral Resources
DOE	Department of Energy
DOM	Dead organic matter
DOT	Department of Transport
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EEDSM	Energy Efficiency and Demand Side Management
EELN	The Energy Efficiency Leadership Network
EEPIBP	Energy Efficiency in Public Buildings and Infrastructure Programme
EETMS	Energy Efficiency Target Monitoring System
EF	Emission factor
EPIP	Environmental Protection and Infrastructure Programme
EPWP	Expanded Public Works Programme
ESCo	Energy Service Company
F-gases	Flourinated gases: e.g., HFC, PFC, SF_6 and NF_3
FOD	First order decay
FOLU	Forestry and Other Land Uses
FSA	Forestry South Africa
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GFOI	Global Forest Observations Initiative
Gg	Gigagram
GHG	Greenhouse gas
GHGIP	Greenhouse Gas Improvement Programme
GIR	Greenhouse Gas Inventory & Research Centre of Korea
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GWP	Global Warming Potential

HCD	Human Capital Development
HCFT	Hydrogen and Fuel Cell Technologies
HFC	Hydrofluorocarbons
HWP	Harvested wood products
HySA	National Hydrogen and Fuel Cell Technologies Research, Development and Innovation Strategy
ICA	International Consultation and Analysis
ICFR	The Institute for Commercial Forestry Research
IDC	Industrial Development Corporation
IDM	Integrated Demand Management
IDZ	Industrial Development Zone
IEA	International Energy Agency
IEE	Industrial Energy Efficiency
IEF	Implied emission factor
IEP	Integrated Energy Plan
INEP	Integrated National Electrification Programme
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use
IPTN	Integrated Public Transport. Network
IRP	Integrated Resource Plan
LIFE	Low Impact and Fuel Efficient
LPG	Liquefied petroleum gas
LTAS	Long Term Adaptation Scenarios
LTMS	Long Term Mitigation Scenarios
LTO	Landing/take off
M&E	Monitoring and Evaluation
MCA	Multi-Criteria Analysis
MCEP	Manufacturing Competitiveness Enhancement programme
MCF	Methane conversion factor
MEF	Manure emission factor
MPA	Mitigation Potential Analysis
MRV	Monitoring, Reporting and Verification.
N_2O	Nitrous Oxide

NAEIS	National Atmospheric Emissions Inventory System
NAMA	Nationally Appropriate Mitigation Actions
NC	National Communications
NCCC	National Climate Change Committee
NCCRD	National Climate Change Response Database
NCCRP	National Climate Change Response Policy
NCPC	National Cleaner Production Centre of South Africa
NDC	National Determined Contributions
NDMC	National Disaster Management Centre
NE	Not estimated
NEES	National Energy Efficiency Strategy
NERSA	National Energy Regulator of South Africa
NGHGIS	National Greenhouse Gas Inventory System
NIR	National Inventory Report
NO_2	Nitrogen Dioxide
NOWCS	National Organic Waste Composting Strategy
NO_x	Oxides of nitrogen
NPC	National Planning Commission
NTCS	A National Terrestrial Carbon Sinks Assessment
NTCSA	National Terrestrial Carbon Sinks Assessment
NWBI	R National Waste Baseline Information Report
NWMS	National Waste Management Strategy
OCGT	Open Cycle Gas Turbine
ODA	Official Development Assistance
PASA	Petroleum Agency of South Africa
PCSP	Pilot Carbon Storage Project
PFC	Perfluorocarbons
PPD	Plateau and Decline
PPM	Parts per million
PPP	Pollution Prevention Plan
PRASA	Passenger Rail Agency of South Africa
PRP	Pastures, rangelands and paddocks

PSEE	Private Sector Energy Efficiency Project
PTAS	Project Technical Advisory Services
QA/QC	Quality assurance/quality control
REDD+	Reducing emissions from deforestation and forest degradation
REDISA	Recycling and Economic Development Initiative of South Africa
REI4P	Renewable Energy Independent Power Producer Procurement Programme
RSA	Republic of South Africa
SAAQ	IS South African Air Quality Information System
SAD	System Architecture and Design
SADC	Southern African Development Community
SAEON	South African Earth Observation Network
SAIS	A South African Iron and Steel Institute
SA-LED	South Africa Low Emissions Development
SALGA	South African Local Government Association
SAMI	South African Minerals Industry
SANBI	South African National Biodiversity Institute
SANEDI	South African National Energy Development Institute
SANS	South African National Standard
SAPIA	South African Petroleum Industry Association
SAR	Second Assessment Report
SARVA	South African Risk and Vulnerability Atlas
SDG	Sustainable Development Goals
SET	Sectoral Emission Targets
SF_6	Sulphur hexafluoride
SNE	Single National Entity
SOC	Soil Organic Carbon
STEP	Subtropical Thicket Ecosystem Project
SWH	Solar Water Heater
TAM	Typical animal mass
TAR	Third Assessment Report (IPCC)
TAR	Third Assessment Report
TCCCA	Transparency, consistency, comparability, completeness and accuracy

TJ	Terajoule
TM	Tier method
TMR	Total mixed ratio
TNA	Technology Needs Assessment
TNC	Third National Communication
TOW	Total organics in wastewater
UN	United Nations
UNDP	United Nations Development Programme
UNEP	UN Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
USAID	United States Agency for International Development
USD	United States Dollar
VER+	Verified Emission Reduction
WAM	With Additional Measures
WCWDM	Water Conservation and Water Demand management
WEM	With Existing Measures
WRI	World Resources Institute
WWF	World Wildlife Fund
WWTP	Wastewater treatment plant-derived
ZAR	South African Rand

1. NATIONAL CIRCUMSTANCES

1.1. Introduction

South Africa is certainly 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 stabilizing greenhouse gas (GHG) concentrations in the atmosphere, hence reducing carbon footprints and preventing harmful human activity interference in the climate system.

In accordance with the National Climate Change Response Policy (NCCRP) White Paper (Department of Environmental Affairs, 2011), climate change remains a threat to sustainable development and livelihoods. Thus, there is a greater need to scale up efforts to address the effects of climate change and further adhere to the UNFCCC convention. South Africa continues to transition to a low carbon and climate resilient economy. This is evident through the many projects and programmes targeted at addressing climate change, mainstreaming of climate change into development policies and the effective monitoring and reporting on GHG emissions, mitigation and adaptation actions (DEA, 2018). In December 2017, South Africa submitted its Second BUR (BUR-2) to the UNFCCC and the report has undergone a technical assessment through the International Consultation and Analysis (ICA).

The information reported in BUR-3 on national circumstances builds on the work initiated and included in the BUR-2 and the TNC. Information on the geographic profile and general climatic conditions for South Africa is updated to include current efforts and measures that South Africa has undertaken to address climate change. Thus the information on national circumstances, institutional arrangements, population dynamics, economy, energy and climate impacts are updated from the BUR-2.

1.2. Institutional Arrangements

South Africa has three spheres of government, namely national, provincial and local. The Constitution of the Republic of South Africa (RSA, 1996) guarantees the autonomy of each of these government spheres. Local government also 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. With regards to climate change, the NCCRP 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. **Table 1.1** provides an institutional arrangement that South Africa currently has in place to address climate change response actions.

Table 1.1 Domestic institutional arrangements to address climate change response actions

Structure	Function
Parliament and Portfolio Committees	Oversee the implementation of the NCCRP Review legislation to support the NCCRP BURs and National Communication reports are submitted to the committee for their approval.
The Inter-Ministerial Committee on Climate Change (IMCCC)	Executive (Cabinet) level committee coordinates and aligns climate change response actions with national policies and legislation IMCCC shall oversee all aspects of the implementation of the NCCRP The Minister of the Environment chairs the IMCCC.
Forum of South African Directors-General clusters	South African Director-General clusters based on their different mandates will guide the implantation of NCCRP actions.
Intergovernmental Committee on Climate Change (IGCCC)	Operationalise cooperative governance Consists of the relevant national and provincial departments and organised local government.
National Disaster Management Council	Responsible for ensuring that the National Framework for Disaster Risk Management provides clear guidance across all spheres and sectors of government for managing climate change-related risk Ensuring that an effective communications strategy is in place for early warnings to vulnerable communities.
MINMEC and MINTECH	Facilitate a high level of policy and strategy coherence among the three spheres of government Guide climate change work across the three spheres of government.
National Committee on Climate Change (NCCC)	Consult with stakeholders from key sectors that impact on or are impacted by climate change Advises on matters relating to national responsibilities Advises on the implementation of climate change-related activities.
National Economic Development and Labour Council (NEDLAC)	Forum where government comes together with organised business, labour and community groupings on a national level Ensure that climate change policy implementation is balanced and meets the needs of all sectors of the economy.
City Resilience Committees	Forums where city government come together to discuss climate change issues and how cities need to take lead in climate action.

1.2.1. The Role of the National Department of Environmental Affairs

The Department of Environmental Affairs (DEA) 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, programs 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 (SDG), Sendai Framework for Disaster Risk Reduction and the Paris Agreement. All these frameworks and policies play a significant role in the current efforts required for developing countries to become low carbon and climate resilient economies.

The work of DEA is underpinned by the Constitution of the Republic of South Africa (RSA, 1996), the National Development Plan (NDP), National Environmental Management Act (NEMA) (DEA, 2015), NCCRP and other relevant legislation and policies applicable to government to address environmental management, including climate change. DEA is responsible for co-ordination and management of all climate change-related information such as mitigation, adaption, monitoring and evaluation programmes.

The Department leads the work on the ongoing preparation of National Communications (NCs) and Biennial Update Reports (BURs) under the Chief Directorate: International Climate Change Relations and Negotiations. 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 DEA 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 the reports reflect the national circumstances.

The PSC is chaired by DEA and comprises government officials from the following national departments: DEA, Department of International Relations and Cooperation, Department of Science and Technology, Department of Transport, Department of Energy, Department of Mineral Resources, Department of Trade and Industry, Department of Education, Department of Economic Development, Department of Human Settlements, Department of Agriculture Forestry and Fisheries, Department of Public Enterprises, Department of Rural Development and Land Reform, Department of Cooperative Governance and Traditional Affairs, Department of Health, Department of Water Affairs, National Treasury, the Presidency and the National Disaster Management Centre. The NCs, BURs and 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: International Climate Change Relations and Negotiations, and undergo an international review process.

1.2.2. Provincial and Local Government

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 co-ordinate their respective climate change responses. South Africa's Local Government Association (SALGA) is mandated to support, represent and advise local governments on issues pertaining to governance at community level. The role of local government in South Africa is critical because it is the sphere of government closest to the people. Hence, 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 due to having enough capacity to do so. District and Local Municipalities are undertaking Climate Vulnerability Assessments and are already mainstreaming climate action into their policies, strategies and plans under the guidance of DEA and SALGA. Provincial development priorities related to climate change were reported in the 2nd BUR, in Table 2 under the National Circumstances Chapter (DEA, 2017).

1.2.3. Progress made in sector related climate change responses

South Africa's continues to uphold its commitment to promoting a low carbon economy and climate resilience society. This is evident in the many increasing efforts by all levels of government and private sector organizations in mainstreaming climate change in their development policies, plans, strategies and reporting on emissions. **Table 1.2** below provides an updated summary of the advancements made in sectoral climate change responses through the development of numerous national programmes, plans and strategies.

Table 1.2: Sectoral climate change programmes, plans and strategies

Institution	Sectoral programmes, plans and strategies
Department of Agriculture, Forestry and Fisheries (DAFF)	• Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) • National Forests Act, 1998 (Act No. 84 of 1998) • Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries (2013) • Sectoral Cold Spell Management Plan (2015) • Draft Climate Change Adaptation and Mitigation Plan for The South African Agricultural and Forestry Sectors (2015) • Strategic Plan for DAFF 2015/16 to 2019/20 (2015) • Draft Climate Smart Agriculture Strategic Framework for Agriculture, Forestry and Fisheries (2018) • Draft Conservation Agriculture Policy (2017) • Draft Policy for the Sustainable Management of Veld (range) and Forage Resources in South Africa (2014)
Department of Energy (DoE); ESKOM	• National Energy Act, 2008 (Act No. 34 of 2008) • Electricity Regulation Act, 2006 (Act No. 4 of 2006) • Petroleum Products Act, 1977 (Act No. 120 of 1977) • Gas Act, 2001 (Act No. 48 of 2001) • Municipal Infrastructure Rehabilitation Programme • Draft Integrated Energy Plan for South Africa (2016) • Draft Integrated Resources Plan for South Africa (2018) • Draft Post-2015 Energy Efficiency Strategy (NEES) (2016) • National Energy Efficiency Strategy (NEES) (2005) • DoE Environmental Management Plan for 2015-2020 3rd Ed. (2016) • State of Renewable Energy in South Africa (2015) • Draft Regulations on Registration, Reporting on Energy Management and Submission of Energy Management Plans (2015) • Energy Efficiency Target Monitoring System (EETMS) • Integrated Demand Side Management (IDM) Programme • Diversification of electricity generation sources: Renewable Energy Independent Power Producer Procurement (REIPPP) Programme • Diversification of electricity generation sources: South African Wind Energy Programme (SAWEP) • National Industrial Biofuels Strategy (NIBS) (2007) • Draft position paper on South African Biofuels Regulatory Framework (2014) • The National Solar Water Heater Programme • The Energy Efficiency Demand Side Management Programme • Energy Efficiency Standards and Appliance Labelling Programme

Institution	Sectoral programmes, plans and strategies
DEA; South African Weather Services (SAWS); South African Earth Observation Network (SAEON); South African Biodiversity Institute (SANBI); Development Bank of Southern Africa (DBSA)	• National Environmental Management Act, (No 107 of 1998) • Environment Conservation Act, 1989 (Act No. 73 of 1989) • Waste Tyre Regulations (2008) • Regulations for the Prohibition of the Use, Manufacturing, Import and Export of Asbestos and Asbestos Containing Materials (2008) • Mineral and Petroleum Resources Development Act, 2008 (Act No.49 of 2008) • National Environmental Management: Air Quality Act No 39 of 2004 (NEM:AQA) • National Environmental Management: Air Quality Amendment Act, 2014 (Act No. 20 of 2014) • Declaration of Temporary Asphalt Plants as a Controlled Emitter (2014) • Declaration of Small-Scale Char and Small-scale Charcoal Plants as Controlled Emitters (2015) • White Paper on Integrated Pollution & Waste Management for RSA (2000) • List of Activities which result in Atmospheric Emissions which have or may have a Significant Detrimental Effect on the Environment, including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural heritage • National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter Less than 2.5 micron metres (PM2.5) • Draft Strategy to Address Air Pollution in Dense Low-income Settlements (2016) • White Paper on Integrated Pollution & Waste Management for RSA (2000) • National Ambient Air Quality Standards (2009) • National Policy for the Provision of Basic Refuse Removal Services to Indignant Households (2011) • National Environmental Management: Waste Amendment Act, 2014 (Act No. 26 of 2014) • Waste Classification and Management Regulations (2013) • National Norms and Standards for the Assessment of Waste fort Landfill Disposal (2013) • Declaration of a Small Boiler as a Controlled Emitter and Establishment of Emission Standards (2013) • National Dust Control Regulations (2013) • National Atmospheric Emission Reporting Regulations (2015) • National Climate Change Response Policy White Paper (2011) • National Waste Management Strategy (2011) • Municipal Solid Waste Tariff Strategy (2012) • The National Organic Waste Composting Strategy (2013) • South Africa's Intended Nationally Determined Contribution (INDC) (2016) • A National Climate Change Monitoring and Evaluation system of the AFOLU Sector (2015) • South African National Terrestrial Carbon Sink Assessment (2015) • National Framework for Air Quality Management in South Africa • Air Quality Offset Guidelines (2016) • National Pollution Prevention Plans Regulations (2016) • National Greenhouse Gas Emission Reporting Regulations (2017) • Assessment of the Potential to Produce Biochar and its Application to South African Soils as a Mitigation Measure (2015) • Development of Potential Verification Standards and Methodologies for Carbon Offset Projects in the AFOLU sector in South Africa (2015) • Declaration of Greenhouse Gases as Priority Air Pollutants (2016) • National Pricing Strategy for Waste Management (2016) • Towards the development of a GHG emissions baseline for the Agriculture, Forestry and Other Land Use (AFOLU) sector in South Africa (2016) • Improvement of the Greenhouse Gas Emissions Inventory for the Agricultural Sector (2016) • Green Fund • Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry (2017) • Unlocking Barriers and Opportunities for Land Use for Land Use Based Climate Change Mitigation (2017)

Institution	Sectoral programmes, plans and strategies
	• Draft Alternative Greenhouse Gas Emission Pathways for South Africa (2018) • Draft Climate Change Bill (2018) • Policies and Measures (2018) • South Africa's Greenhouse Gas Inventory 2000-2015 (2018) • Expanded Public Works Programme • Draft Low Emissions Development Strategies (2019) • Environmental Implementation Management Plan (EIMP) for 2015-2020 • Climate Change Adaptation Plans for South African Biomes (2015) • Revised National Biodiversity Strategy and Action Plans and the Strategic Framework and Overarching Implementation Plan for Ecosystem-Based Adaptation (EbA) in South Africa (2015) • Strategic Plan for Measurement, Reporting and Verification: AFOLU Sector 2016 to 2020 • EIA Guidelines for Renewable Energy Projects (2015) • Update of 2014 Mitigation Potential Analysis for South Africa • Biodiversity Sector Climate Change Response Strategy (2014) • Southern Ocean Carbon – Climate Observatory (SOCCO) • Draft South Africa's National Adaptation Strategy (2016) • Long-Term Adaptation Scenarios (2013) • Green Economy Model (2013)
Department of Health; Human Sciences	• National Climate Change Health and Adaptation Plan 2014–2019 (NCCHAP)
Research Council (HSRC)	• Department of Health Environmental Management Plan (2016)
Department of Rural Development and Land Reform (DRDLR)	• DRDLR Strategic Plan for 2015-2020 • Climate Change Adaptation Sector Strategy for Rural Human Settlements (2013) • Spatial Planning and Land Use Management Act (Act No. 16 of 2013) (2013) • Regulations in terms of the Spatial Planning and Land Use Management Act, 16 of 2013 (2015) • Adaptation Plan
Department of Science and Technology (DST); Council for Scientific and Industrial Research (CSIR); National Research Foundation (NRF).	• Global Change Grand Challenge (GCGC) National Research Plan • 10-Year Innovation Plan under the Global Change Research Plan (GCRP) • South African Risk and Vulnerability Atlas (2010) • Climate Change Vulnerability Analysis (2014/15) • Updating the 2007 Technology Needs Assessment (for completion by 2019)
Department of Water and Sanitation (DWS); Water Research Commission (WRC)	• National Water Resource Strategy, Second edition (2013) • Climate Change Response Strategy for Water Resources in South Africa (2014) • National Water Act, 1998 (No.36 of 1998) • National Sanitation Policy (2016) • Water Conservation and Demand Management National Strategy Framework (1999) • White Paper on Basic Household Sanitation (2001) • National Water Policy Review (2015)
Ministry of Cooperative Governance & Traditional Affairs (COGTA)	• Disaster Management Amendment Act 2015 (Act no 16 of 2015)

Institution	Sectoral programmes, plans and strategies
Department of Transport (DoT)	• Draft Roads Policy 92018) • Draft Revised White Paper on National Transport Policy (2018) • Department of Transport Revised Strategic Plan for the fiscal years 2015/16 – 2019/20 (2017) • National Transport Master Plan 2050; • Minimum Requirements for the Preparation of Integrated Transport Plans (2016); • Roads Policy for South Africa, draft Green paper (2016); • Draft Green Transport Strategy 2016-2021 (2016) • National Land Transport Strategic Framework (2015); • PRASA National Strategic Plan (2012); • Non-Motorised Transport Policy (2012); • Transnet Long-term Planning Framework (2012); • Road Freight Strategy for South Africa (2011); • Transport Action Plan (2010); • Public Transport Strategy (2007); • National Ports Act, 2005 (Act 12 of 2005) • National Roads Act,1972 (Act 54 of 1971) • Road Transportation Act, 1977 (Act 74 of 1977) • Urban Transport Act, 1977 (Act 78 of 1977) • Road Traffic Act, 1989 (Act 29 of 1989) • National Road Traffic Act, 1996 (Act 93 of 1996) • National Land Transport Act, 2009 (Act 05 of 2009) • Civil Aviation Act, 2009 (Act 13 of 2009) • Marine Pollution (Prevention of Pollution from Ships), 1986 (Act 2 of 1986)
Department of Trade and Industry (DTI)	• Industrial Policy Action Plan (IPAP) 2012/13 – 2014/15; • DTI Environmental Implementation Plan for 2015-2020 4th Ed. (2017) • National Industrial Policy Framework (NIPF) (2007); • Industry Incentive Schemes • Vehicle Emissions Fuel Economy and CO_2 Emissions Labelling Scheme in terms of the Standards Act 1993. • National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977)

1.3. Population

South Africa's population was estimated to be about 55.9 million in 2016 (Stats SA, 2017a). Migration from rural to urban areas remains an important demographic process in shaping the age structure and distribution of the provincial population. Between the period of 2011–2016 it is estimated that approximately 247 437 people have migrated from the Eastern Cape whilst Limpopo is estimated to experience an out-migration of nearly 305 030 people. During the same period, Gauteng and Western Cape are estimated to experience an inflow of migrants of approximately 1 216 258 and 363 114 respectively, due to people seeking better opportunities in urban areas (see also StatsSA, 2017a; Turok, 2012). Nonetheless, climate change impacts continue to exert pressure on urban governance and service delivery as the increasing urban population requires more services in the midst of climate change effects.

Table 1.3: Provincial distribution of the total population by 2016 (Stats SA, 2017a)

Province	Population Estimate	Percentage of total population (%)
Eastern Cape	7 061 700	12.6
Free State	2 861 600	5.1
Gauteng	13 498 200	24.1
KwaZulu-Natal	11 079 700	19.8
Limpopo	5 803 900	10.4
Mpumalanga	4 328 300	7.7
Northern Cape	1 191 700	2.1
North West	3 790 600	6.8
Western Cape	6 293 200	11.3
Total	55 908 900	100,0

Table 1.4 provides further details of other relevant population indicators which have an effect on the country's vulnerability to climate change. As South Africa's population continues to increase, there is a strong likelihood of rising carbon footprints and increase in emissions. This also implies that the demands for services such as energy, transport, water, health, etc. will increase and consequently exert pressure on the economy.

Table 1.4: Population indicators for South Africa (StatsSA, 2017a)

Population Indicators	Value
Growth rate	1.62% (2015 – 2016), increased from 1.22% (2002 – 2003)
Population aged younger than 15 years	30.1%
Population aged 60 years or older	8.0%
Life expectancy at birth	59.7 years for males 65.1 years for females
Infant mortality rate	33.7 per 1000 live births
HIV prevalence rate	12.7% of the total South African population
Total number of people living with HIV	7.03 million

South Africa's emissions per capita increased from 9.93 t CO_2e per person in 2000 to 10.8 t CO_2e per person in 2007. Emissions then declined after 2010 from 10.7 t CO_2e per person to 9.8 t CO_2e per person. This is due to South Africa's strong reliance on a coal based energy production system from the energy sector, and heavy emissions from the transport sector. The GHG emissions per capita are a function of South Africa's population growth trends and GHG emission reduction initiatives. The GHG emissions per capita are also reliant on the economic development currently underway in South Africa. Thus, South Africa's GHG emissions continue to show increasing trends and these trends are expected to continue to rise between 2020 and 2025, and hence are in alignment with the Peak-Plateau-Decline trajectory (DEA, 2011; DEA, 2017).

Figure 1.1 indicates GHG emissions per capita for the period 2000-2015, as adjusted by the recalculations in the 2012 National GHG Inventory Report.

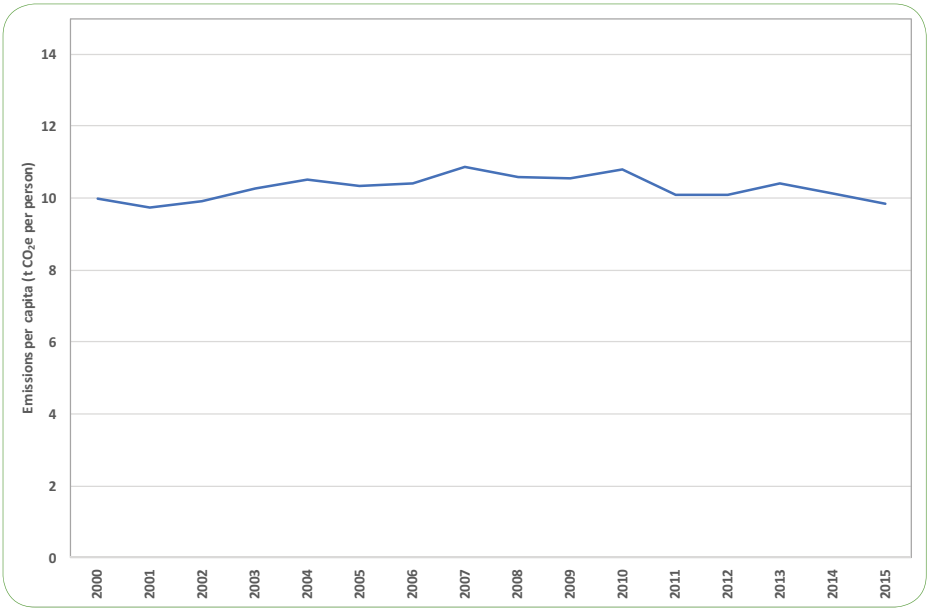

Figure 1.1: Indicates South Africa's GHG emissions per capita excluding FOLU from 2000 to 2015

The NCCRP (DEA, 2011) identifies water, health and human settlements as priority sectors that are negatively affected by climate change. The agricultural sector has since been identified as a priority sector due to the many threats presented by climate change to food security in the country. In addition, between 2015 and 2016, South Africa experienced a severe drought that resulted in many crop losses and livestock deaths, thus posing a threat to food security for many small holder farmers and rural populations. Climate change is expected to increase droughts and high temperatures as well as rainfall variability (DEA, 2016). This would affect food systems which could lead to food insecurity, hunger and malnutrition. Vulnerability to drought conditions still persist in cities like Cape Town, where the water sector is stressed as there is insufficient water for domestic uses due to poor rainfall and lowering dam levels (DST, 2010; DEA, 2016).

According to DST (2010), high population regions are mostly vulnerable to climate change effects. High population regions present many challenges that require governments to adopt responsive measures and implement disaster risk reduction and create an enabling environment for climate resilience to take place. In areas with high population growth, particularly in provinces such as Gauteng, KwaZulu-Natal and Western Cape, there tends to be high unemployment rates and rising urban poverty rates. Hence, climate change is expected to exacerbate these conditions and further intensify the competition for basic resources such as water, healthcare,

sanitation and electricity. Such challenges will result in reduced water quality, sanitation challenges and pose a threat to food security (DST, 2010).

1.4. Economy

South Africa is one of the largest growing economies in Africa. In 2016, the growth rate reached 0.7% as a result of a decrease in mining and manufacturing production. The growth rate, however, indicated a decline from the previous year due climate related issues. The agricultural sector was severely impacted by the drought conditions that resulted in reduced crop yields (StatsSA, 2015). In addition, the GDP of South Africa increased by 0.7% in the fourth quarter of 2016. **Table 1.5** details the features of the South African economy.

Table 1.5: Features of the South African economy (StatsSA, 2017b; SARS, 2015)

Feature	Detail
Gross Domestic Product(GDP)	USD 1, 1 trillion (fourth quarter 2016) (StatsSA, 2017b)
GDP Growth	0.7% (fourth quarter, 2016)
Per Capita GDP	USD 7 504,30 in 2016
GDP by sector	• Agriculture, forestry and fishing industry: Mining and quarrying industry: 0,1% decline • Manufacturing: 3,1% • Mining 11,5% decrease (-0,9%) • Electricity, gas and water: 2.4% • Construction: 0,4% • Wholesale, retail, motor trade, catering and accommodation: 2,1% • Transport, storage and communication: 2,6% • Finance, real estate and business services: 1,6% • General government services: 1,4 • Personal services: 1,0%
Consumer Price Index (CPI) Inflation	6.8% (2016)
Population below upper-bound poverty line (R 992)	55.5% in 2015 (data up to 2015)
Unemployment	26.6%
Exports	12,5% increase
Imports	6,1% increase
Public Debt	51,7% of GDP (2016)

The percentage change in GDP year on year and quarter on quarter (GDP Q/Q) for the period 2008 to 2016 is demonstrated in **Figure 1.2** below.

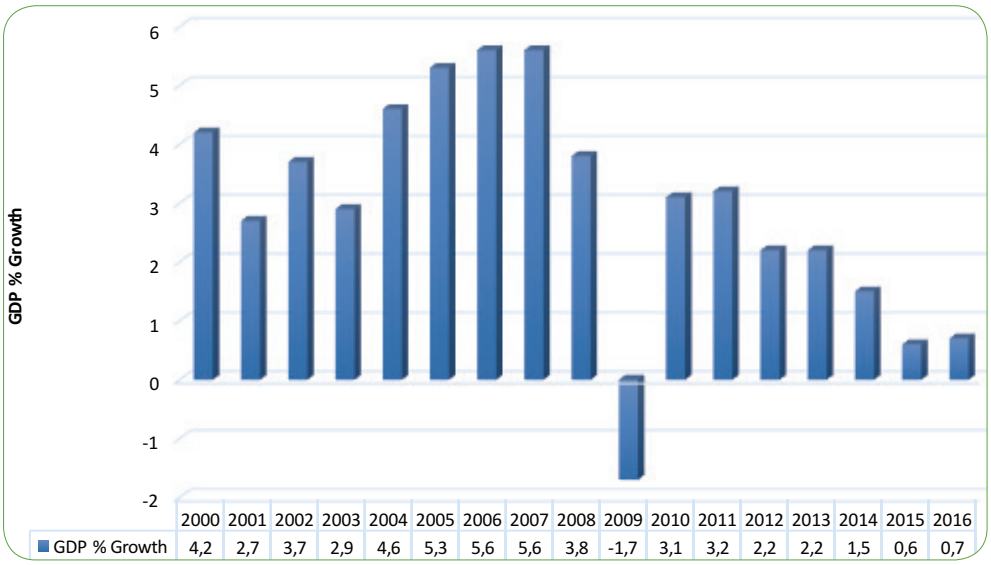

Figure 1.2: South Africa's GDP percentage change, 2000-2016 (StatsSA, 2017b)

South Africa has a well-developed mining, transport, energy, manufacturing, tourism, agriculture, commercial timber and pulp production, service sectors, and it is a net exporter of energy, food, telecommunications, and other services to neighbouring countries (DEA, 2017). However, during the last quarter of 2016, the largest negative contributor to growth in GDP was the mining and quarrying industry, which decreased by 11.5% and contributed-0.9 of a percentage point to GDP growth as shown in Figure 1.3 (Stats SA, 2017b) Secondly, the manufacturing decreased by 3.1% and contributed-0.4 of a percentage point. In terms of the agriculture industry, there was a decline of 0.1% as a result of decreasing production in horticultural products. According to Stats SA (2017), the manufacturing industry contracted by 3.1% as a result of a noticeable decrease on the food and beverages division, petroleum, chemical products, rubber and plastic products division, and the motor vehicles, parts and accessories and transport equipment division.

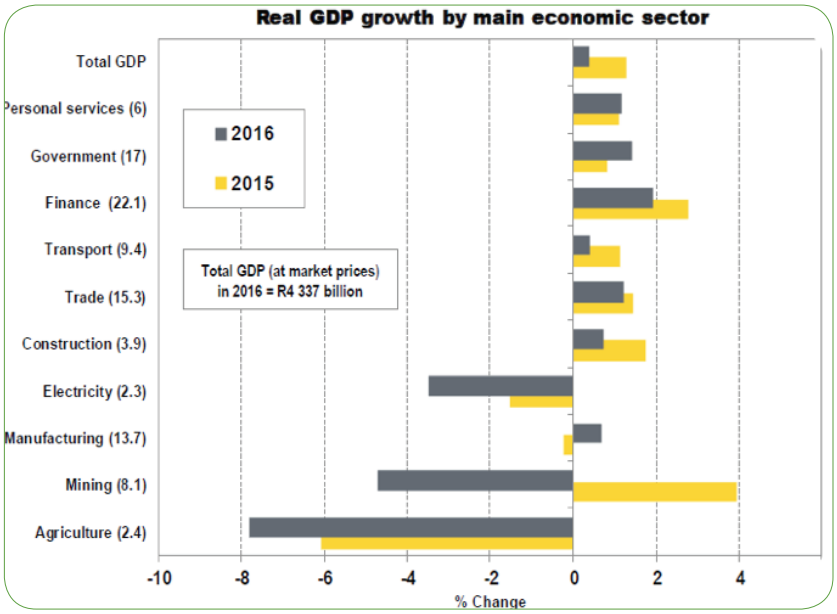

Figure 1.3: South Africa's Real GDP growth by main economic sector for 2015 and 2016 (Stats SA, 2017; IDC, 2017)

1.4.1. Trends in South Africa's HDI component indices 1990-2015

The HDI is an average measure of basic human development achievements in a country. South Africa, through its National Development Plan (NPC, 2011), identifies human development as a critical part of inclusive growth. In 2016, the HDI scale for South Africa was at 0,666. This dropped to 0.435 (a loss of 34.7 percent) when the value was reduced due to inequality. This clearly indicates that South Africa remains one of the most unequal countries in terms of resource redistribution. **Figure 1.4** captures the trends in the HDI indices from 1990s to 2015 as noted in the findings of the UNDP (2015).

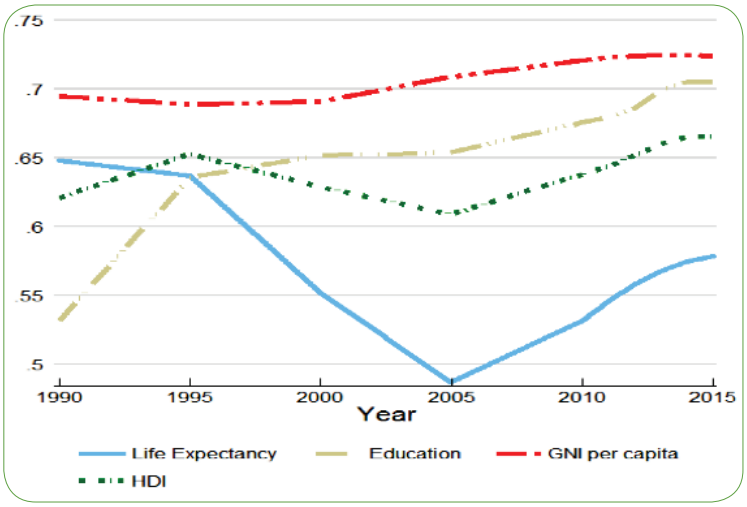

Figure 1.4. South Africa Human Development Index (UNDP, 2015)

1.5. Energy

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 level consumption rate is caused by the industries that are energy intensive and the type of coal used in the energy supply system is energy intensive. The South African manufacturing industry at present depends largely on primary extraction and relatively low-grade processing, making it a heavy user of energy. In addition, South Africa's energy intensity is high per capita GDP, but similar if adjusted for power purchasing parity and the per capita consumption of primary energy was lower. The public sector continues to invest in infrastructure, with particular focus on new construction related to electricity generation. By the end of 2016, the public-sector capital expenditure displayed an increasing trend since 2012. The capital expenditure increased from R203 billion in 2012 to R284 billion by the end of 2016 with an average rise of 8.7% per year.

Infrastructural spending also underpins some of the goals of the NDP, in particular the provision of service delivery and infrastructural development. Hence, well-maintained energy infrastructure facilitates trade, improves connectivity, attracts investment, and allows communities to access services.

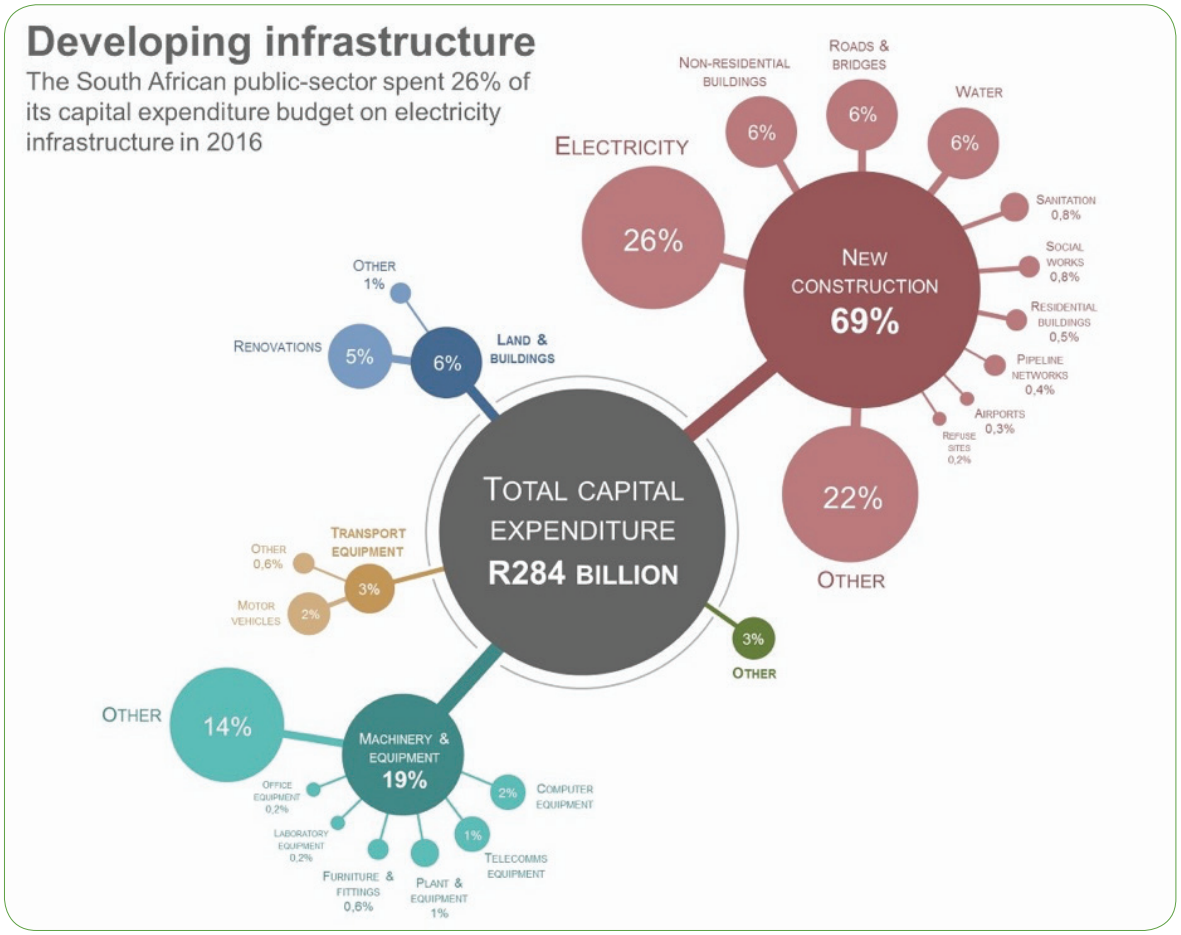

Figure 1.5: Capital expenditure budget on electricity infrastructure (Stats SA, 2017b)

Investments in electricity reached a staggering R284 Billion in 2016 (Figure 1.5), with more than a quarter of the South Africa's public-sector capital expenditure being spent on new electricity infrastructure. In addition, there was a cumulative contribution of 18% from non-residential buildings (6%), roads and bridges (6%) and water (6%) (Stata SA, 2017b). The power utility Eskom was the biggest capital spender of the 772 public-sector entities covered in the report. Eskom contributed about 25.7% (R73 billion) to total capital expenditure, focusing mainly on the continued construction of the Kusile and the Medupi power stations, and the Ingula Pumped Storage Scheme (Stats SA, 2017b).

A new draft IRP for 2018 has been published which 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 articulated on the future scale and role of nuclear energy and renewable energy technologies. The updated draft plan continued to reiterate that coal will continue to play a role in providing energy in the future, but to be limited to electricity generation. Alternative and more economically viable options such as gas and crude oil exist, for the production of liquid fuels, but have severe cost implications. Coal then continues to provide base-load power in the foreseeable future, although coal will be put out of place substantially over time by improvements in solar, wind, nuclear and gas energy sources. These alternatives options reduce GHG emissions and other pollutants, of which help to improve security of supply and in most cases, lower the cost of providing energy when externality costs are accounted for (Stats SA, 2017b; DEA, 2017). The reviewing of coal purchase contracts is underway in order to achieve optimal balance between price, quality and flexibility (DoE, 2016).

1.6. Climate

A comprehensive overview of South Africa's prevailing climatic conditions was presented in BUR-1. BUR-2 reported on the adverse climate change impacts and natural disasters experienced since 2014, and this BUR-3 report provides an updated account of the climate change impacts subsequent to this. The common natural disasters in South Africa include; drought, flooding, erratic rainfall patterns, extreme storms and fires. Between 2015 and 2016, South Africa experienced one of the major droughts to be recorded in history (DEA, 2016). Some of the economic losses that were incurred include livestock deaths and reduced crop production. The drought resulted in escalating food prices and food insecurity for many citizens, particularly those living in low-income communities and vulnerable households. The National Disaster Management Centre (NMDC) Annual Report for 2016/17 (NDMC, 2017) focused quite extensively on drought.

According to the NDMC (2017), the agricultural sector was severely impacted by drought, thus having a negative effect on the food processing sector and on food prices. The report further reiterates that government's response to the drought entailed short-, medium- and long-term planning measures. These included creating an enabling environment for farmers to have access to interest-free loans, access to fodder, refurbishing and drilling of boreholes and the provision of water tanks. The government also imposed water restrictions on commercial operations, farmers and residential customers.

Some of the climate change impacts between 2014 and 2016 include the following:

Hydrological impacts:

- Decreasing average national dam storage accelerated during 2015, leading to a value of only 53% of storage nationally by mid-2016.
- Groundwater levels for the period 30 December 2014 to 30 December 2016 decreased in Limpopo, Northwest, Northern KZN, Northern Cape and parts of the Western Cape provinces due to increased abstractions during the drought period.

Drought impacts:

- Agricultural losses have been significant during this period of drought. Several reports of thousands of cattle deaths in the drier parts of the Lowveld have been observed.
- Loss of large game (hippo and buffalo) in reserves such as the Kruger National Park which generate tourist revenue for the country and critical biodiversity has also been impacted.
- The conditions impacted negatively on the availability of water for human and livestock consumption, with some water resources declining and others drying up.
- Grazing veld and pasture land also diminished, particularly in communal areas.
- Crop farmers were also affected, particularly with the increased temperatures and heatwaves experienced in some parts of the country.
- A drought awareness campaign was conducted in partnership with the KwaZulu-Natal Provincial Disaster Management Centre at uMkhanyakude Local Municipality, one of the localities hardest hit by the drought in the province. This initiative supported the drought mitigation efforts taken by the NDMC and other stakeholders.

Hailstorms:

- Other parts of the country also experienced severe weather, such as the hailstorm in the City of Ekurhuleni, Gauteng, which resulted in severe infrastructure damage in the education and human settlements sectors.
- Damage in the City of Ekurhuleni, in areas such as Etwatwa, Vosloorus, Katlehong, Thokoza and Palm Ridge/ Eden Park affected education and human settlements infrastructure.
- An amount of R35 588 000 was approved and made available to the province from the Provincial Disaster Grant for the repair of damages to schools and houses (NDMC, 2016).

1.7. National and Regional Priorities and Circumstance Related to Climate Change

South Africa continues to make a significant transition towards becoming a climate resilient and low carbon economy. This is evident in the increased mitigation and adaptation efforts and commitment towards implementing the recommendations of the Paris agreement and other recent related policies. Climate change continues to negatively impact the South African economy directly and indirectly thus posing a threat to people's livelihoods. In 2017, Statistics South Africa reported that more than 53% of South African citizens were unable to afford to buy bread for their families. This indicated a high level of vulnerability and the extent to which people's livelihoods were threatened.

South Africa still remains one of the most unequal economies in the world, with a large uneven distribution of wealth, persistent unemployment and a large group of people dependant on subsistence agriculture for food security. Climate change exacerbates the conditions of poverty and food insecurity for many South Africans residing in rural communities and those classified as the urban poor, residing in informal human settlements. However, in the midst of it all, South Africa continues to contribute towards the identification of opportunities for further climate change actions and management of current and future climate risks. This is observed through the consolidated gains the country has attained in enhancing people's ability to cope with climate change effects, conservation of biodiversity and improving livelihoods and well-being.

South Africa's climate change response actions are guided by section 24 of the Constitution of the Republic of South Africa, NDP and the NCCRP (DEA, 2011). The NDP provides a '2030 vision' to guide the country to transition in sustainable development pathway. Therefore, there is a need to address emerging climate change concerns along the way. For example, a recent study by the United Nations Children's Fund (UNICEF, 2017) in South Africa has highlighted on the direct and indirect impacts of climate change on children's health, education, nutrition, safety and access to adequate

housing and sanitation. It becomes evident through this study that response measures need to be in place in order to prioritize programmes and projects that address climate change. Climate projections are revealing a warming climate trend for South Africa and more incidents of flooding and drought will be exacerbated.

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2. NATIONAL GHG INVENTORY

2.1. Introduction

This chapter presents a summary of the national GHG inventory for South Africa for the period of 2000 to 2015. The full national inventory was subjected to an independent review process and data was finalized and incorporated into this report. As with the previous inventory of 2012, this inventory was compiled in accordance with the IPCC 2006 Guidelines for National GHG Inventories and covers all four sectors, namely:

- Energy;
- Industrial Process and Product use (IPPU);
- Agriculture, Forestry and Other Land Use (AFOLU); and
- 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_20), hyrdofluorocarbons (HFCs), and perfluorocarbons (PFCs). Sulfur hexafluoride (SF_6) emissions are not reported due to a lack of data. An analysis of key trends is presented, including per capita and GDP emissions. The trends per sector are also presented, highlighting the methods, data and quality control 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 BUR-1 and BUR-2

The inventory presented in the BUR-2 documented the advancements that the country has made in terms of the compilation, quality control processes and reporting of GHG emissions. In particular it is important to note that South Africa started reporting its GHG emissions in 1997, with vast gains made since then in terms of the documentation of and replication of inventories. Specifically, advancements made in the systems used to collect data and document the methodologies allow for the inventories to be easily updated by building on the data collection sheets and thus allow for improving on the analysis of data.

One of the most important improvements in the inventory since the BUR-2 is the development of the National GHG Inventory Management System (NGHGIS). Through this system SA aims to manage and simplify its reporting requirements to the UNFCCC. The system has been designed to ensure transparency, consistency, comparability, completeness and accuracy (TCCCA) of inventories as defined in the guidelines for preparation of inventories. It will ensure the quality of the inventory through planning, preparation and management of inventory activities in accordance with Article 5 of the Kyoto Protocol. The following processes are included and documented in detail in the national system:

Institutional arrangements

- collection of activity data
- methodologies used to develop country specific emission factors
- methodologies on estimation of GHG emissions by sources and removals by sinks
- quality assurance and quality control procedures
- planned improvements verification at national level

The national inventory systems comprises both the inventory report itself and all the documentation for the inventory which describe how the inventory was prepared. It therefore also serves as an archiving system for the National GHG Inventory.

2.3. Institutional context

South Africa uses a hybrid (centralised/distributed) approach in terms of the programme management for the GHG inventory. 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 DEA) in a centralised manner. The DEA is currently responsible for collecting activity data for the compilation of Energy, IPPU and Waste sector inventories, including quality control. The AFOLU sector inventory is compiled by external consultants (Gondwana Environmental Solutions (GES)) who have been appointed formally through a contract.

2.4. GHG emissions inventory (2000-2015)

2.4.1. Summary of 2015 national inventory

The national GHG inventory includes estimates from the four IPCC sectors, Energy; IPPU; AFOLU and Waste. The latest GHG emissions inventory covers the period of 2000 to 2015 and includes CO_2, CH_4, N_2O, HCFs and PFCs. Due to a lack of data, indirect GHG emissions have not been estimated, only NO_x and CO emissions from biomass burning are included.

Emissions are to be reported using the IPCC 1996 Guideline table format, however since SA 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 Guideline reporting formats, and in order to be transparent about the relationship between the IPCC 1996 and 2006 categories is shown in **Table 2.1.**

It is important to note that in previous inventories the GWP from the *IPCC Third Assessment Report* (TAR) (IPCC, 2001) were applied, while in this inventory for 2015 the *IPCC Second Assessment Report* (SAR) (IPCC, 1996) GWP were used.

Table 2.1. Relationship between the IPCC 1996 and 2006 Guideline categories

IPCC 1996 Categories	IPCC 2006 categories
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

IPCC 1996 Categories	IPCC 2006 categories
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; 5.B - Forest and grassland conversion; 5.C - Abandonment of management soils; 5.D - CO_2 emissions and removals from soil; 5.E - Other	3.B.1- Forest land
	3.B.2- Cropland
	3.B.3- Grassland
	3.B.4- Wetlands
	3.B.5- Settlements
	3.B.6- Other Land
	3.C - Aggregate sources and non-CO_2 emissions sources on land
4.E - Prescribed burning of savannas; 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)

IPCC 1996 Categories	IPCC 2006 categories
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 NO_x and NH_3
	5.B – Other
	Memo items
	International bunkers
	International aviation
	International water-borne transport
	Multilateral operations

Emissions of CO_2, CH_4 and N_2O and GHG pre-cursors are provided in **Table 2.2** and F gas emission estimates are provided in **Table 2.3**

Table 2.2: National greenhouse gas inventory (2015) of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors

IPCC 2006 category	Emissions (Gg)			Emissions (Gg)	
	Net CO_2	CH_4	N_2O	NO_x	CO
	(Gg)			(Gg)	
Total	**431 473.16**	**2 421.65**	**78.67**	**50.89**	**1 076.60**
1 - Energy	**423 181.56**	**195.75**	**8.44**		
1.A - Fuel Combustion Activities	**397 861.48**	**22.47**	**8.44**	NE	NE
1.A.1 - Energy Industries	258 696.23	2.95	3.95	NE	NE
1.A.2 - Manufacturing Industries and Construction	36 704.14	0.47	0.50	NE	NE
1.A.3 - Transport	53 034.12	14.61	2.53	NE	NE
1.A.4 - Other Sectors	48 253.83	4.39	1.44	NE	NE
1.A.5 - Non-Specified	1 173.16	0.05	0.01	NE	NE
1.B - Fugitive emissions from fuels	**25 320.09**	**173.29**	NE	NE	NE
1.B.1 - Solid Fuels	20.79	75.57	NE	NE	NE
1.B.2 - Oil and Natural Gas	641.83	NE	NE	NE	NE
1.B.3 - Other emissions from Energy Production	24 657.47	97.72	NE	NE	NE
1.C - Carbon dioxide Transport and Storage	NE			NE	NE
1.C.1 - Transport of CO_2	NE			NE	NE
1.C.2 - Injection and Storage	NE			NE	NE
1.C.3 - Other	NA			NE	NE
2 - Industrial Processes and Product Use	**35 777.59**	**4.34**	**1.11**		
2.A - Mineral Industry	6 178.52	NE		NE	NE
2.B - Chemical Industry	569.00	4.15	1.11	NE	NE
2.C - Metal Industry	28 756.28	0.19	NE	NE	NE
2.D - Non-Energy Products from Fuels and Solvent Use	273.79	NE	NE	NE	NE
2.E - Electronics Industry	NE		NE	NE	NE
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE			NE	NE
2.G - Other Product Manufacture and Use			NE	NE	NE
2.H - Other	NA	NA	NA	NE	NE
3 - Agriculture, Forestry, and Other Land Use	**-27 522.43**	**1 332.59**	**66.44**	**50.89**	**1 076.60**
3.A - Livestock		**1 264.15**	**3.68**		
3.A.1 - Enteric Fermentation		1 232.41			

IPCC 2006 category	Emissions (Gg)			Emissions (Gg)	
	Net CO_2	CH_4	N_2O	NO_x	CO
	(Gg)			(Gg)	
3.A.2 - Manure Management		31.74	3.68		
3.B - Land	**-27 811.07**	**30.24**	**NE**		
3.B.1 - Forest land	-33 315.04	NE	NE		
3.B.2 - Cropland	3 591.10	NE	NE		
3.B.3 - Grassland	-3 362.86	NE	NE		
3.B.4 - Wetlands	0.00	30.24	NE		
3.B.5 - Settlements	2 904.96	NE	NE		
3.B.6 - Other Land	2 370.78	NE	NE		
3.C - Aggregate sources and non-CO_2 emissions sources on land	**948.74**	**38.20**	**62.76**	**50.89**	**1 076.60**
3.C.1 - Emissions from biomass burning	IE	38.20	2.49	50.89	1 076.60
3.C.2 - Liming	462.64				
3.C.3 - Urea application	486.10				
3.C.4 - Direct N_2O Emissions from managed soils			51.03		
3.C.5 - Indirect N_2O Emissions from managed soils			7.19		
3.C.6 - Indirect N_2O Emissions from manure management			2.05		
3.C.7 - Rice cultivations		NO	NO		
3.C.8 - Other (please specify)	NO	NO	NO		
3.D - Other	**-660.10**	NA	NA		
3.D.1 - Harvested Wood Products	-660.10				
3.D.2 - Other (please specify)	NO	NO	NO		
4 - Waste	**36.44**	**888.97**	**2.67**		
4.A - Solid Waste Disposal		750.30	NE		
4.B - Biological Treatment of Solid Waste		NE	NE		
4.C - Incineration and Open Burning of Waste	36.44	11.15	0.26		
4.D - Wastewater Treatment and Discharge		127.52	2.41		
4.E - Other	NO	NO	NO		
5 - Other					
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NO_x and NH_3			NE	NE	NE
5.B - Other			NO	NO	NO
Memo items					
International bunkers	**11 491.12**	**0.87**	**0.30**	NA	NA
International aviation	2 295.59	0.10	0.02	NA	NA
International water-borne transport	9 195.53	0.78	0.28	NA	NA
Multilateral operations	NA	NA	NA	NA	NA

Shaded cells do not require entries
NE: Not estimated
NO: Not occurring

Table 2.3: National greenhouse gas inventory of anthropogenic emissions of HFCs and PFCs

IPCC 2006 category	Emissions CO_2 Equivalents (Gg)	
	HFCs	PFCs
	CO_2 equivalents (Gg)	
Total	**3 482.12**	**2 186.11**
1 - Energy		
1.A - Fuel Combustion Activities		
1.A.1 - Energy Industries		
1.A.2 - Manufacturing Industries and Construction		
1.A.3 - Transport		
1.A.4 - Other Sectors		
1.A.5 - Non-Specified		
1.B - Fugitive emissions from fuels		
1.B.1 - Solid Fuels		
1.B.2 - Oil and Natural Gas		
1.B.3 - Other emissions from Energy Production		
1.C - Carbon dioxide Transport and Storage		
1.C.1 - Transport of CO_2		
1.C.2 - Injection and Storage		
1.C.3 - Other		
2 - Industrial Processes and Product Use	**3 482.12**	**2 186.11**
2.A - Mineral Industry		
2.B - Chemical Industry		
2.C - Metal Industry	NE	2 186.11
2.D - Non-Energy Products from Fuels and Solvent Use		
2.E - Electronics Industry	NE	NE
2.F - Product Uses as Substitutes for Ozone Depleting Substances	3 482.12	NE
2.G - Other Product Manufacture and Use	NE	NE
2.H - Other		
3 - Agriculture, Forestry, and Other Land Use		
3.A - Livestock		
3.A.1 - Enteric Fermentation		
3.A.2 - Manure Management		
3.B - Land		
3.B.1 - Forest land		
3.B.2 - Cropland		
3.B.3 - Grassland		
3.B.4 - Wetlands		

IPCC 2006 category	Emissions CO_2 Equivalents (Gg)	
	HFCs	PFCs
	CO_2 equivalents (Gg)	
3.B.5 - Settlements		
3.B.6 - Other Land		
3.C - Aggregate sources and non-CO_2 emissions sources on land		
3.C.1 - Emissions from biomass burning		
3.C.2 - Liming		
3.C.3 - Urea application		
3.C.4 - Direct N_2O Emissions from managed soils		
3.C.5 - Indirect N_2O Emissions from managed soils		
3.C.6 - Indirect N_2O Emissions from manure management		
3.C.7 - Rice cultivations		
3.C.8 - Other (please specify)		
3.D - Other		
3.D.1 - Harvested Wood Products		
3.D.2 - Other (please specify)		
4 - Waste		
4.A - Solid Waste Disposal		
4.B - Biological Treatment of Solid Waste		
4.C - Incineration and Open Burning of Waste		
4.D - Wastewater Treatment and Discharge		
4.E - Other	NO	NO
5 - Other		
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NO_x and NH_3		
5.B - Other		
Memo items		
International bunkers	NA	NA
International aviation	NA	NA
International water-borne transport	NA	NA
Multilateral operations	NA	NA

Shaded cells do not require entries
NE: Not estimated
NO: Not occurring

2.4.2. National trends in emissions

Gross emissions include those from Energy, IPPU, Livestock, Aggregated and non-CO_2 emissions from land, and Waste. It does not include the removals from the Land and Harvested wood products category (which is termed FOLU (Forest and Other Land Use) in the Report). Net emissions include all emissions and sinks. In other words gross emissions are the total emissions excluding FOLU, while net emissions are the overall total emissions (including FOLU).

South Africa's GHG emissions, excluding FOLU, were 439 238 Gg CO_2e in 2000 and these increased by 101 616 Gg CO_2e (or 23.1%) by 2015 (Table 2.4). Net emissions (i.e. incl. FOLU) in 2015 were estimated at 512 383 Gg CO_2e. Emissions increased slowly over the 15 year period (**Figure 2.3**) with a few small peaks in 2007, 2010 and 2013 (**Table 2.5**). Between 2000 and 2015 the average annual growth in net emissions was 1.27%, with the Energy sector being the main contributor to this increase. The 1994 GHG inventory is not shown here as South Africa has made a decision to use the year 2000 as a base year.

Table 2.4: Changes in South Africa's gross and net emissions between 2000 and 2015 by sector

Greenhouse gas source and sink sector	Emissions (Gg CO_2e)		Difference (Gg CO_2e)	Change (%)
	2000	2015	2000-2015	2000-2015
Total net emissions (incl. FOLU)	**426 214**	**512 383**	**86 169**	**20.2**
Total gross emissions (excl. FOLU)	**439 238**	**540 854**	**101 616**	**23.1**
1. ENERGY	343 790	429 907	86 117	25.0
2. IPPU	34 071	41 882	7 811	22.9
3. AFOLU (excl. FOLU)	50 539	49 531	-1 008	-2.0
3. AFOLU (incl. FOLU)	37 515	21 060	-16 455	-43.9
4. WASTE	10 838	19 533	8 695	80.2

Gross emissions increased by 1.15% (6 157 Gg CO_2e) between 2012 and 2015. The increase was due to a 0.05%, 7.5%, 2.8% and 9.3% increase in the Energy, IPPU, Agriculture and Waste sectors, respectively.

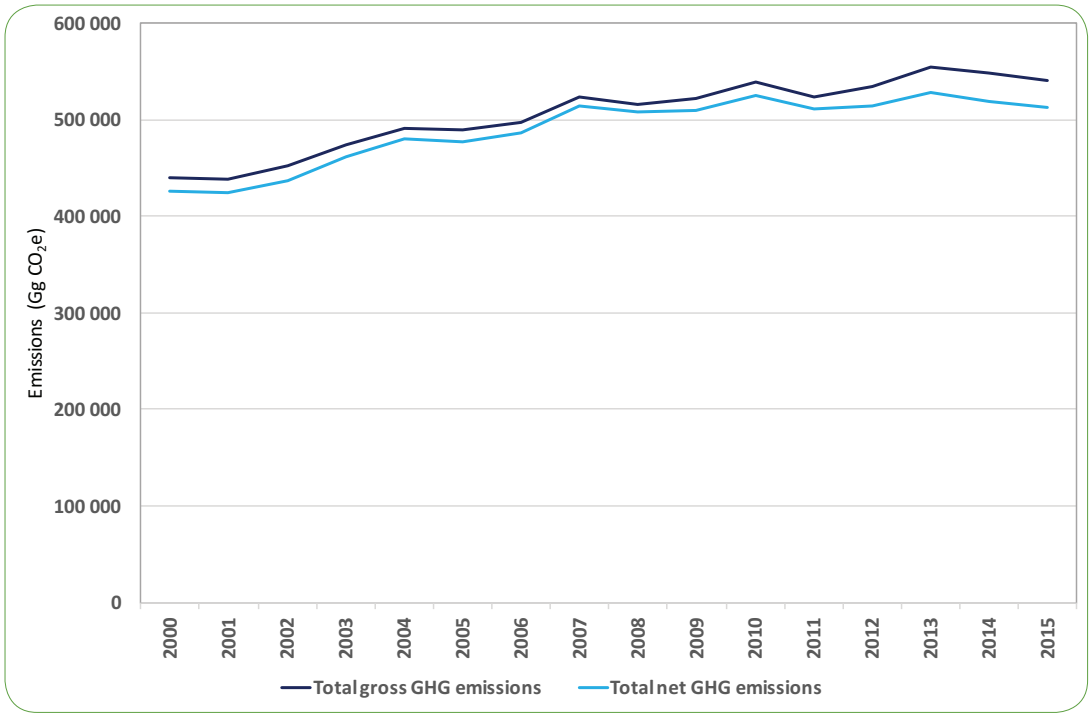

Figure 2.1: National inventory trend (gross and net) for aggregated GHG emissions, 2000 – 2015

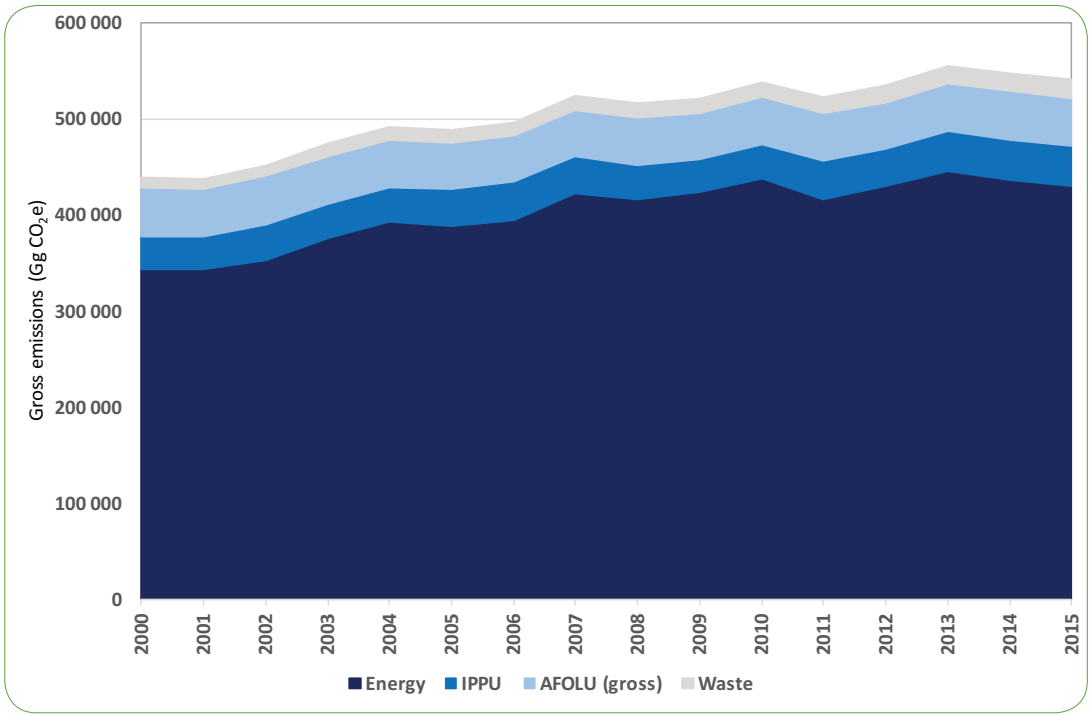

Figure 2.2: Sectoral contribution to the trend in the gross emissions for South Africa, 2000 – 2015

Table 2.5: Trends in national gross and net emissions in South Africa between 2000 – 2015.

Year	Gross total	Net total	Annual change in net emissions
	Gg CO_2e		(%)
2000	439 238	426 214	
2001	438 167	423 800	-0.57
2002	452 261	436 969	3.11
2003	473 942	460 781	5.45
2004	490 972	479 410	4.04
2005	488 656	477 797	-0.34
2006	496 908	485 909	1.70
2007	523 802	514 472	5.88
2008	516 256	508 699	-1.12
2009	521 246	510 168	0.29
2010	538 778	524 297	2.77
2011	522 861	511 377	-2.46
2012	534 697	514 520	0.61
2013	554 705	527 468	2.52
2014	547 509	518 250	-1.75
2015	540 854	512 383	-1.13

2.4.3. Emission trends by sector

Figure 2.2 and **Table 2.6** show the trend in emissions from the four sectors in South Africa between 2000 and 2015. **Figure 2.3** shows the trend in the percentage contributed by each sector.

The *Energy* sector was the largest contributor to South Africa's gross emissions in 2015, comprising 79.5% of total emissions. This was followed by the *AFOLU* sector (excl. FOLU) (9.2%), the *IPPU* sector (7.7%) and the *Waste* sector (3.6%) (Figure 2.2). The relative contribution to the total gross emissions by the four sectors over the 15 year period is shown in Figure 2.2. The contribution of the Energy sector and Waste sector increased by 1.2% and 1.1% respectively, while a decline in the contribution from the other sectors to the gross emissions is noted during this period (Figure 2.2).

Table 2.6: Sectoral contribution to the GHG emissions in South Africa between 2000 and 2015.

Year	Energy	IPPU	AFOLU (excl. FOLU)	AFOLU (incl. FOLU)	Waste
	Gg CO_2e				
2000	343 790	34 071	50 539	37 515	10 838
2001	342 382	34 057	50 226	35 858	11 502
2002	353 158	36 141	50 826	35 534	12 137
2003	376 389	35 607	49 191	36 030	12 755
2004	392 715	35 784	49 119	37 557	13 355
2005	387 459	39 118	48 140	37 280	13 940
2006	393 755	40 173	48 469	37 469	14 511
2007	422 640	38 223	47 871	38 541	15 069
2008	415 228	36 048	49 364	41 807	15 616
2009	423 148	34 352	47 596	36 518	16 150
2010	436 922	36 442	48 743	34 261	16 671
2011	416 244	40 228	49 108	37 624	17 282
2012	429 712	38 955	48 163	27 986	17 866
2013	445 189	41 349	49 780	22 543	18 387
2014	436 458	41 878	50 208	20 948	18 965
2015	429 907	41 882	49 531	21 060	19 533

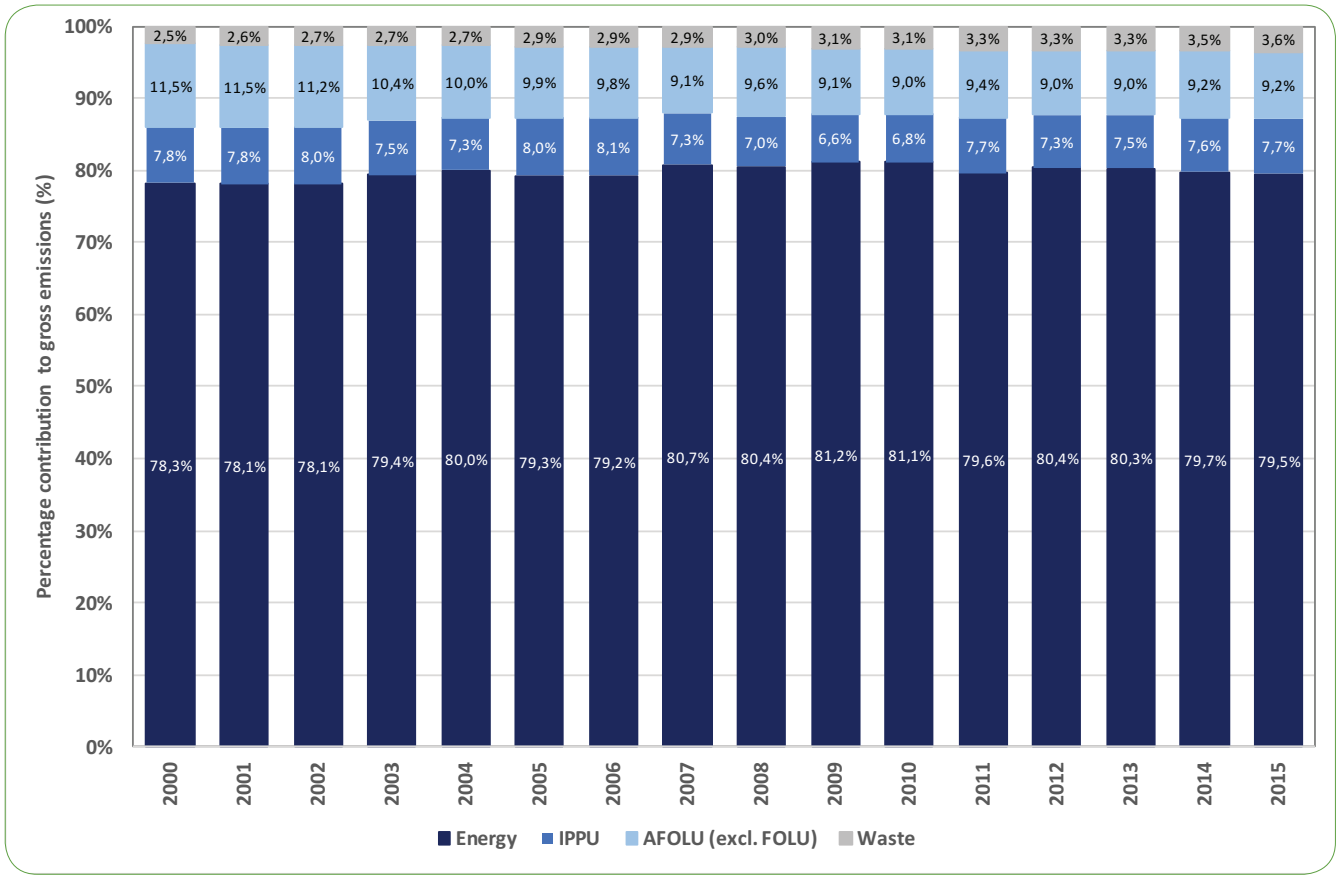

Figure 2.3: Percentage contribution of the sectors to the total gross CO_2e emissions between 2000 to 2015

Energy sector emissions increased from 343 790 Gg CO_2e in 2000 to 429 907 Gg CO_2e in 2015. The main contributor to the increased *Energy* emission is the population. Increasing population leads to increased energy consumption in the *stationary energy* category, and an increase in the *transport* category emissions due to increased number of vehicles. Since 2012 Energy emissions increased in 2013, but then declined in 2015.

The IPPU sector contributed 41 882 Gg CO_2e to the gross emissions in 2015. This is an increase since 2012 (38 955 Gg CO_2e). The contribution in this sector has varied between 6.6% (2009) and 8.1% (2006). Emissions have continued to increase since 2000 and the main drivers are the *Iron and steel industry* and *Ferroalloy production* emissions. In addition, since 2005 the HFC contribution from *Refrigeration and air conditioning* category has been steadily increasing. The increase is mostly due to improvements in methods and input data. There was a 10.4% increase in emissions from 2010 to 2011 and this was due to the incorporation of HFC emissions from foam blowing agents, fire protection and aerosols. These emissions were not in the previous inventory and have only been incorporated since 2011.

The *AFOLU* sector (gross) contributed an average of 9.9% to the gross emissions between 2000 and 2015. The contribution has declined by 2.4% since 2000. The main drivers of change in the gross emissions in this sector are declining livestock populations. The *AFOLU* sector produced 49 531 Gg CO_2e (gross) and 21 060 CO_2e (net) in 2015. The *AFOLU*

contribution to the net emissions is 4.1% in 2015, which is a 4.7% reduction in contribution since 2000. The reason for this is the *Land sink* has been increasing since 2011 and in 2015 is almost double the sink in 2000. Reduced biomass losses due to fire and increasing conversion of grasslands to forest lands are the main drivers for this increasing sink.

The *Waste* sector emissions have increased from 10 837 Gg CO_2e in 2000 to 19 533 Gg CO_2e in 2015. The *Waste* sector contribution has slowly increased from 2.5% in 2000 to 3.6% in 2015. The emissions in this sector are driven by population growth.

2.4.4. Emission trends by gas

CO_2 gas is the largest contributor (85,0% – 84.2%) to South Africa's gross (Figure 2.4) and net emissions. This is followed by CH_4 (9.4% in 2015) and then N_2O (4.5% in 2015). The contribution from CH_4 and N_2O declined between 2000 and 2015, while CO_2 and F-gases increased over the same period.

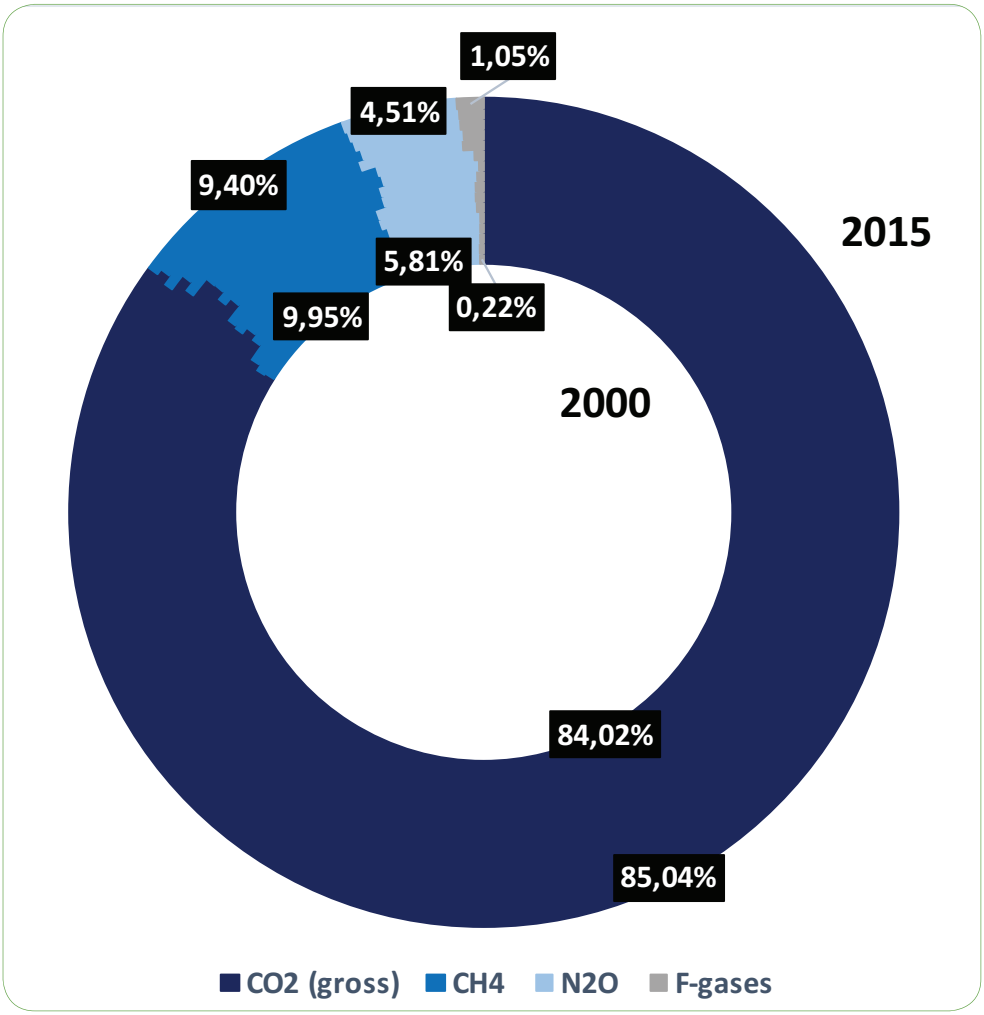

Figure 2.4: Contribution of the various gases to the total gross GHG emissions between 2000 and 2015

2.4.4.1. Carbon dioxide

Figure 2.5 presents the contribution of the main sectors to the trend in national gross CO_2 emissions (excl. FOLU). The energy sector is by far the largest contributor to CO_2 emissions in South Africa, contributing an average of 91.9% between 2000 and 2015, and 92.0% in 2015. The categories *1A1 energy industries* (59.7%), *1A3 transport* (12.8%) and *1A4 other sectors* (12.4%) were the major contributors to CO_2 emissions in 2015. The IPPU sector contributed an average of 7.9% between 2000 and 2015, while the AFOLU sector (net) contributed an average of 0.2%.

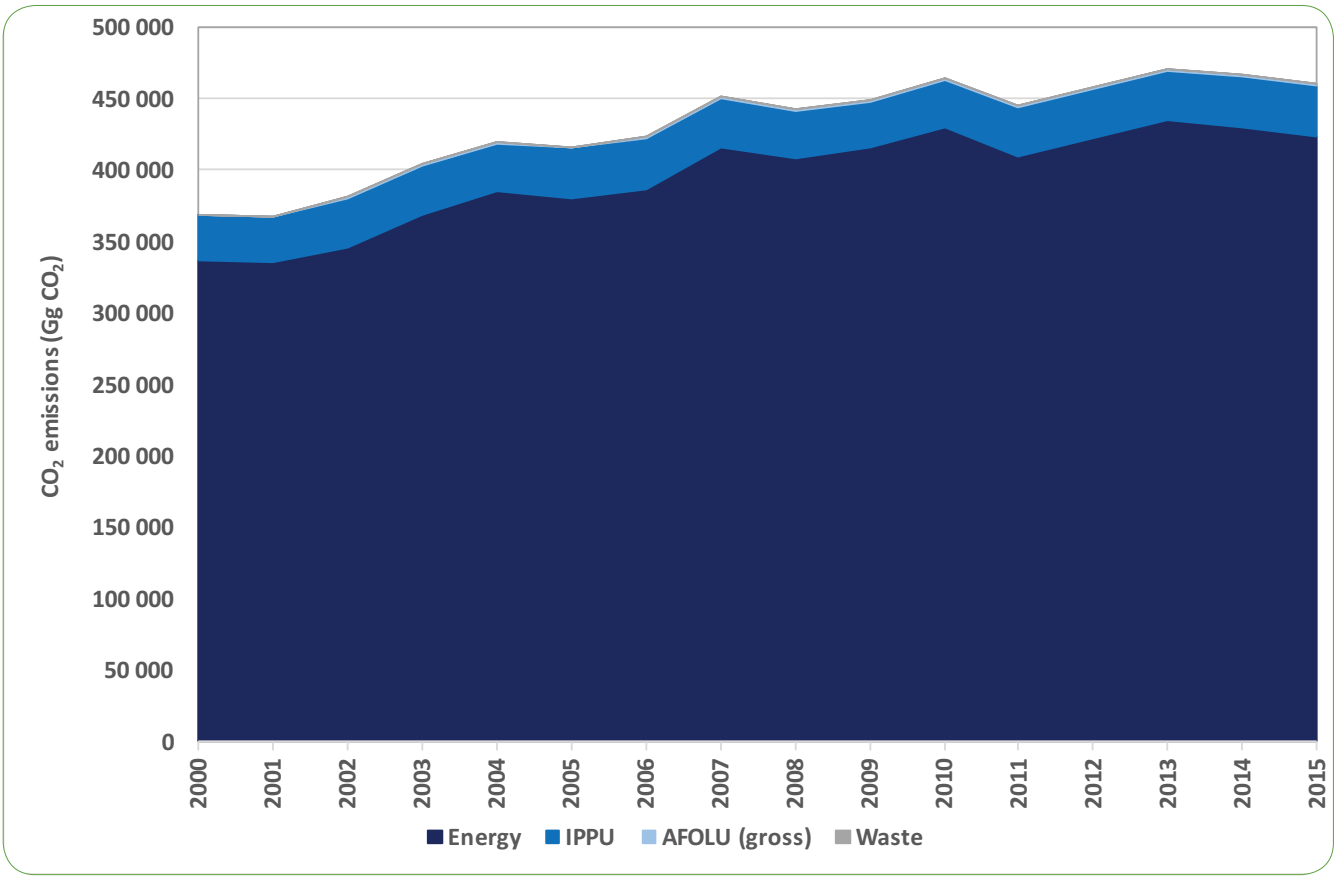

Figure 2.5: Trend and sectoral contribution to CO_2 emissions (excl. FOLU), 2000 – 2015

2.4.4.2. Methane

The sector contributions to the total CH_4 emissions (excl. FOLU) in South Africa are shown in **Figure 2.6**. National CH_4 emissions increased from 43 699 Gg CO_2e (2 081 Gg CH_4) in 2000 to 50 855 Gg CO_2e (2 425 Gg CH_4) in 2015. The AFOLU livestock category and waste sectors were the major contributors, providing 52.2% and 36.7.0%, respectively, to the total CH_4 emissions in 2015. The contribution from livestock declined by 11.7%, while the contribution from the waste sector increased by a similar amount (13.5%) over the period 2000 to 2015. There was a large increase in CH_4 emissions in 2013 from the energy sector and this is due to an increase in emissions from charcoal production.

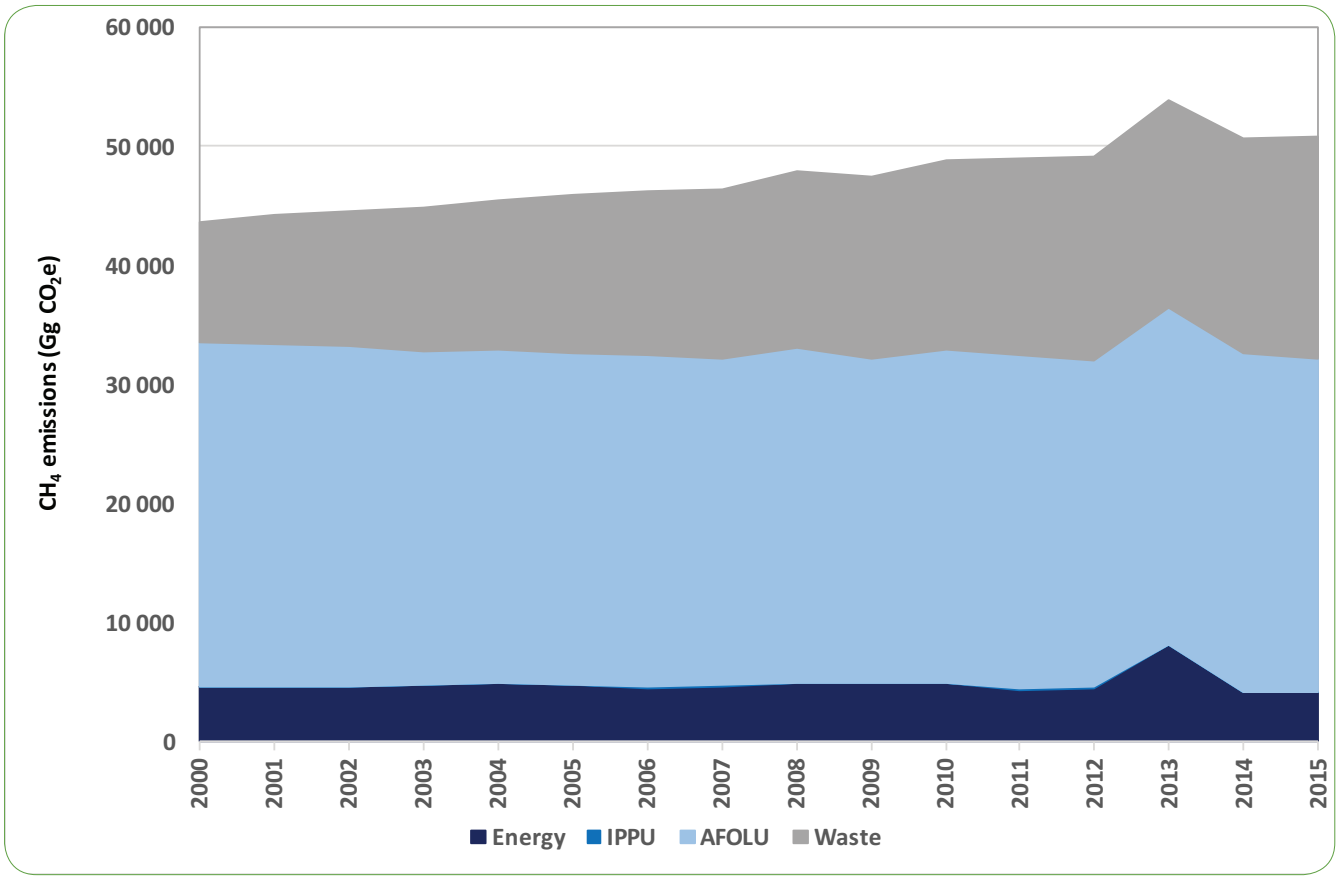

Figure 2.6: Trend and sectoral contribution to the CH_4 emissions, 2000 – 2015

2.4.4.3. Nitrous oxide

Figure 2.7 shows the contribution from the major sectors to the national N_2O emissions in South Africa. The emissions declined by 4.5% over the 2000 to 2015 period from 25 525 Gg CO_2 e (82.4 Gg N_2O) to 24 387 Gg CO_2 e (79.6 Gg N_2O). The category on aggregated and non-CO_2 sources on land (which includes emissions from managed soils and biomass burning) contributed an average of 79.8% to the total N_2O emissions over the period 2000 to 2015, while the energy sector and livestock subsector (which includes manure management) contributed an average of 10.9% and 4.4%, respectively. IPPU N_2O emissions declined from 1 645 Gg CO_2e (5.3 Gg N_2O) in 2000 to 345 Gg CO_2e (1.1 Gg N_2O) in 2015.

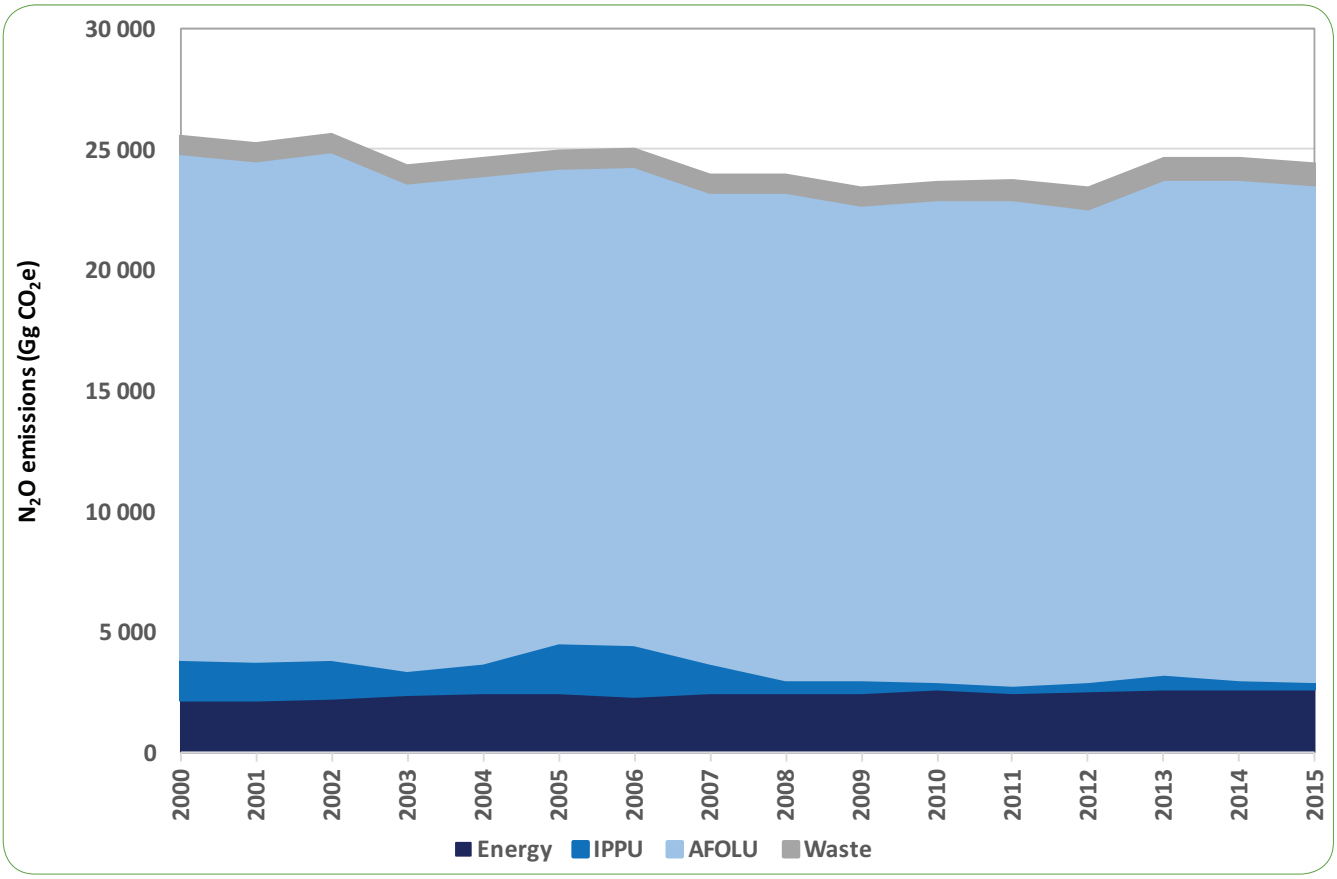

Figure 2.7: Trend and sectoral contribution to N_2O emissions, 2000 – 2015

2.4.4.4. F-gases

Hydrofluorocarbon (HFC) and perfluorocarbon (PFC) emissions were estimated for the IPPU sector in South Africa. Emission estimates vary annually between 983 Gg CO_2e (2000) and 5 668 Gg CO_2e (Figure 2.8). Emissions increase from 2012 was due to the addition of HFC emissions from air conditioning, foam blowing and aerosols.

HFCs have only been included since 2005 when emissions were 842 Gg CO_2e. Emissions have increased over the 15 year period to 3 482 Gg CO_2e in 2015. HFCs include HFC-23, HFC-32, HFC-125, HFC-134a, HFC-152a and HFC-143a.

PFC emissions (which include CF_4 and C_2F_6) were estimated at 982 Gg CO_2e in 2000. This increased to 970 Gg CO_2e in 2007, then declined to 108 Gg CO_2e in 2009 and increased again to 2 446 Gg CO_2e in 2013. There is a sharp decline in emissions from the metal industry between 2006 and 2009 and this is attributed to reduced production caused by electricity supply challenges and decreased demand following the economic crisis that occurred during 2008/2009. Increases in 2011 and 2012 were due to increased emissions from aluminium plants. The industry was used to control the electricity grid and had to switch on and off at short notice leading to inefficient operations and large emissions of C_2F_4 and CF_4.

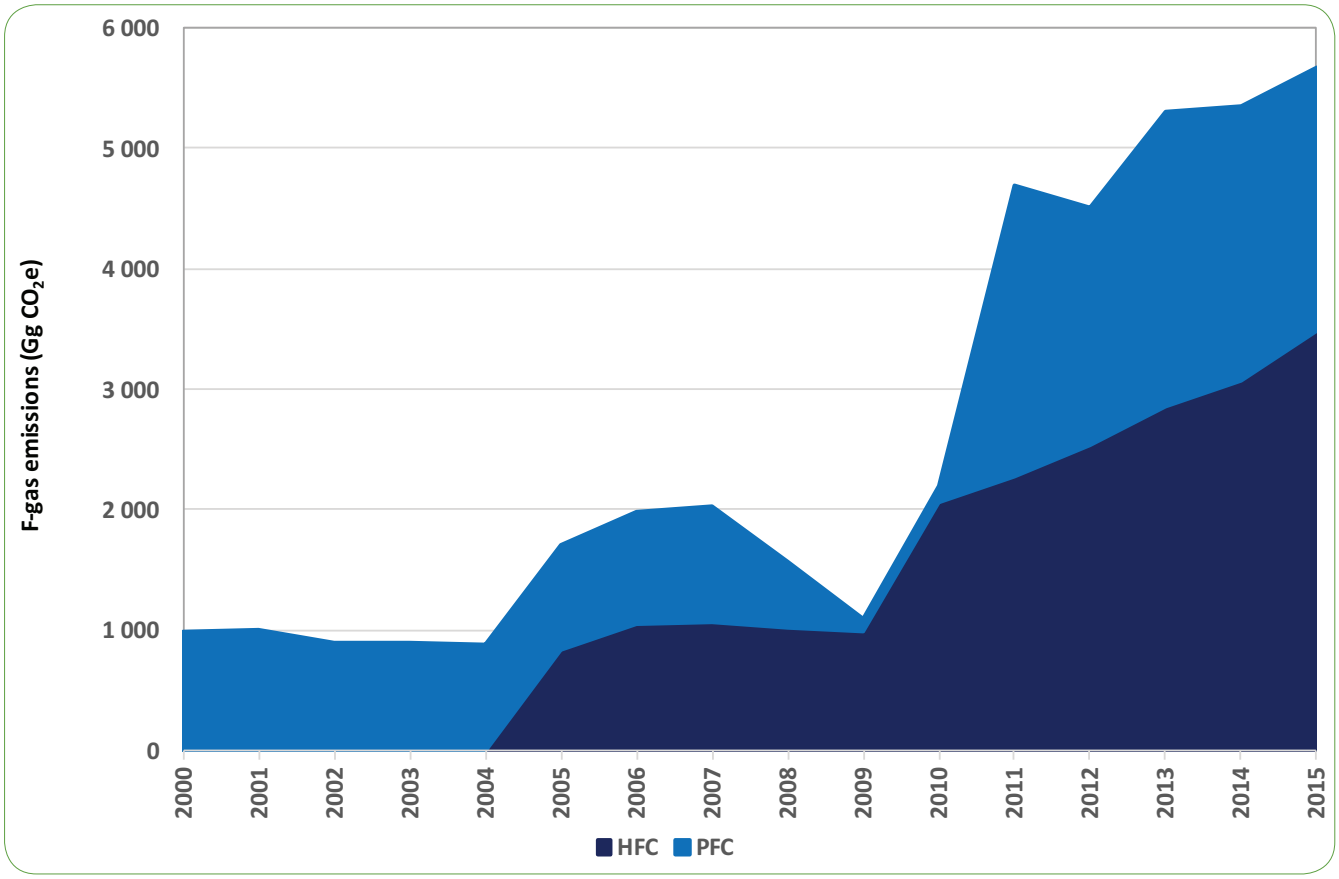

Figure 2.8: Trend in F-gas emissions, 2000 – 2015

2.4.5. Emission trends per capita

South Africa's emissions per capita increased from 9.93 t CO_2e per person in 2000 to 10.8 t CO_2e per person in 2007. Emissions then decline after 2010 from 10.7 t CO_2e per person to 9.8 t CO_2e per person (**Figure 2.9**).

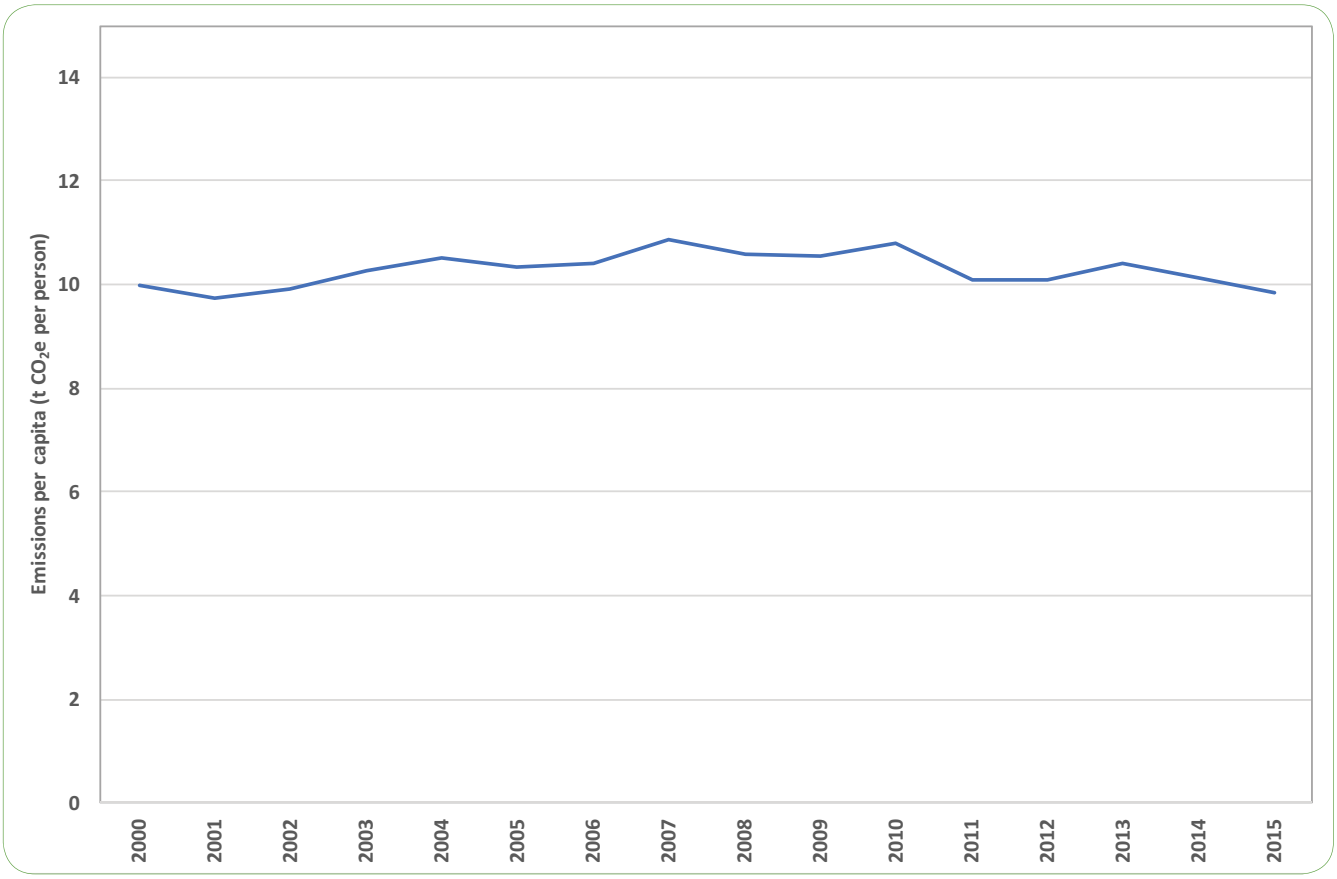

Figure 2.9: South Africa's emissions per capita (excluding FOLU), 2000 – 2015

2.5. Sectoral analysis

2.5.1. Energy

2.5.1.1. Trends

Total emissions from the energy sector for 2015 were estimated to be 429 907 Gg CO_2e, with Energy industries found to be the main contributor, accounting for 59.1% of emissions from the energy sector. This was followed by transport (12.9%) and other sectors (11.3%).

Energy sector emissions increased by 25.0% between 2000 and 2015. **Figure 2.10** shows the increasing trend in energy emissions over this period. The growth in emissions is due to the 17.8% (39 394 Gg CO_2e) increase in electricity and heat production, as well as the 44.2% increase (16 582 Gg CO_2e) in transport emissions (Table 2.7). Emissions from fuel combustion activities increased by 29.0%, while fugitive emissions from fuels declined by 12.1%.

Detailed sector emissions are provided in Annex A.

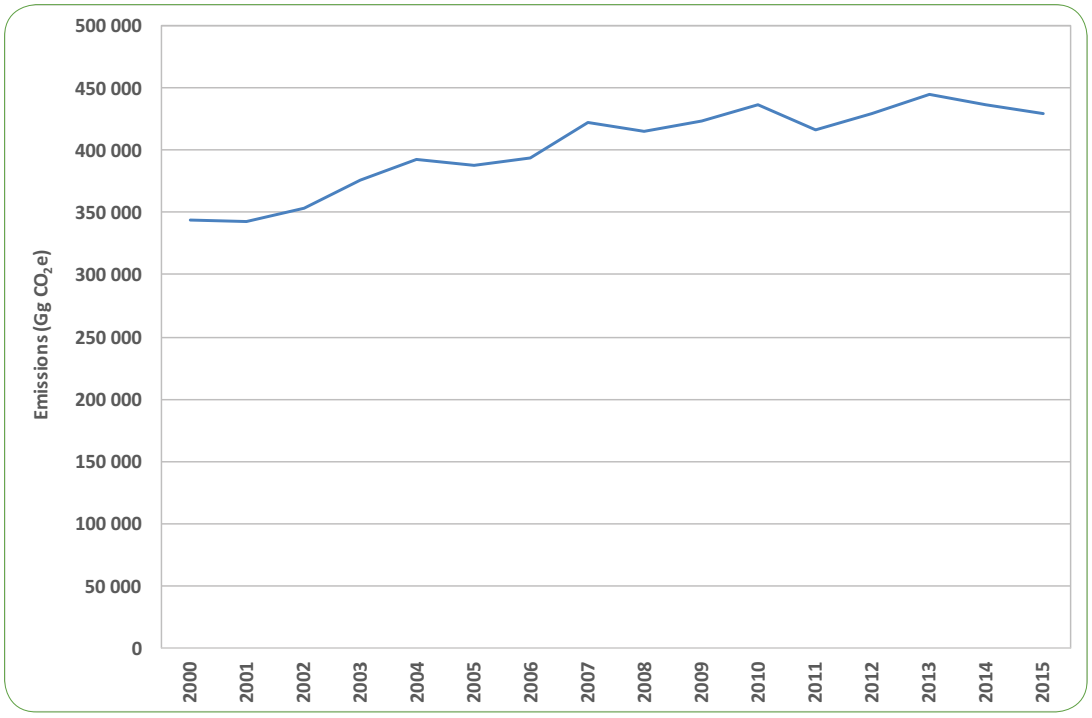

Figure 2.10: Trends in South Africa's energy sector emissions, 2000 – 2015

Table 2.7: Emission trends for the sub-categories in the energy sector, 2000 – 2015

	1A	1B	1C
	Fuel combustion activities	Fugitive emissions from fuels	Carbon dioxide transport and storage
	Gg CO_2e		
2000	310 823	32 967	NE
2001	309 199	33 184	NE
2002	319 311	33 847	NE
2003	343 401	32 988	NE
2004	358 012	34 702	NE
2005	356 658	30 800	NE
2006	363 123	30 632	NE
2007	391 538	31 101	NE
2008	385 133	30 095	NE
2009	392 659	30 489	NE
2010	406 889	30 033	NE
2011	387 312	28 932	NE
2012	399 875	29 838	NE
2013	411 396	33 793	NE
2014	407 001	29 457	NE
2015	400 948	28 959	NE

2.5.1.2. 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 2.8. Fugitive emissions from the category *Flaring* (1.B.2.a.i) were estimated using Tier 3 methods, as were *Other emissions* from *energy production* (1.B.3). The primary activity data sources are provided in **Table 2.9** with more details available in the 2015 NIR.

Table 2.8: Summary of methods and emission factors for the energy sector

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		TM	EF	TM	EF	TM	EF	
A	**Fuel combustion activities**							
1	**Energy industries**							
	a. Main activity electricity and heat production	T1, T2	DF, CS	T1	DF	T1	DF	CS CO_2 EF for sub-bituminous coal (Technical Guidelines: DEA, 2016)
	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, 2016)
3	**Transport**							
	a. Civil aviation	T1	DF	T1	DF	T1	DF	
	b. Road transportation	T1	DF	T1	DF	T1	DF	
	c. Railways	T1	DF	T1, T2	DF, CS	T1	DF	CS CH_4 EF for gas/diesel oil
	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, 2016)
	b. Residential	T1, T3	DF, CS	T1	DF	T1	DF	CS CO_2 EF for sub-bituminous coal (Technical Guidelines: DEA, 2016)
	c. Agriculture/Forestry/ Fishing/ Fish farms	T1, T4	DF, CS	T1	DF	T1	DF	CS CO_2 EF for sub-bituminous coal (Technical Guidelines: DEA, 2016)
5	**Non-specified**							
	a. Stationary	T1, T2	DF, CS	T1	DF	T1	DF	CS CO_2 EF for sub-bituminous coal (Technical Guidelines: DEA, 2016)
	b. Mobile	NE		NE		NE		

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		TM	EF	TM	EF	TM	EF	
B	**Fugitive emissions from fuels**							
1	**Solid fuels**							
	a. Coal mining and handling	T2	CS	T2	CS	NO		
	b. Uncontrolled combustion and burning coal dumps	NE		NE		NO		
	c. Solid fuel transformation	NE		NE		NO		
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
C	**Carbon dioxide transport and storage**							
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		

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

*only for sub-bituminous coal

Table 2.9: Activity and emission factor data sources for the energy sector

Sub-category	Activity data	Activity data sources
Electricity generation	Fuel consumption for public electricity generation	Eskom
	Fuel consumption for auto electricity producers	Energy balance (DoE)
	NCVs	Eskom
Petroleum refining	Fuel consumption	Energy balance (DoE)
Manufacture of solid fuels and other energy industries	No activity data, only emission data- based on Mass Balance Approach	PetroSA
		Sasol
Manufacturing industries and construction	Other kerosene, bitumen and natural gas consumption	Energy balance (DoE)
	Gas/Diesel consumption	SAPIA
	Residual fuel oil consumption	Energy digest
	LPG consumption	SAMI report (DMR)
Transport	Domestic aviation gasoline consumption	SAPIA
	Domestic aviation jet kerosene consumption	Energy balance (DOE)
	Road transport fuel consumption	Energy balance (DoE)
	Road transportation other kerosene consumption	SAPIA
	Railway fuel oil consumption	Energy balance (DoE)
	Railway gas/diesel oil consumption	SAPIA
	Water-borne navigation fuel consumption	
	International aviation Jet Kerosene consumption	Energy balance (DoE); SAPIA
Commercial/institutional	Other kerosene, gas/diesel oil, gas works gas and natural gas consumption	Energy balance (DoE)
	Sub-bituminous coal consumption	Energy digest
	Residual fuel oil consumption	SAPIA
Residential	Coal consumption	SAMI report (DMR)
	LPG consumption	SAPIA
	Sub-bituminous coal consumption	Energy digest
	Other fuel cunsumption	Energy balance (DOE)
Agriculture/forestry/fishing/fish farms	Other kerosene consumption	SAPIA
	Gas/diesel oil consumption	Energy Digest
	Other fuel consumption	Energy balance (DOE)
Stationary non-specified	Fuel consumption	SAPIA
Mining	Coal consumption	SAMI report (DMR)
Oil flaring	Emissions	PetroSA
Manufacturing of solid fuels and other industries	Emissions	Sasol; PetroSA
	Charcoal production	FAO

2.5.1.3. Reference approach

The reference approach outputs were compared to the sectoral emissions for the period 2000 to 2014 and the CO_2 emissions were always higher using the reference approach. The average difference in CO_2 emissions using the reference and sectoral approach was 11.6% and 23.0% for the years 2013 and 2014, respectively. The largest differences were seen in the solid fuels, where consumption is consistently higher with the reference approach. Allocation of solid fuels between energy use, non-energy use as well as use for synfuels production remains one of the key drivers of the differences observed between the two datasets. The liquid fuel consumption is fairly similar between the two approaches, whereas for gaseous fuels the consumption data is similar for the years 2000 to 2006 and then the difference increases after that. This could be due to the fact that the energy balance data was the main data source for the years 2000 to 2006, after which the sectoral consumption was derived from the DMR SAMI reports data.

There are a number of possible reasons for the discrepancy:

- 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.
- High distribution losses for gas will cause the Reference Approach to be higher than the Sectoral Approach,
- Unrecorded consumption of gas or other fuels may lead to an underestimation of the Sectoral Approach.
- 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.
- 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 2000-2015 time series based on the information provided by industry;
- 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;
- Inconsistencies on the sources of activity data within the time series and in some cases the application of extrapolation
- 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.
- 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.

2.5.1.4. Recalculations

In the energy sector, the only improvements were:

- New data source for railway consumption;
- Updated domestic aviation consumption data;
- Improved residual fuel oil consumption data for road transport; and
- The addition of the water-borne navigation emissions.
- Change in GWP
- These changes lead to a 0.32% in the 2012 emissions for the energy sector.

2.5.1.5. Improvements

Improvement recommendations and needs include:

Energy industries:

- The electricity generation sector is a key category and its estimate has a significant influence on the country's total inventory of GHGs. Therefore increasing the accuracy of GHG calculations by applying country-specific emission factors for this sector will improve the national GHG inventory estimate. Other improvements for this category would be to:
  - Formalise the data collection process to ensure continuous collection of data and time-series consistency;
  - Collect plant specific data for coal combusted;
  - Obtain more detailed information from the national power producer to assist in the explanation of trends throughout the reporting period;
  - Obtain a list of auto power producers and obtain data directly from the producers. This is important going forward since growth is expected within this sector.

Manufacturing Industries and construction:

- Obtain facility level data, possibly through the new GHG regulation.

Transport:

- Modelling of transport emissions; and
- Determining country specific emission factors.

Non-specified:

- Source activity data for pipeline transport;

Solid fuels and natural gas:

- Collection of fugitive emissions from mines and spontaneous combustion of underground coal seams.

2.5.2. IPPU

2.5.2.1. Trends

In 2015 the IPPU sector produced 41 882 Gg CO_2e, which is 7.7% of South Africa's gross GHG emissions. The largest source category is the metal industry category, which contributes 73.9% 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 14 093 Gg CO_2 (45.5%) and 13 420 Gg CO_2 (43.4%), respectively. The mineral industry and the product uses as substitute ODS subsectors contribute 14.8% and 8.3%, respectively, with all the emissions from the product uses as substitute ODS being HFCs. Ferroalloy production and ammonia production produce a small amount (91 Gg CO_2e) of CH_4, while chemical industries are estimated to produce 345Gg CO_2e of N_2O.

Figure 2.11 shows that over the period of 2000-2015 IPPU emissions increased by 17.9% (6 102 Gg CO_2e) between 2000 and 2006, after which there was a 14.5% (5 821 Gg CO_2e) decline to 2009. Emissions then increased again by 21.9% (7 530 Gg CO_2e) by 2015.

IPPU emissions showed an increase of 7.5% (2 927 Gg CO_2e) between 2012 and 2015. The main contributors to this increase was the ferroalloy production category, which increased by 15.4% (1 793 Gg CO_2e) over this period, and the Product uses as substitutes for ozone, which increased 37.8%. HFCs from product uses as substitute ODS were only reported from 2005, due to a lack of data prior to this. In addition, since the previous 2012 submission, improvements were made to this category and for the first time emissions from the categories mobile air conditioning, foam blowing agents, fire protection and aerosols were included in the inventory. This led to the 37.8% increase (955 Gg CO_2e) in emissions between 2012 and 2015. These emissions were included from 2011 as data prior to this was not available. The emissions from this category were 2 528 Gg CO_2e in 2012, and these increased to 3 482 Gg CO_2e in 2015.

Trends in the category contributions are shown in Table 2.10. Detailed sector emissions are provided in Annex A.

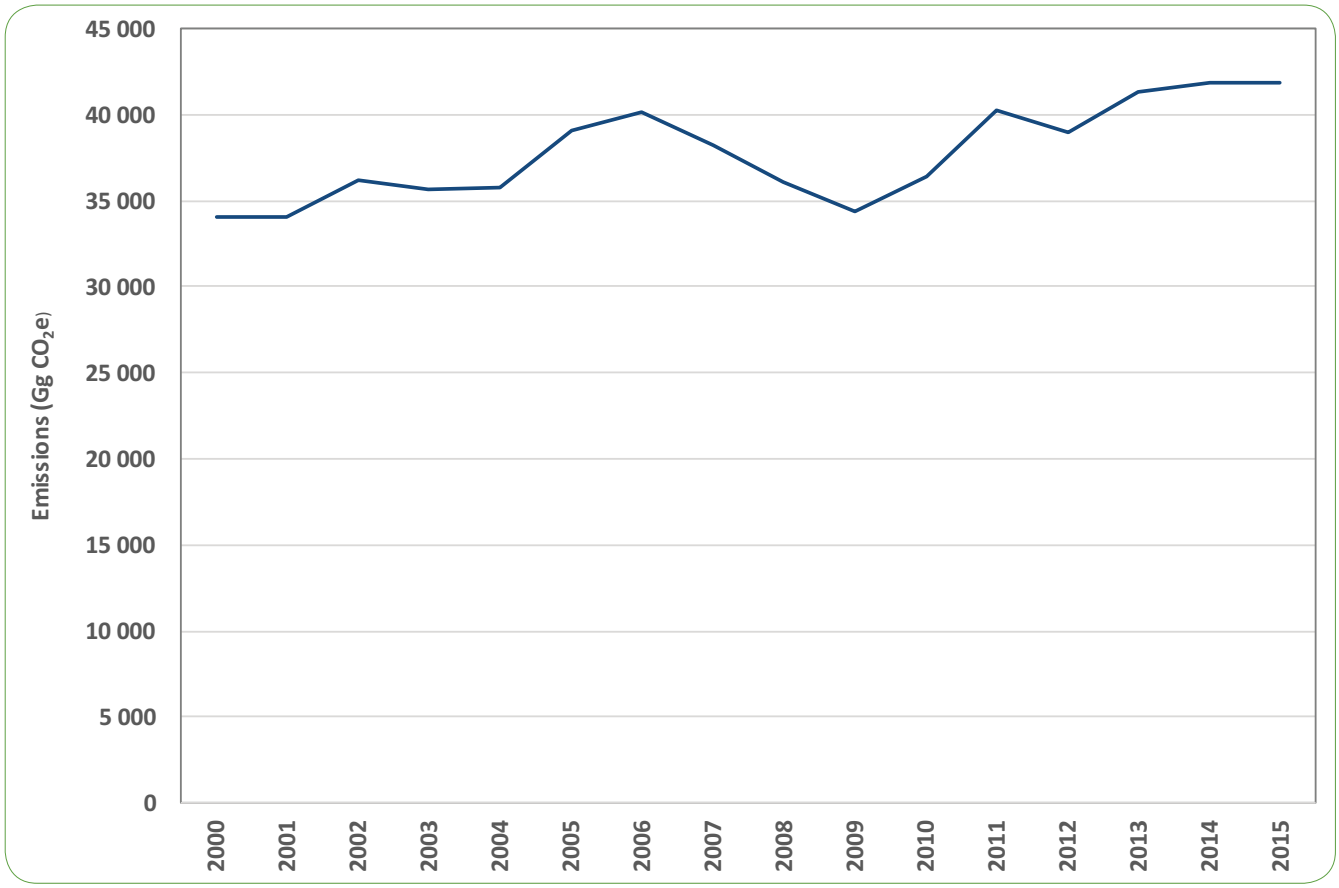

Figure 2.11: Trends in South Africa's IPPU sector emissions, 2000 – 2015

Table 2.10: Trends in the IPPU sub-categories between 2000 and 2015

	2A	2B	2C	2D	2E	2F	2G
	Mineral industry	Chemical industry	Metal industry	Non-energy products from fuels and solvent use	Electronics industry	Product uses as substitutes for ozone depleting substances	Other product manufacture and use
2000	4 386	2 774	26 715	196	NE	0	NE
2001	4 304	2 715	26 813	226	NE	0	NE
2002	4 824	2 744	28 322	250	NE	0	NE
2003	5 096	2 169	28 093	249	NE	0	NE
2004	4 993	2 473	28 072	246	NE	0	NE
2005	5 736	2 974	29 099	468	NE	842	NE
2006	6 132	2 747	29 740	509	NE	1 045	NE
2007	6 064	1 969	28 892	234	NE	1 063	NE
2008	6 321	1 226	27 254	221	NE	1 026	NE
2009	6 591	1 068	25 467	234	NE	992	NE
2010	5 917	1 021	27 204	234	NE	2 066	NE
2011	5 720	1 071	30 966	196	NE	2 274	NE
2012	5 457	931	29 785	254	NE	2 528	NE
2013	5 688	1 152	31 384	272	NE	2 853	NE
2014	5 770	928	31 842	273	NE	3 066	NE
2015	6 179	1 002	30 946	274	NE	3 482	NE

2.5.2.2. Methods and Data

Activity data in the IPPU sector are derived from a variety of sources with South Africa using a combination of Tier 1, Tier 2 and Tier 3 methods as shown in **Table 2.10** with more details available in the 2015 NIR. The *Mineral industry* applies a T1 method except for *Cement production* which uses a Tier 2 approach. The *Chemical industry* data are reported as amalgamated, as there are number industries where there is only one company involved and so the data is reported as confidential. Estimates for this category mostly use a Tier 3 approach, except *Titanium dioxide production* and *Petrochemical and carbon black production* where a Tier 1 method and default factors was applied. The Metal industries used a mixture of Tier 1, 2 and 3. A Tier 1 was also used to calculate emissions from *Non-energy products from fuels and solvents* and HFC emissions from *Product uses as substitutes for ODS* category.

Table 2.11: Summary of methods and emission factors for the IPPU sector

GHG Source and sink category		CO_2		CH_4		N_2O		PFCs		HFCs	
		TM	EF	TM	EF	TM	EF	TM	EF	TM	EF
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		NE		NE		NE		NE	
B	Chemical industry										
1	*Ammonia production*	T3	CS	T3	CS						
2	*Nitric acid production*	NO		NO		T3	CS	NO		NO	
3	*Adipic acid production*	NO		NO		NO		NO		NO	
4	*Caprolactam, glyoxal and glyoxylic acid production*	NO		NO		NO		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		NO		NO		NO		NO	
8	*Petrochemical and carbon black production*	T1	DF	NE		NE		NO		NO	
9	*Fluorochemical production*			NA		NA		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		T3	CS	NO	

GHG Source and sink category		CO_2		CH_4		N_2O		PFCs		HFCs	
		TM	EF	TM	EF	TM	EF	TM	EF	TM	EF
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*	NA		NA		NA		NA		T1	DF
2	*Foam blowing agents*	NA		NA		NA		NA		T1	DF
3	*Fire protection*	NA		NA		NA		NA		T1	DF
4	*Aerosols*	NA		NA		NA		NA		T1	DF
5	*Solvents*	NE		NE		NE		NE		NE	
G	Other product manufacture and use										
1	*Electrical equipment*	NE		NE		NE		NO		NO	
2	*SF_6 and PFCs from other product uses*	NE		NE		NE		NE		NE	
3	*N_2O from product uses*	NO		NE		NE		NO		NO	
H	Other										
1	*Pulp and paper industry*	NE		NE		NE		NO		NO	
2	*Food and beverage industry*	NE		NE		NE		NO		NO	

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

2.5.2.3. Recalculations

Recalculations for the IPPU sector led to a 4.9% (1 826 Gg CO_2e) increase in emissions on the 2012 data. There were two reasons for recalculations in this sector, namely a change in data source and the addition of new categories.

In the *mineral industry* category the data source and methodological approach for cement production was changed and the lime production data were corrected to use the total quicklime and hydrated lime values provided in the SAMI reports (DMR, 2015). The corrected lime values were only available from 2008 so there is an inconsistency in the time series. The *metal industry* emissions were recalculated due to a change in the zinc production data source.

A recent in-country study on HFCs provided HFC emissions for refrigeration, air conditioning, foam blowing agents, fire protection and aerosols. This data was not available for years prior to 2011 so the emissions for these categories have been added to the *product uses as substitute ODS* category from 2011 onwards. This led to an 86.2% increase in the emissions for this category.

2.5.2.4. Improvements

Needs and suggested improvements for this sector include:

- Cement production:
  - Collection of activity data from all cement production plants in South Africa. The activity data must include the CaO content of the clinker and the fraction of this CaO from carbonate. According to the 2006 IPCC Guidelines, it is good practice to separate CaO from non-carbonate sources (e.g. slag and fly ash) and CaO content of the clinker when calculating emissions.
  - It is evident that there are discrepancies between the cement production data from industry and the cement production data published by the DMR, as a recommendation, the DMR should work with the cement production industry to ensure accuracy and consistency between the two data sources.
- Lime production:
  - Collect activity data from all lime production plants in South Africa and obtain information of dolomitic lime.
  - Develop country-specific emission factors, LKD factors and hydrated lime correction factors.
- Glass production:
  - Collect more data on the cullet ratio.
- Ammonia, nitric acid, carbide and titanium production:
  - Recommended that the country-specific emission factors which were applied by the industry be made transparent.
- Lead and zinc production:
  - Data be collected to determine the relative amounts of lead and zinc produced from primary and from secondary materials. This would allow for the selection of more appropriate emission factors.

2.5.3. AFOLU

2.5.3.1. Trends

GHG emissions and removals from agriculture as well as land use and forestry are included. Emissions from fuel combustion in this sector are not included here as these fall under the agriculture/forestry/fisheries subsector. The AFOLU sector gross emissions in South Africa was a source of 49 531 Gg CO_2e in 2015. The source remained fairly constant over the 15 year period (Figure 2.12).

In 2015 the net emissions were estimated at 21 060 Gg CO_2e. *Livestock* and A*ggregated and non-CO_2 emissions* were estimated to emit 27 688 Gg CO_2e and 21 208 Gg CO_2e in 2015, respectively. The *Land* and *HWP* categories were estimated to be sinks (27 176 Gg CO_2e and 660 Gg CO_2e, respectively). Methane contributed the most (55.2%) to the gross emissions in 2015, with *Livestock* providing 97.1 % (26 547 Gg CO_2e) to this amount. *Aggregated and non-CO_2 emissions sources on land* contributed 91.7% (19 457 Gg CO_2e) to the N_2O emissions.

The gross emissions from the AFOLU sector declined by 2.02% (1 008 Gg CO_2e) between 2000 and 2015, while net emissions declined by 45.03% (16 456 Gg CO_2e) over the same period (Table 2.12). This large decline is due to the doubling of the *Land* sink over this period. There were, however fluctuations in the *Land* sink throughout the 15 year period (Figure 2.12). Total GHG emissions from *Livestock* declined by 2.3%, from 28 334 Gg CO_2e in 2000 to 27 688 Gg CO_2e in 2015. The decline was attributed mainly to the decreasing cattle, sheep and goat populations.

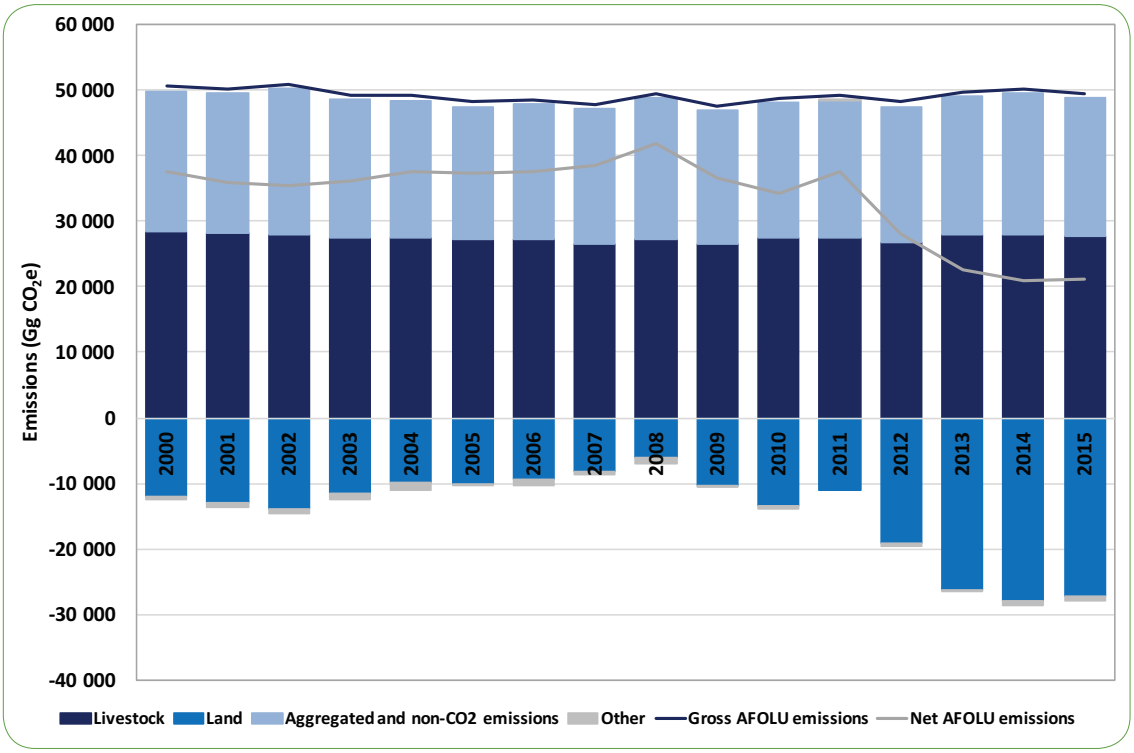

Figure 2.12: Emission trends for South Africa's AFOLU sector, 2000 – 2015

Table 2.12: Trends in AFOLU sub-category emissions between 2000 and 2015

	3A	3B	3C	3D	3
	Livestock	Land	Aggregated and non-CO_2 emissions from land	Other	Total AFOLU
	Gg CO_2e				
2000	28 334	-12 077	21 570	-312	37 515
2001	28 178	-13 058	21 413	-675	35 858
2002	28 027	-13 840	22 163	-817	35 534
2003	27 489	-11 599	21 067	-927	36 030
2004	27 341	-9 742	21 143	-1 185	37 557
2005	27 195	-10 028	20 310	-197	37 280
2006	27 125	-9 483	20 709	-882	37 469
2007	26 472	-8 113	20 763	-581	38 541
2008	27 127	-6 141	21 602	-781	41 807
2009	26 568	-10 344	20 393	-98	36 518
2010	27 344	-13 356	20 764	-490	34 261
2011	27 484	-10 931	20 989	81	37 624
2012	26 854	-19 033	20 674	-509	27 986
2013	27 817	-26 225	21 329	-377	22 543
2014	27 841	-27 932	21 732	-693	20 948
2015	27 688	-27 176	21 208	-660	21 060

The *Land* component is estimated to be a sink, varying between 6 141 Gg CO_2e and 27 932 Gg CO_2e (Figure 2.12). The major variation in this category was caused by changes in carbon stock losses due to fire and fuelwood collection, and the increase in conversion of grasslands to woodlands and bare ground to grasslands. Losses due to fire disturbance were greatly reduced in 2015, thereby leading to an increased sink.

Emissions from *Aggregated and non-CO_2 emission sources* declined by 1.7% between 2000 and 2015, and varied by a maximum of 9.3% over the 15 year period. 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 43.8% to the gross AFOLU emissions. *HWP* estimates indicate that this subsector is a small sink of CO_2, varying between a minimum of 98 Gg CO_2e (2011) and a maximum of 1 185 Gg CO_2e (2006). This sink increased from the 2000 sink estimate of 312 Gg CO_2e to 660 Gg CO_2e in 2015.

There was a 2.88% (1 368 Gg CO_2e) increase in the gross emissions from AFOLU sector since 2012. This can be attributed to an increase in livestock population during this period. The net AFOLU emissions have declined by 24.7% (6 926 CO_2e) since 2012 due to a 42.8% (8 144 Gg CO_2e) increase in the land sink. *Aggregated and non-CO_2 emissions on land* increased by 362 Gg CO_2e (2.6%), while the *HWP* sink increased by 151 Gg CO_2e (29.6%) since 2012.

Detailed sector emissions are provided in Annex A.

2.5.3.2. Land change mapping methods

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 2006 IPCC Guidelines.

The 1990 and 2013-14 National Land-Cover Datasets were derived from multi-seasonal Landsat 5 and Landsat 8 imagery with 30 x 30m raster cells, respectively. The 1990 National Land-Cover Dataset made use of imagery from 1989 to 1991, while the 2013-14 National Land-Cover Dataset used 2013 to 2014 imagery (see further details in the National Inventory Report).

A few corrections were made to these maps for the purpose of this inventory:

- Both landcover datasets contained area of oceans, which was removed from each dataset by extracting the dataset from within the national boundary;
- Wetlands were extracted from each dataset, merged into a single wetland dataset (1990 and 2014 combined wetlands) and merged with the 1990 and 2014 landcover datasets. This was conducted to mitigate against dry versus wet years where moisture availability would influence the area detected, rather than the landcover actually undergoing a land change process; and
- The same process was applied to the degraded land class for similar reasons. As such, the 1990 and 2014 datasets contained the exact same area for wetlands and degraded land.

It was assumed that land change was linear over the 24 year period and annual change was determined based on this assumption. In future new land change maps will be developed to provide change data at shorter intervals and this data will then be incorporated to future inventories.

2.5.3.3. Emission methods and data

The AFOLU sector uses a mix of T1 and T2 methods as indicated in Table 2.13. For enteric fermentation and manure management country specific emission factors are taken from Du Toit et al. (2013a-d) and Moeletsi et al. (2015), The National Terrestrial Carbon Sinks Assessment (DEA, 2015) provided some of the input carbon stock data for the Land sub-category, with soil management data for croplands being provided by Tongwane et al. (2016). Details of sources of activity data are provided in **Table 2.14** with more details available in the 2015 NIR.

Table 2.13: Summary of methods and emission factors for the AFOLU sector

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		TM	EF	TM	EF	TM	EF	
A	**Livestock**							
1	**Enteric fermentation**							
	a.i. Dairy cattle	NA		T2	CS	NA		CS EF for CH_4 and N_2O from Du Toit et al. (2013) were applied for all indicated livestock.
	a.ii. Other cattle	NA		T2	CS	NA		
	b. Buffalo	NA		IE	IE	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 (Game)	NA		T2	CS	NA		
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. (2013) were applied.
	a.ii. Other cattle	NA		T2	CS	T2	DF	
	b. Buffalo	NA		IE	IE	NO		
	c. Sheep	NA		T2	CS	NO		CS EF for CH_4 from Du Toit et al. (2013) 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. (2013) were applied.
	i. Poultry	NA		T2	CS	T2	DF	
	j. Other (Game)	NA		T2	CS	T2	DF	

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		TM	EF	TM	EF	TM	EF	
B	**Land**							
1	**Forest land**							
	a. Forest land remaining forest land	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2015)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE
	b. Land converted to forest land	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2015)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE
2	**Cropland**							
	a. Cropland remaining cropland	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2015)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE
	b. Land converted to cropland	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2014)
		Soil: T2	Soil: DF, CS					Country specific stock change factors were applied.
3	**Grassland**							Mineral soil only, organic soils NE
	a. Grassland remaining grassland	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2015)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE
	b. Land converted to grassland	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2015)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		TM	EF	TM	EF	TM	EF	
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		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2015)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE
	b. Land converted to settlements	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		DOM: T2	DOM: CS					Country specific DOM stocks are utilized from NTCSA (DEA, 2015)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE
6	**Other land**							
	a.Other land remaining other land	Biomass: NE		NE		NE		
		Soil: T1	Soil: DF					
	b. Land converted to other land	Biomass: T2	Biomass: CS	NE		NE		Country specific activity data and EF are applied (see data sources table)
		Soil: T1	Soil: DF					Mineral soil only, organic soils NE
C	**Aggregated sources and non-CO_2 emissions on land**							
1	**Biomass burning**	T2	DF, CS	T2	DF, CS	T2	DF, CS	Country specific Mb, Cf and EF for savannas and croplands were applied (DEA, 2009; DAFF, 2010)
2	**Liming**	T1	DF	NA		NA		
3	**Urea application**	T1	DF	NA		NA		

GHG Source and sink category		CO_2		CH_4		N_2O		Details
		TM	EF	TM	EF	TM	EF	
4	**Direct emissions from managed soils**							
	Synthetic fertilizers	NA		NA		T1	DF	
	Animal waste added to soils	NA		NA		T1, T2	DF	Country specific manure management data was applied (Du Toit et al., 2013; Moeletsi et al., 2015)
	Other organic fertilizers	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**							
	Volatilization	NA		NA		T1	DF	
	Nitrogen leaching and runoff	NA		NA		T1	DF	
7	**Rice cultivation**	NO		NO		NO		
D	**Other**							
1	**Harvested wood products**	T2	DF	NA		NA		

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

Table 2.14: Activity and emission factor data sources for the AFOLU sector

Sub-category	Activity data	Data source
Enteric fermentation	Population data	DAFF (2016)
		SA Poultry Association (SAPA) (2016)
		Du Toit et al. (2013d)
	Herd composition	Du Toit et al. (2013a-d)
	Livestock activity data (weights, intake, DMD, etc)	Du Toit et al. (2013a-d)
		Moeletsi et al. (2013)
	Emission factors	Du Toit et al. (2013a-d)
Manure management	Manure management data	Du Toit et al. (2013a-d)
		Moeletsi et al. (2013)
	N excretion rates	IPCC 2006 Guidelines
		Du Toit et al. (2013a-d)
General land data	Land cover and change maps (1990 – 2013/14)	GTI (2015); DEA (2015)
	Climate map	Moeletsi et al. (2013)
	Soil map	Moeletsi et al. (2013)
	Litter data	National Terrestrial Carbon Sinks Assessment (DEA, 2015)
Forest land	Plantation data	Forestry South Africa Industry facts (2016)
		Du Toit et al. (2016)
		Alembong (2015)
		Timber Statistics reports (DAFF, 2016)
	Natural forests and woodlands	DEA (2015)
Cropland	Planted/harvested areas	DAFF Agricultural Abstracts (2016);
		DAFF – Crop estimates committee (2014)
		Statistics SA (2007)
		FAOStat (2016)
	Yield	DAFF Agricultural Abstracts (2016)
		Moeletsi et al. (2013)
		FAOStat (2016)
	Crop management data	Moeletsi et al. (2013)
		Tongwane et al. (2016)
	Perennial crop data	Citrus Growers Association Statistics Book (2016)

Sub-category	Activity data	Data source
Grassland	Biomass data and growth rates	Masubelele et al. (2014)
		National Terrestrial Carbon Sinks Assessment (DEA, 2015)
	Grassland management data	Fairbanks et al. (2000)
		Matsika (2007)
Settlements	Management data	Fairbanks et al. (2000)
		DEA (2016)
Other lands	Soil carbon data	IPCC (2006)
Biomass burning	Burnt area data	MODIS burnt area product (2016)
	Mass of fuel available	DEA (2009)
		Van Leeuwen et al. (2014)
		DAFF (2010)
	Emission factors	DEA (2009)
Liming	Lime consumption	SAMI Reports (2016)
Urea application	Urea import data	SARS (2016)
Synthetic fertilizers	Total N fertilizer consumption	Fertilizer Association of SA
	N content of fertilizers	Grain SA Report
Organic fertilizers	Waste production data for sewage sludge	Waste sector
	Compost calculations	DAFF (2010)
Crop residues	Crop area planted	DAFF (2016)
		Crop Estimates Committee
		Statistics SA (2007)
		FAOStat (2016)
	Crop yield data	Moeletsi et al. (2013)
		Tongwane et al. (2016)
		FAOStats (2016)
	C:N ratios	Moeletsi et al. (2013)
		Tongwane et al. (2016)
	Crop residue management	Tongwane et al. (2016)
		Moeletsi et al. (2013)
Harvested wood products	Production, import and export data for HWP	FAOStat (2016)

2.5.3.4. Recalculations

The AFOLU sector is under continual improvement which leads to recalculations. As in the previous 2012 inventory, significant changes have been made to this sector which include the following improvements:

- Updated manure management data due to new data;
- Updated livestock emission factors for sheep, goats and pigs to incorporate all livestock categories;
- Update of the dairy herd composition;
- Complete overlay of land cover/land use with soil, climate and ecoregion maps;
- Re-calculation of the annual change using these new map overlays;
- Improved biomass and soil carbon calculations due to the improved map overlays;
- Change in Fuelwood calculations to be partial tree part removals instead of whole tree removals;
- Incorporation of forestry annual biomass increment data;
- Update and validation of biomass factors;
- Inclusion of specific crop data and fallow lands to move to a Tier 2 calculation for Croplands;
- Change in grassland category to include low shrublands as well as grasslands;
- Improvement of calculations of biomass stock changes in converted lands to move towards a Tier 2 approach in all land categories;
- Other land soils not assumed to be zero;
- Update of crop residue emissions due to the inclusion of detailed crop data;
- Inclusion of litter data for all land categories; and
- Updated HWP data due to an update in the FAO data.
- Change in GWP

The recalculated gross AFOLU emissions were 7.3% to 9.4% lower than the estimates in the 2012 submission (**Figure 2.13**). These changes were largely due to a 9% to 11% reduction in the Livestock estimates and a 8% to 12% reduction in the Aggregated and non-CO_2 emissions. Net AFOLU emissions were 3.1% to 21.7% lower than the 2012 estimates. The change was attributed mainly to the recalculation in the Land sector.

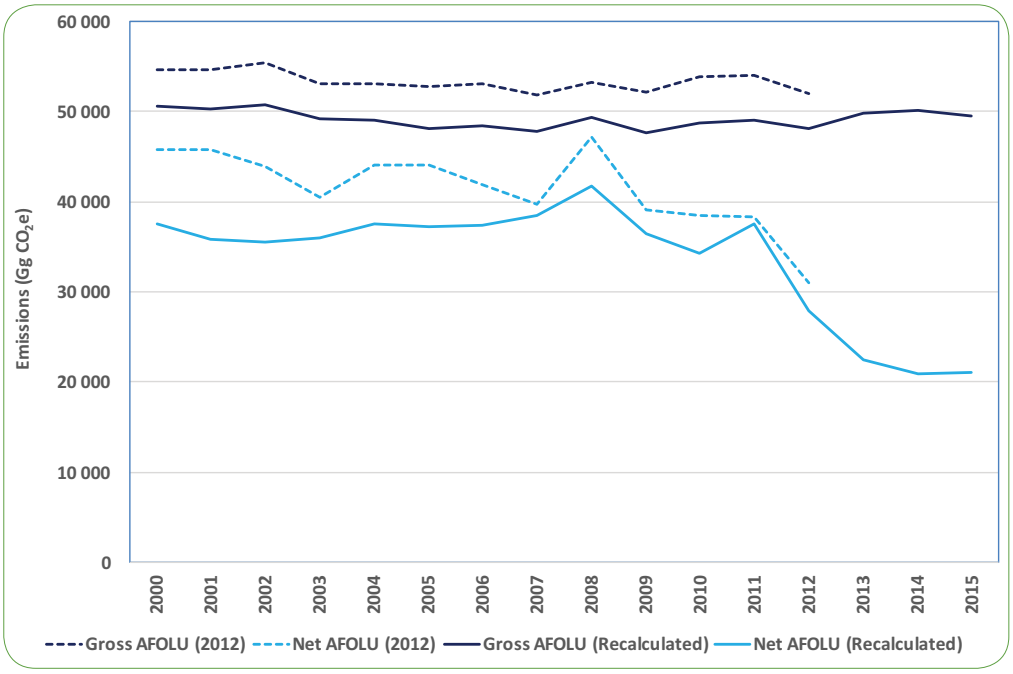

Figure 2.13. Change in AFOLU emission estimates due to recalculations since 2012 submission

2.5.3.5. Improvements

There are several needs and improvements which are required to improve the estimates in the AFOLU sector:

Livestock:

- The largest uncertainty in the livestock sector is the livestock numbers. National data seems to differ from data from livestock associations so these differences need to be resolved and numbers agreed upon;
- Collect more data on manure management as current data is very limited and show varying results;

Land:

- There is a need for updated land cover change maps and these need to be produced on a more regular (every 4 – 5 years) basis;
- Incorporate the biome maps into the land change maps;
- There is a need for more consistency in data sets (inventory, NTCSA, Forest Resource Assessment) and a lot of this is due to different land classifications. Need to engage with other stakeholders to ensure more consistency;
- Include land degradation if possible;
- Move towards modelling of carbon stocks;
- Improvements to be considered in next inventory:
    - Investigation and possible correction of period of land change. Since the land change maps were over a 24 year period change is assumed over the 24 year period. The IPCC default period is 20 years, therefore this will be investigated to determine if it is having any impact on the data in more recent years;
    - Consider extending the time-series to go back to 1990 as much of the data is available;
    - Calculate and incorporate stock change data for plantations;

Soil management:

- There is a need for more data on crop area estimates. Currently data is erratic and estimates are only provided for some crops on a regular basis;
- Need for more data on fertiliser application as this data is no longer being collected.

Finally uncertainty estimates are still required for the AFOLU sector and this will be addressed in the next inventory.

2.5.4. Waste

2.5.4.1. Trends

GHG emissions into the atmosphere from managed landfills and wastewater treatment systems in South Africa are estimated for this sector. Emissions from *Open burning of waste* have not previously been estimated and are incorporated for the first time in this inventory, though emissions from incineration and biological treatment of organic waste still need to be addressed.

In 2015 the *Waste* sector produced 19 533 Gg CO_2e or 3.6% of South Africa's gross GHG emissions. The largest source category is the *Solid waste disposal* category which contributed 80.7% (166 981 Gg CO_2e) towards the total sector emissions.

South Africa's *Waste* sector produces mainly CH_4 (95.6%), with smaller amounts of N_2O (4.2%) and CO_2 (0.2%). *Solid waste disposal* increased its contribution to the total *Waste* sector emissions by 8.6% since 2000, while the contribution from *Incineration and open burning of waste* decreased by 0.8%, while the contribution from *Wastewater treatment and discharge* declined by 7.8%.

Waste sector emissions have increased by 80.2% from the 10 838 Gg CO_2e in 2000. Emissions increased steadily between 2000 and 2015 (**Figure 2.14**). There are two likely reasons for the increase: firstly, the first order decay (FOD) methodology has an in-built lag-effect and, as a result, the reported emissions from solid waste in managed landfills in a given year are likely to be due to solid waste disposed of over the previous 10 to 15 years. Secondly, in South Africa the expected growth in the provision of sanitation services, particularly with respect to collecting and managing solid waste streams in managed landfills, is likely to result in an increase in emissions of more than 5% annually. In addition, at present very little methane is captured at the country's landfills and the percentages of recycled organic waste are low. Intervention mechanisms designed to reduce GHG emissions from solid waste are likely to yield significant reductions in the waste sector.

Emissions from *Solid waste disposal* more than doubled between 2000 (7 814 Gg CO_2e) and 2015 (15 756 Gg CO_2e), while emissions from *Incineration and open burning of waste* and *Wastewater treatment and discharge* both increased by 24.9% over this period (**Table 2.15**).

Detailed sector emissions are provided in Annex A.

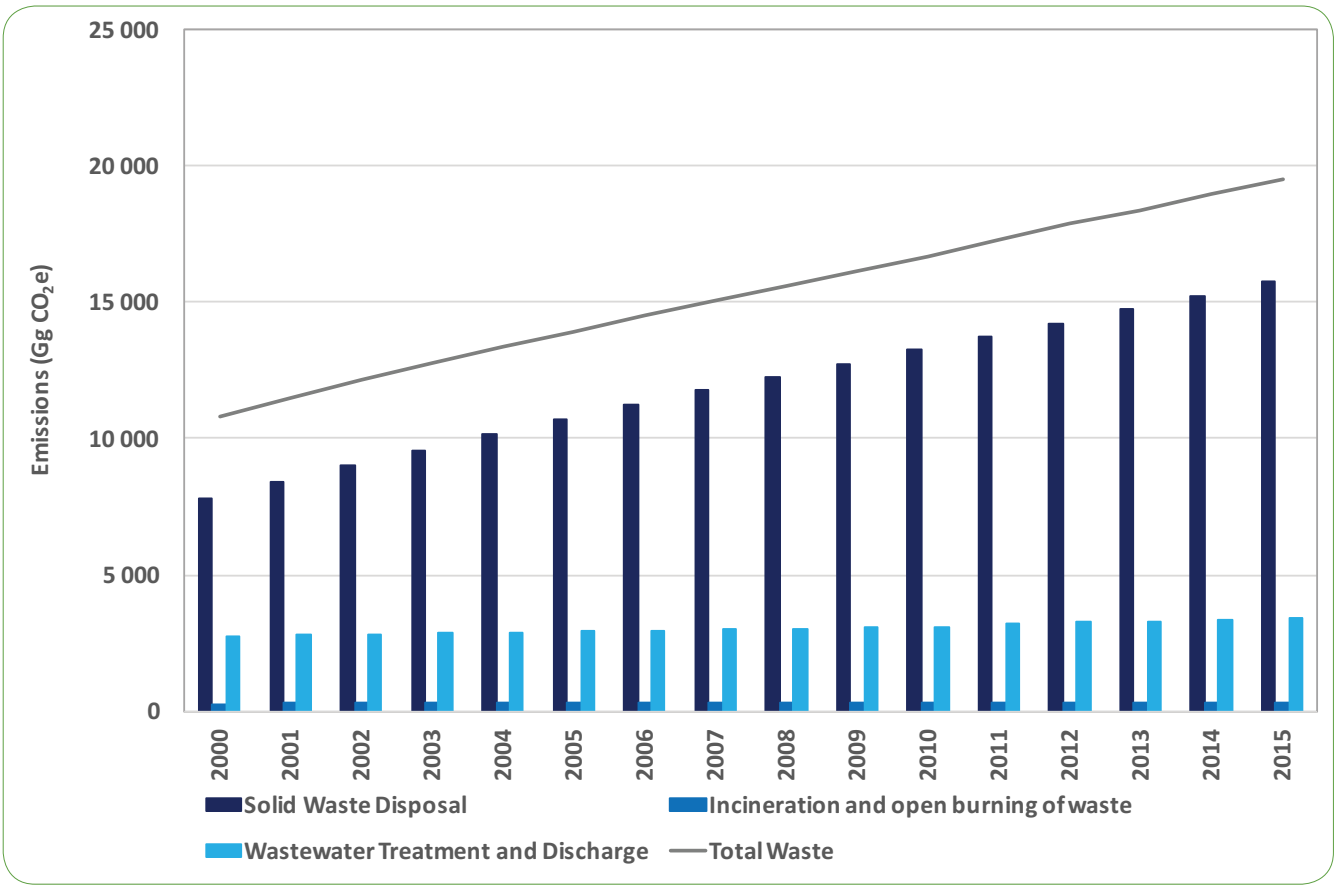

Figure 2.14: Trend in emissions from Waste sector, 2000 – 2015

Table 2.15: Trends in emissions from the Waste sector sub-categories between 2000 and 2015.

	4A	4B	4C	4D	4
	Solid Waste Disposal	Biological treatment of solid waste	Incineration and open burning of waste	Wastewater Treatment and Discharge	Total Waste
2000	7814	NE	280	2743	10838
2001	8416	NE	286	2800	11502
2002	9008	NE	290	2839	12137
2003	9585	NE	294	2875	12755
2004	10148	NE	297	2910	13355
2005	10696	NE	301	2943	13940
2006	11231	NE	304	2976	14511
2007	11753	NE	308	3009	15069
2008	12263	NE	311	3042	15616
2009	12760	NE	314	3075	16150
2010	13244	NE	318	3109	16671
2011	13724	NE	330	3228	17282
2012	14225	NE	338	3303	17866
2013	14732	NE	339	3317	18387
2014	15250	NE	345	3371	18965
2015	15756	NE	350	3427	19533

2.5.4.2. Methods and data

The IPCC Tier 2 first order decay model has been used to estimate solid waste emissions, while Tier 1 methods were used to estimate all other emissions in the Waste sector. **Table 2.16** outlines the methodologies used to calculate emissions in the waste sector, with a full description provided in the 2015 NIR.

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. Activity data sources are shown in **Table 2.17**. 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 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 main sources of data for the Waste sector are shown in Table 2.17. The emissions factors for different wastewater treatment and discharge systems were taken from the IPCC 2006 Guidelines as was the data on distribution and utilization of different treatment and discharge systems.

Table 2.16: Summary of methods and emission factors for the Waste sector

GHG Source and sink category		CO_2		CH_4		N_2O	
		TM	EF	TM	EF	TM	EF
A	Solid waste disposal			T1	DF		
B	Biological treatment of solid waste	NE		NE		NE	
C	Incineration and open burning of waste	T1	DF	T1	DF	T1	DF
D	Waste water treatment and discharge	NA		T1	DF	T1	DF

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

Table 2.17: Activity data sources for the waste sector

Sub-category	Activity data	Data source
Solid waste disposal	Population data	Statistics SA (2015);
		UN (2012)
	Waste composition	IPCC 2006
	Waste generation rate for each component	DEA (2012)
	GDP	World bank
Open burning of waste	Population data	Statistics SA (2015);
		UN (2012)
	Fraction of population burning waste	Own construction based on fraction of waste not disposed-off to landfill sites
Wastewater treatment and discharge	Population data	Statistics SA (2015);
		UN (2012)
	Split of population by income group	Statistics SA (2015)
	BOD generation rates per treatment type	IPCC 2006
	Per capita nitrogen generation rate	IPCC 2006

2.5.4.3. Recalculations

Recalculations were performed for all years between 2000 and 2015 due to the following changes, updates and improvements:

- Correction in the population number for Solid waste disposal as the 9% of the population using open burning was subtracted;
- Update in the waste generation rate per capita due to the incorporation of country specific information; and
- Open burning of waste estimates were added.
- Change in GWP

Recalculated emissions were between 4.1% and 11.2% (increasing from 2000 to 2015) lower than the 2012 emissions.

The recalculation in the *Solid waste disposal emissions* produced outputs that are 8% to 15% lower than the previous submission. There was no change in the estimates for *Wastewater treatment and discharge*. The increase in emissions is due to the introduction of emission estimates from *Open burning*.

2.5.4.4. 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. No specific improvements are planned; however South Africa has identified the following areas to be considered in the improvement plan for the future:

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

The DEA is currently undertaking a study to collect actual activity data for this category for the period 2000 – 2015. They will collect the following:

- 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

2.6. Key categories

The key categories are the most significant emission sources in South Africa. There are two approaches which can be used to determine the key categories; namely, the level approach and the trend approach. The former is used if only one year of data is available, while the latter can be used if there are two comparable years. The inventory provides emissions for more than one year; therefore, both the level and trend assessments for key category analysis were performed.

The key categories have been assessed using the Approach 1 level (L1) and Approach 1 trend (T1) methodologies from the 2006 IPCC Guidelines (IPCC, 2006). The key category analysis identifies 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 2015, or the trend of emissions.

Table 2.18 shows the 10 top key categories using the level and trend assessment and the full results are provided in the 2015 NIR.

Table 2.18: Key categories for South Africa

Level assessment (2015)			Trend assessment (2000 - 2015)		
IPCC Category code	IPCC Category	GHG	IPCC	IPCC Category	GHG
1A1a	Electricity and Heat Production	CO_2	1A4b	Residential	CO_2
1A3b	Road Transport	CO_2	3B1b	Land converted to forest land	CO_2
1A2	Manufacturing Industries and Construction	CO_2	1B3	Other Emissions from Energy Production	CO_2
1A1c	Manufacture of Solid Fuels and Other Energy Industries	CO_2	3B3b	Land converted to grassland	CO_2
1A4b	Residential	CO_2	1A3b	Road Transport	CO_2
1B3	Other Emissions from Energy Production	CO_2	1A4a	Commercial/Institutional	CO_2
3B1b	Land converted to forest land	CO_2	4A	Solid Waste Disposal	CH_4
3A1a	Enteric fermentation- cattle	CH_4	2C1	Iron and Steel Production	CO_2
1A4a	Commercial/Institutional	CO_2	1A1c	Manufacture of Solid Fuels and Other Energy Industries	CO_2
3C4	Direct N_2O emissions from managed soils	N_2O	3A1a	Enteric fermentation- cattle	CH_4

2.7. Uncertainty analysis

An uncertainty analysis was completed for the Energy and IPPU sectors in this inventory. It was indicated that an uncertainty analysis would be conducted on the AFOLU and Waste sectors in this inventory, but due to a lack of capacity this will only be completed in the next submission.

The uncertainty on the 2015 Energy estimates was determined to be 6.52%, while the uncertainty on the trend was 5.91%. For the IPPU sector the uncertainty was determined to be 8.83% and 4.74% on the 2015 estimates and the trend, respectively.

2.8. Quality control and assurance procedures

2.8.1. Quality control

Quality control (QC) procedures are performed by experts during the process of compiling the inventory for South Africa. This process is to ensure the attainment of quality objectives, so as to comply with the IPCC good practice guidance and the IPCC 2006 Guidelines. General inventory QC checks include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions.

Category-specific QC checks are also undertaken with 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.

2.8.2. Quality assurance

Quality Assurance, as defined in the *IPCC Good Practice Guidance* (IPCC, 2000; 2014), comprises a "planned system of review procedures conducted by personnel not directly involved in the inventory compilation and development process". The quality assurance process includes both expert review and a general public review (**Figure 2.15**). The expert and public reviews each present an 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 Inventory Report or reflected in the inventory estimates.

As part of the NGHGIS project South Africa developed a quality assurance/quality control plan. Due to timing this plan was not fully implemented in this 2015 inventory, but will be utilised in the next inventory. The QA/QC procedures as discussed below were implemented in this 2015 inventory. It describes general QA/QC procedures, and for source specific QA/QC procedures see each source sector for detailed descriptions. An independent review of the 2015 inventory was carried out by IBIS Consulting in 2018 and public comment process commenced in September 2018. All the inputs from the independent review and public comment process were addressed and documented in the independent review and public comment databases.

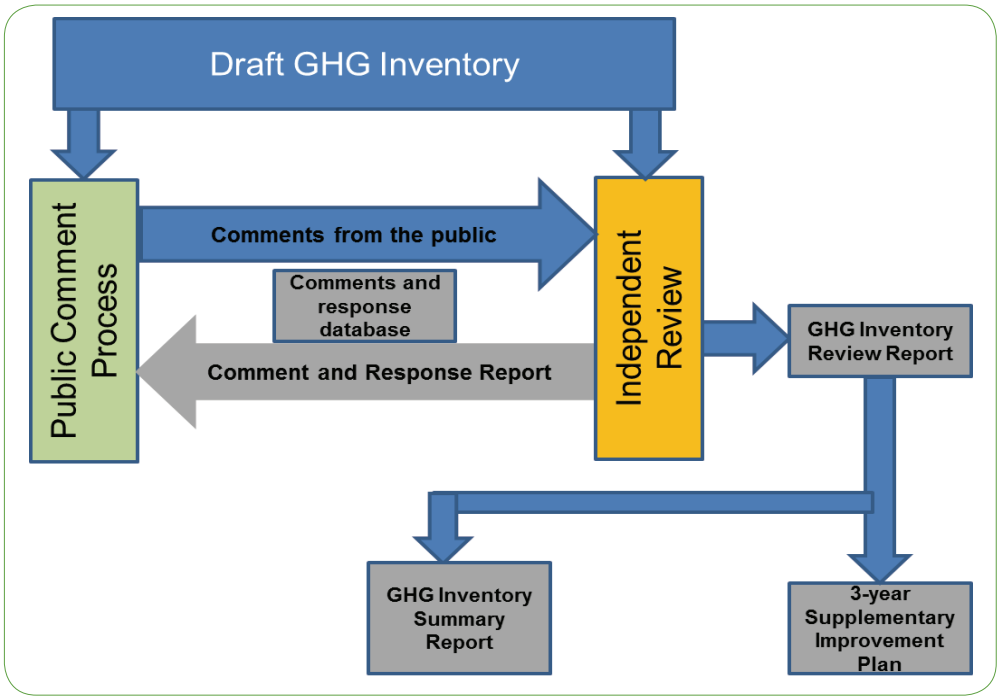

Figure 2.15: The independent review process for the 2000 – 2015 inventory

2.8.3. Verification

Emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system. These include measurement and research projects and programmes initiated to support the inventory system, 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 National Inventory Report.

2.9. Data storage and archiving

The NGHGIS for South Africa will assist in managing and storing the inventory related documents and processes. The NGHGIS will, amongst other things, keep records of the following:

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

The procedures for data storage and archiving are described in detail in the QA/QC plan that was recently developed as part of the NGHGIS.

2.10. Completeness

The South African GHG emission inventory for the period 2000 – 2015 is not complete, mainly due to the lack of sufficient data. Table 2.13 identifies some of the sources in the 2006 IPCC Guidelines which were not included in this inventory and the reason for their omissions. Further detail on completeness is provided in the various sector tables (see Annex A). It is also noted that SF_6 has not yet been included in the inventory.

Table 2.19: Activities in the 2015 inventory which are not estimated (NE), included elsewhere (IE) or not occurring (NO)

NE, IE or NO	Activity	Comments
NE	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 covering the period 2000-2014
	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
	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
	Other process use of carbonates	
	Electronics industry	A study was to be undertaken in 2015 to understand emissions from this source category
	CO_2 from organic soils	Insufficient data on the distribution and extent of organic soils. Project has just been initiated by DEA to identify and map organic soils. These emissions could potentially be included in the next inventory.
	HWP from solid waste	This will be included in the next inventory
	CO_2, CH_4 and N_2O emissions from Combined Heat and Power (CHP) combustion systems	
	CH_4, N_2O emissions from biological treatment of waste	
	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.
IE	CO_2, CH_4 and N_2O emissions from off-road vehicles and other machinery	
	Ozone Depleting Substance replacements for fire protection and aerosols	
	CO_2 emissions from biomass burning	These are not included under biomass burning, but rather under disturbance losses in the Land sector.
NO	Other product manufacture and use	
	Rice cultivation	
	CO_2, CH_4 and N_2O emissions from Soda Ash Production	
	CO_2 from Carbon Capture and Storage	
	CO_2, CH_4 and N_2O emissions from Adipic acid production	
	CO_2, CH_4 and N_2O Caprolactam, Glyoxal and Glyoxylic acid production	
	Precursor emissions have only been estimated for biomass burning, and only for CO and NO_x	

2.11. Planned improvements

The collection of data and information is still a challenge when compiling the GHG inventory for South Africa. The data and information are often collected from national aggregated levels rather than from point or direct sources which makes the use of higher-tier methods difficult. Where more disaggregated data and emission factors were available, a higher-tier method was used to improve on the previous inventory. South Africa's aim is to incorporate more country-specific data and move towards a Tier 2 or 3 approaches for the key categories in particular.

The DEA is in the process of implementing a NGHGIS which will have more clearly defined roles and a more detailed inventory preparation process. These processes were developed after the initial start date for the preparation of this inventory, so the full inventory preparation cycle will be implemented and adhered to in the next inventory submission. The institutional arrangements for the national inventory compilation have not changed since that which was reported in the BUR-2.

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3. MITIGATION ACTIONS AND THEIR EFFECTS

3.1. Introduction

South Africa's overall approach to mitigation is informed by two contexts: first, its contribution as a responsible global citizen to the international effort to reduce global Greenhouse Gas (GHG) emissions; and second, its successful management of the development and poverty eradication challenges it faces (DEA, 2011a). South Africa's long-term vision is of a low-carbon and climate-resilient economy and society in South Africa, that reduces both poverty and GHG emissions. South Africa's mitigation component of its Nationally Determined Contributions (NDCs) moves from a "deviation from business-as-usual" form of commitment and takes the form of a peak, plateau and decline GHG emissions trajectory range such that South Africa's emissions by 2025 and 2030 will be in a range between 398 and 614 Mt CO_2e, as defined in national policy. The effectiveness of mitigation actions would thus be benchmarked against this GHG emission range.

3.2. Summary Since BUR-1 and BUR-2

In BUR-1 and BUR-2, South Africa discussed the development of the climate change flagship programmes, the Mitigation Potential Analysis (MPA). Sectoral Emission Targets (SET's), GHG regulations, carbon tax and carbon offsets. In this BUR, progress on the development of these climate change policies and regulations is included. Specifically, the MPA has informed the Greenhouse Gas Pathways project, Policies and Measures project and the methodologies of the SETs. To reduce GHG emissions in the key industrial emission sectors in the country including the mining, energy production and manufacturing sectors, GHGs have been declared priority air pollutants and regulations set out to guide the development of Pollution Prevention Plans (PPPs). The National Terrestrial Carbon Sinks Assessment (NTCSA) provides a spatial understanding of the status of South Africa's carbon sinks and is a first for the continent. To further support the communication of South Africa's mitigation efforts, the national GHG emission inventory reporting system has been formalised through legislation to streamline current reporting efforts and link this system to the National Atmospheric Emission Inventory System (NAEIS) for reporting. Additionally South Africa has taken an integrated planning approach to responding to climate change through the drafting of the Climate Change Bill by being cognisant of the need to create an enabling environment for development whilst tackling climate change impacts and reducing GHG emissions.

3.3. Policy and Institutional Context for Mitigation

As South Africa is committed to keeping global warming to less than 2°C above pre-industrial levels, and has pledged to "deviate from business as usual", through the "peak, plateau and decline" in GHG emission of 34% by 2020 and 42% by 2025, below business-as-usual emission levels. South Africa's emissions by 2025 and 2030 are forecast to range between 398 Mt CO_2e and 614 Mt CO_2e (DEA, 2015a). Policy instruments to aid in achieving this are under development and include a carbon tax, SETs for sectors, company-level carbon budgets, as well as regulatory standards and controls for specifically identified GHG pollutants and emitters. This mix of policies and measures will be implemented at a national level over five-year periods. Specifically, the 2016 and 2020 phase will focus on developing and demonstrating the mix of policies and measures in order to meet South Africa's Cancun pledge. The 2021-2025 and 2026-2030 phases will focus on achieving the pledges made in the NDC. This level of effort will enable South Africa's GHG emissions to peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter.

South Africa's BUR-1 discussed four key mitigation initiatives led by Government in an effort to transition to a low-carbon economy, namely the Climate Change Flagship Programmes (DEA, 2016c), the MPA (DEA, 2014), SETs, and Carbon Tax (National Treasury, 2015). The progress made with these mix-of-measures is presented below. Each of these mitigation

policy initiatives have cross-sectoral implications for the primary emitting sectors: Energy, Waste, Industrial Processes and Product Use (IPPU) and Agriculture, Forestry and Other Land Use (AFOLU).

The DEA and the Department of Agriculture, Forestry and Fisheries (DAFF) have endeavoured to address development and climate change challenges simultaneously within the AFOLU sector. The policy interventions specifically promote resource efficiency, greater productivity and social equity through mitigation and adaptation efforts. Policy interventions include amongst others the Draft Climate Change Adaptation and Mitigation Plan for The South African Agricultural and Forestry Sectors (DAFF, 2015) and the Draft Climate Smart Agriculture Strategic Framework for Agriculture, Forestry and Fisheries (DAFF, 2018). Studies were undertaken to improve the AFOLU sector GHG inventory including the Development of a Greenhouse Gas Emissions Baseline for the Agriculture, Forestry and Other Land Use sector in South Africa (DEA, 2016f), the Improvement of the Greenhouse Gas Emissions Inventory for the Agricultural Sector (DEA, 2016g) and the National Terrestrial Carbon Sinks Assessment (DEA, 2015c). Monitoring and evaluation requirements linked to the national greenhouse gas emission inventory to support the reporting of progress of implementation of policy, actions and measures in the sector are indicated in the report National Climate Change Monitoring and Evaluation system of the Agriculture, Forestry and Other Land Use Sector (DEA, 2015b). Further information about AFOLU policy development is discussed in Annexure B.3.

3.3.1. Development of Sectoral Emission Targets

The long-term vision is part of South Africa's fair contribution to the objectives of the UNFCCC – to stabilise concentrations of GHGs in the atmosphere, while allowing development to proceed in a sustainable manner (DEA, 2015c). Achieving the long-term vision will give effect to the rights of all South Africans to an environment that is not harmful to their health or well-being and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures.

The process of defining carbon budgets will be guided by this vision and by SETs that have defined the emissions available to a sector or subsector. Realising the vision will require a mix of measures, which are government instruments applied across the economy and a wide range of sectors. Mitigation plans by economic actors will be important responses to company carbon budgets, SETs and measures, and all of these should be understood in an integrated manner. Furthermore, all of these elements should be understood as part of the implementation of South Africa's mitigation response, as set out in the NCCRP (DEA, 2011a), which refers to other measures, such as the carbon tax (National Treasury, 2015a).

This vision can best be achieved as a partnership between government, business and civil society. While determining SETs and carbon budgets are ultimately decisions to be made by government, there will be consultation by DEA. SETs are a set of emissions reduction goals for the short- (ST, 2016–2020), medium- (MT, 2020–2030) and long-term (LT, 2030–3050) for key sectors and/or subsectors of the economy.

The rationale for SETs is to determine a strategic pathway for GHG emissions from sectors, as part of South Africa's mitigation efforts, while simultaneously achieving its developmental goals. Key objectives include:

- In the long-term, the broader mitigation system aims to achieve both developmental and climate goals;
- Contribute to achieving our peak, plateau and decline (PPD) trajectory;
- Provide clear metrics to guide sectors in remaining within SETs (and, where appropriate, subsectors within sub-sectoral SETs);
- Flexibility – operationalise flexibility where possible, while ensuring rigour, as needed

SETs are presented as a range, with distinct methodologies for the upper and lower boundaries, as well as for the three time periods mentioned above. The range is meant to provide an indication of what is technically feasible over time. The upper and lower SET boundaries will inform the resulting final sectoral SETs to be determined by the DEA, but the sum of the sectoral SETs will not exceed the PPD, which is the performance benchmark of the National GHG Emissions Trajectory Range specified in the NCCRP. Long-term sectoral SETs may be subject to revision over time to account for the evolution in assumptions and technological advancement. Sectoral SETs, as well as the PPD, are aspirational of nature and ambitious in the longer term. Key sectors include energy (power and non-power), industry, transport, waste and AFOLU.

The key to providing a successful ambitious trajectory is the decarbonisation of the national energy mix. As the single highest emitting sector significant reduction capacity can be achieved in the energy sector with minimal impact on the economic viability of industry other than coal mining. The mechanism to promote this transition within government is available through the Inter-Ministerial Committee on Climate Change. Analysis has demonstrated that a mix of 50% renewable energy by 2030 is achievable without overwhelming impacts, assuming government investment and a revision of the Integrated Resource Plan allows such a trajectory (WWF, 2010). Whilst South Africa has already invested significantly through the coal power build programme since the 2010 analysis, the cost of renewables has decreased more than expected, and a 50% mix may still be achievable.

The methodology to determine the sectoral allocation of GHG emissions for key sectors is based on various research sources. The South African Greenhouse Gas MPA (DEA, 2014) is drawn upon, but does not represent sufficient mitigation potential to achieve South Africa´s aspirational goals to limit emissions to the PPD range in the medium to long-term by itself. Further sectoral analysis was conducted, including research based on both local expert (beyond MPA) and international experience (IPCC, 2006). The starting point for sector SETs is their 2010 historical share of national emissions, as per the GHG Inventory for South Africa 2000–2010 (published in November 2014, DEA, 2014c).

3.3.2. Carbon Tax

The Paris Agreement will require sizable reductions in energy-related GHG emissions by large emitters. There has been substantial efforts by the South African government and parastatal companies to reduce emissions with 110 Mt CO_2e alone estimated to have been reduced in 2015. The private sector including companies and industries which disclose their emission reductions to the Carbon Disclosure Project (CDP) have also contributed to the country's current mitigation efforts with 7.5 Mt CO_2e estimated to have been reduced in 2016 and 6.8 Mt CO_2e in 2017 (CDP, 2017). Cumulative greenhouse gas emission reductions in 2015 of the private sector were not reported in CDP reports.

Carbon tax seeks to level the playing field between carbon intensive (fossil fuel-based firms) and low carbon emitting sectors (renewable energy and energy efficient technologies). The introduction of a carbon price changes the relative prices of goods and services, making emission-intensive goods more expensive relative to those that are less emissions intensive. Thus, this provides a powerful incentive for consumers and businesses to adjust their 'business as usual' behaviour to becoming more conscious about GHG emissions awareness.

The design of the carbon tax tries to address concerns about the impact of higher energy prices on low income households and on the international competiveness of South African firms (especially the mining and manufacturing sectors). The phased approach to the carbon tax provides flexibility and a clear timeframe indicating the transition that will be needed.

An extensive stakeholder engagement process began in 2010 with the discussion paper on the carbon tax (National Treasury, 2010). Stakeholder workshops were held with mainly businesses, government departments and Non-Governmental Organisations (NGOs) in 2011, 2013, 2014, 2015 and 2016. In 2014, a benchmarking study was published which aimed to investigate the carbon tax policy objectives and the role of benchmarking therein; and to translate these into clear guidance for benchmarking in the South African context that meets the policy objectives. A draft Carbon Tax Bill was released for public comment in 2015 (National Treasury, 2015). Bilateral consultations on the 1st Draft Carbon Tax Bill with industry occurred in 2016. An impact modelling study was completed in 2016 to explore the implications of carbon tax on emission reductions, economic growth and other macroeconomic aggregates such as employment, consumption and real wages. In 2017, a revised draft of the Carbon Tax Bill, that incorporated some of the comments received on the 2015 iteration was released and introduced to South Africa's Parliament (National Treasury, 2017). On the 19th March 2019, the National Council of Provinces Finance Committee proposed 1 June 2019 as the implementation date of the carbon tax (Parliament Monitoring Group, 2019).

The revised Carbon Tax Bill seeks to incentivise large emitters to reduce their GHG emissions. The Bill states that the rate of the carbon tax on GHG emissions must be an amount of R120 per ton carbon dioxide equivalent. Based on extensive stakeholder engagements and in order to ensure a smooth transition to a low carbon economy, a number of transitional tax-free allowances are provided which include:

- A basic tax-free allowance of 60 per cent;
- An additional tax-free allowance of 10 per cent for process emissions;
- An additional tax-free allowance of 10 per cent for fugitive emissions;
- A variable tax-free allowance for trade-exposed sectors (up to a maximum of 10 per cent);
- A maximum tax-free allowance of 5 per cent for above average performance;
- A 5 per cent tax-free allowance for companies with a Carbon Budget;
- A carbon offset allowance of either 5 or 10 per cent; and
- The total tax-free allowances during the first phase (up to 2022) can be as high as 95 per cent

Over time, these percentage based tax free allowances could be replaced with an absolute tax-free threshold which could be in line with the proposed carbon budgets. A study on the options for alignment and integration of the carbon tax and carbon budget policy instruments post 2020 has been completed (World Bank, 2017). The mandatory carbon budgets regime will be introduced in a way that is fully-aligned with the carbon tax, and resulting in no double penalty. An integrated review process to assess both instruments will be done, which will inform any significant changes in the tax rate and the implementation of the carbon budgets.

To inform the Carbon Tax, the National GHG Emissions Reporting Regulations (DEA, 2015d) were published in 2015. The purpose of these regulations is to introduce a single national reporting system for the transparent reporting of GHG emissions. Thresholds for mandatory reporting are provided in the regulations based mainly on energy production, energy consumption and greenhouse gas emissions. The regulations also reinforce the accuracy of mandatory emission accounting with requirements for completeness, methods, verification and validation of information. Entities monitoring and reporting fugitive and combustion emissions from all GHG emission sources and source streams belonging to activities listed in Annexure 1 of the regulations must be complete and cover all processes taking into account the capacity thresholds specific to the

different activities as listed in Annexure 1 of the regulations. Approved procedures and/or emission factors are available to quantify carbon dioxide equivalent (CO_2e) emissions with a relatively high level of accuracy for different processes and sectors. Procedures of review are also outlined whereby alternative methods and emission factors can be evaluated and considered.

Requirements for verification and validation of reporting GHG emissions are set out in the Technical Guidelines for Monitoring, Reporting and Verification of GHG Emissions by Industry (DEA, 2017a). The Technical Guidelines embody the latest methods for estimating emissions and are based on the 2006 IPCC Guidelines for compilation of National GHG inventories (IPCC, 2006). In addition, these guidelines will be subject to review annually depending on the availability of new methodologies, emission factors and refinements to existing methodologies. In terms of data quality management, entities reporting their GHG emissions will need to integrate quality assurance/quality control procedures with in-house quality management systems. In terms of verification, the DEA will conduct an assessment which could include a comparison with methods defined in the Technical Guidelines for Monitoring, Reporting, Verification and Validation of Greenhouse Gas Emissions by Industry, with earlier submissions, with submissions from similar facilities and with other independent data. It would be expected that verifiers from the DEA will be administratively independent of the reporting entities' operations to ensure objectivity and impartiality in the verification process.

3.3.3. Carbon Offsets

Draft regulations for Carbon Offsets were released in June 2016 (National Treasury, 2016). The regulation is aimed at providing an offset mechanism that can be used to develop carbon offset projects to enable a reduction of carbon tax liability. It is through the investment in specific projects that reduce, avoid or sequester emissions that carbon offsets can be generated.

The draft regulations define 'approved project' as a:

- CDM project;
- VCS project;
- Gold standard project;
- Project that complies with another standard approved by the Minister of Energy of a delegated authority.

The regulations also provide for the creation of an offset registry and offset certificates.

3.3.4. Carbon Budgets

Recognising that due to the current emissions-intense structure of the economy, many sectors require a flexible mitigation approach, which enables the development and use of lowest-cost options such as offset and other types of market-based mechanisms. For such sectors, a Carbon Budget approach is adopted that specifies desired emission reduction outcomes consistent with the benchmark national GHG emissions range trajectory. The CB process will identify an optimal combination of mitigation actions at the least cost to-and with the most sustainable development benefits for-the relevant sector and national economy to enable and support the achievement of the SETs consistent with the benchmark National GHG Emissions Trajectory Range. Government will actively consult with industry and other key stakeholders in the development of carbon budgets and approaches, mechanisms and outcomes (DEA, 2011a).

Phase 1 of the carbon budget process is underway and the budgets have been setup for 2016 to 2020. The current phase of carbon budgets is not intended to directly reduce GHG emissions, but rather to put the systems and procedures in place that can lead to emission reductions in the next phase. Phase one is voluntary as there is no legal basis to set emission limits for sectors or companies (DEA, 2018). A social and economic impact assessment of phase one was completed with inputs from companies and businesses in South Africa. The findings from the assessment included:

- No economy wide impacts due to carbon budgets
- A decline in income tax revenue as a result of additional monitoring and reporting costs

- No co-impacts including economic development, human health, food and energy security, biodiversity and access to energy.
- No impacts on inflation
- No expectation to influence the local impact of company spending
- No impacts linked to a change in scale of company operations on local communities

The post 2020 period will only become mandatory under the Climate Change Bill. Based on the findings of the engagements with companies and the DEA, several lessons related to minimising the negative socioeconomic impacts of Phase 2 of the carbon budgets were identified. These learning points were suggested to improve the budget allocation process which should be as standardised, simple and streamlined as possible to reduce the time and effort required by companies and the DEA to agree to the carbon budgets.

3.3.5. Draft Climate Change Bill

The Draft Climate Change Bill of 2018 was published for public comment on 8 June 2018 (DEA, 2018b). The comments from the public have been addressed and the draft bill is currently undergoing a cabinet approval process. The intention of this Bill is to build an effective climate change response and a long term just transition to a climate resilient and lower carbon economy and society. The draft Bill specifically provides for a coordinated and integrated response to climate change that seeks to effectively manage climate change impacts, enhance adaptive capacity and build resilience. In order to make a fair contribution to support the global effort to stabilise greenhouse gas concentrations, the draft Bill seeks to ensure that the country determines its GHG emission trajectory. Sectoral emission targets and carbon budgets, consistent with the trajectory, are seen as the means to achieve the desired emission reductions and to regulate the implementation of mitigation actions. The phasing out of synthetic GHG emissions is also contemplated in the draft Bill. The institutional and monitoring and evaluation needs are also described in the Bill.

3.3.6. Regulatory Standards

GHG emission regulations were gazetted in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). These regulations pertained to the declaration of GHGs as priority air pollutants (DEA, 2016a), national pollution prevention plans regulations (PPP), under sections 29(3), 53 (o) and (p) read with section 57(1) (a) of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), (DEA, 2016b) and the National Greenhouse Gas Emission Reporting Regulations, under section 53 (aA), (o) and (p) read with section 12 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (DEA, 2015d).

GHGs were declared as priority air pollutants as part of the DEA (2016a) regulation and includes CO_2, CH_4, N_2O, HFCs, PFCs, SF_6. The regulation requires that a person falling within the specified emitter category to prepare and submit a PPP (DEA, 2016a). PPPs means a plan contemplated in section 29(3) of the National Environmental Management: Air Quality Act 2004 (Act 39 of 2004). Significant emitters are identified as those institutions or companies which emit greater than 0.1 Mt of CO_2 as measured directly or quantified in CO_2 equivalents.

The PPP regulations prescribe the requirements for the development and submission of pollution prevention plans (DEA, 2016b). The production processes identified are reported in accordance with the National Greenhouse Gas Emission Reporting Regulations. An entity conducting a production process where their capacity is equal or above the threshold indicated in the reporting regulations will need to report on the relevant greenhouse gases and associated activity data for all relevant IPCC source categories. In addition to these entities, the DEA could require other entities to report on their GHG emissions by following a consultative process set out in the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004).

The production processes mentioned in the PPP regulations includes:

- Coal mining;
- Production and/or refining of crude oil;
- Production and/or processing of natural gas;
- Production of liquid fuels from coal or gas;
- Cement production
- Glass production;
- Ammonia production;
- Nitric acid production;
- Carbon black production;
- Iron and steel production;
- Ferro-alloys production;
- Aluminium production, excluding foundries;
- Polymers production;
- Pulp and paper production;
- Electricity production from fossil fuels; excluding the use of back-up generators.

As part of the development of the plans, the description of production processes and the specification of the greenhouse gases generated are required. The methodologies for the monitoring and evaluation of GHG emitted are also expected. A baseline and forecasted emission trajectory related to the relevant production processes is also required, along with an assessment of the mitigation measure expected to be implemented to reduce the emissions generated.

The purpose of the GHG reporting regulations is to introduce a single national reporting system for the transparent reporting of GHG emissions, which will be used to inform policy formulation, implementation and legislation (DEA, 2015d). It will support South Africa to meet its reporting obligations under the United Framework Convention on Climate Change and instrument treaties to which it is bound. It will also formalise the processes already undertaken to establish and maintain a National Greenhouse Gas Inventory. These regulations apply to the categories of emission sources adapted from the IPCC (2006) emission inventory reporting guidelines. The relevant emission sources must be registered on the National Atmospheric Emissions Inventory System.

3.3.7. Policies and Measures

South Africa has clear goals for climate change mitigation in national policy, and an international commitment to reduce GHG emissions that is consistent with national policy. The goal of this analysis is to assess the consistency of current and planned mitigation policies and measures against South Africa's current mitigation goals. The analysis is undertaken to assess what additional policies and measures would be necessary (if required) to meet South Africa's mitigation goals. The country's current mitigation goals are collectively indicated in the National Climate Change Response Policy and South Africa's NDC. Furthermore, socio-economic costs and benefits of existing and planned mitigation policies and measures were assessed, consistent with the approach to mitigation outlined in national policy.

Previous and on-going work has been undertaken to assess South Africa's mitigation potential, with the first MPA report published by the DEA in 2014 (DEA, 2014). In contrast to the MPA work (which focused on mitigation potential), the present study has been undertaken with the purpose of examining the effectiveness of policies and measures undertaken or planned towards achieving South Africa's mitigation policy objectives (DEA, 2018c). Once approved by the cabinet, its results will also be published in the mitigation chapter of the next BUR to follow BUR-3.

The immediate objectives of this study are:

- To estimate the individual and total effect of existing and proposed policies and measures (PAMs) on greenhouse gas (GHG) emissions reduction to meet South Africa's long-term climate mitigation goals, and to propose additional policies and measures if required to meet these goals; and
- To assess the socio-economic impacts of these policies and measures.

To address these questions and achieve the objectives of this study, an integrated energy-economy-environment emissions modelling approach was used to model future national greenhouse gas emissions, report the required indicators, and to capture the complex interactions between

different parts of the economy. This consisted of an economy-wide energy systems model (SATIM) for the energy and industrial processes and product use (IPPU) emissions, and spreadsheet models for non-energy emissions (AFOLU and Waste). A computable general equilibrium model (eSAGE) was used to analyse the socio-economic implications of policies, and to provide feedback on changes in economic structure and demand to the other models.

Key existing and planned policies and measures (PAMs) with significant (potential) mitigation impact were identified, on the basis of having an environmental objective (mitigation); measurable targets against which progress can be quantified; and sufficient data being available to undertake analysis. Following this, a reference scenario was developed, modelling the South African economy and its associated GHG emissions from the present until 2050, based on a range of internally-consistent assumptions concerning economic growth and demographic change. All existing policies and/or measures (approved and implemented prior to 2016), were incorporated in the reference scenario, but no further mitigation policies were included. The reference scenario was used as a basis for comparison for analysing the impact of individual policies and measures, as well as their collective impact, and the impact of potential additional measures. In order to assess the combined impact of all planned policies and/or measures GHG emissions, a Planned Policies and/or Measures (PPM) scenario was then modelled.

An assessment of the adequacy of the existing and planned policies and measures was undertaken by comparing the PPM scenario with the national benchmark emissions trajectory range, providing an indication of the 'gap' between what mitigation existing and planned policies and measures will achieve, and what is required. An emissions budget approach was used, and assessment against a range was accomplished by using three long-term emissions budgets from 2020 to 2050, corresponding to the high, medium and low parts of the range. It was found that the combined mitigation impact of all existing and planned PAMs remained within the high and medium emissions budgets, and thus additional policies and measures were only identified for the lower budget, by adding three additional PAMs in the waste and AFOLU sectors, and by identifying further interventions in the energy sector by placing an emissions constraint on the energy model. Furthermore, assessment of the socio-economic impacts of these additional policies and measures were also undertaken. The final PaMs study is currently undergoing a cabinet approval process and will be published afterwards. The outcomes will also be reported in BUR-4.

3.3.8. GHG Pathways

The DEA also initiated work on an analysis of projected Greenhouse emissions Pathways. This was commissioned to embody a clear, sensibly devised emissions reduction profile for the long term, which will support decision making, especially in respect of legislative and other measures implemented to manage national greenhouse gas emissions in the country. Phase 1 of the study was completed in March 2018, with three plausible pathways developed. This work has not been published yet pending the finalisation of similar work that is being done by the National Planning Commission (NPC) on the just transition to a low carbon economy and climate resilient society. Upon finalisation of the study by the NPC, both studies will be checked for alignment and published.

3.4. Progress on the implementation of mitigation actions

Through the National Climate Change Response Monitoring and Evaluation System (M&E System), South Africa is continuously striving to quantify the effects of mitigation policies, strategies and actions implemented in the country. A comprehensive assessment of mitigation related policies, measures and institutional arrangements were provided in BUR-1 and BUR-2. An update to these previously mentioned policies and measures are outlined in this BUR. Significant GHG mitigation was achieved in South Africa between 2000 and 2015, with at least 119 $MtCO_2e$ mitigated in 2015 alone as shown in **Figure 3.1**. The results show progress in reducing GHG emissions as more programmes to mitigate climate change are being implemented. The annual

emission reductions from these mitigation programmes were estimated at 96 $MtCO_2e$/year, 101 $MtCO_2e$/year, 112 $MtCO_2e$/year and 119 $MtCO_2e$/year for 2012, 2013, 2014 and 2015 respectively.

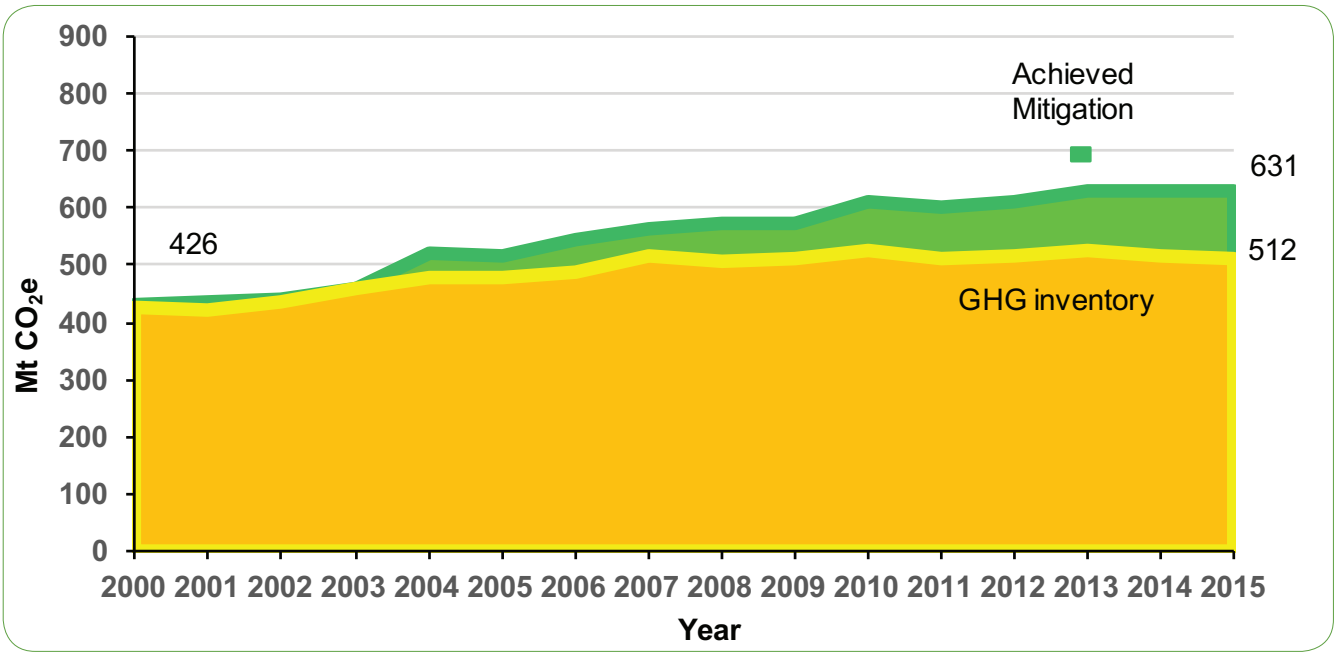

Figure 3.1: South Africa's annual emissions reduction for period 2000-2015

3.4.1. Domestically Supported Nationally Appropriate Mitigation Actions

Mitigation actions at national level which have resulted in substantial emission reductions in the energy sector are mainly large scale renewable energy projects. Important policy drivers that have promoted renewable energy projects include the 2003 White Paper on Renewable Energy (DME, 2003) and the Renewable Energy Independent Power Producers Procurement Programme (REIPPP) (DOE, 2016a). The National Energy Efficiency Strategy (DOE, 2005) and the Eskom Integrated Demand Side Management Program have promoted industrial energy efficiency interventions to optimise processes in production plants and this intervention has been taken up by a number of industries in the manufacturing and mining sectors. In the waste sector, landfill gas to energy projects also contributes substantially to emission reductions at a national level. Landfill gas to energy is an important intervention within the Waste Management Flagship programme. A longer list of policy drivers of mitigation actions is provided in **Table 3.1**.

A breakdown of the emission reductions reported through the various reporting mechanisms and across all sectors is indicated in **Table 3.2** to **Table 3.8**. A key source of data used was the National Climate Change Response Database. More information will be provided about steps taken and envisaged and progress of implementation of individual policies, actions and measures in future biennial update reports including timelines for planning, implementation and expected effects of reported mitigation actions, results achieved and estimates of expected future results for mitigation actions

and policy interactions. This will also include updates to the quantification of GHG emission reductions for mitigation actions for which emissions reductions could not be quantified for in this BUR. Updates to future biennial update reports will include funded research currently proposed which includes:

- The development of indicators to track South Africa's progress on the national response to climate change taking into account the sustainable development goals and NDC in light of the compilation of the annual climate change report.
- Tracking the Transition to a Low Carbon and Climate Resilient Society and Economy including objectives to survey the landscape of available policies and implementing instruments, identify underlying governance and coordination structures and to develop a corresponding metric framework to enhance the understanding and reporting of progress.

Table 3.1: Linkages of mitigation actions with supporting legislation and policy

Sector / Thematic Area	Actions	Government Programme	Supporting Legislation, Policies and Measures
Clean energy generation	Renewable Energy Independent Power Producer Procurement Programme (REIPPP) National Solar Water Heating Programme National Industrial Biofuels Strategy South African Wind Energy Programme (SAWEP)	The Renewable Energy Flagship Programme	National Energy Act, 2008 (Act No. 34 of 2008) Electricity Regulation Act, 2006 (Act No. 4 of 2006) Draft Integrated Energy Plan for South Africa (2016) Draft Integrated Resources Plan for South Africa (2018) State of Renewable Energy in South Africa (2015) White Paper on Renewable Energy of 2003
	SASOL coal-to-gas switch SASOL gas turbines Eskom Open Cycle Gas Turbines (OCGT) Compressed Natural Gas (CNG) industry fuel switch Energy and Environment Partnership (EEP) Programme of Southern and East Africa, 2010 Diversification of electricity generation sources: Bio2watt Project	None	
Energy efficiency	Integrated Demand Management Programme Municipal Energy Efficiency Programme Industrial Energy Efficiency Hydrogen and Fuel Cell Technologies Energy Efficiency Labelling Standards DEA Green vehicles National Energy Efficiency Strategy (NEES) (2005)	The Energy Efficiency and Energy Demand Management Flagship Programme	National Energy Efficiency Strategy (NEES) (2005) Draft Regulations on Registration, Reporting on Energy Management and Submission of Energy Management Plans (2015) Draft Post-2015 Energy Efficiency Strategy (NEES) (2016)
	Private Sector Energy Efficiency Energy Efficiency Leadership Net- work (EELN) Roadmap to Cleaner Fuel- The Clean Fuels 2 specification The Department of Trade and Industry's Incentive Schemes, (DTI, 2013) SASOL energy efficiency projects Green Economy Initiative	The Energy Efficiency and Energy Demand Management Flagship Programme	

Sector / Thematic Area	Actions	Government Programme	Supporting Legislation, Policies and Measures
Efficient Transport Systems	Integrated Rapid Public Transport Networks Biofuels Compressed Natural Gas Transnet Freight Modal Shift Passenger Rail Modal Shift Taxi Recapitalisation Programme	The Transport Flagship Programme	Draft Roads Policy (2018) Draft Revised White Paper on National Transport Policy (2018) Department of Transport Revised Strategic Plan for the fiscal years 2015/16 – 2019/20 (2017) National Transport Master Plan 2050; Minimum Requirements for the Preparation of Integrated Transport Plans (2016); Roads Policy for South Africa, draft Green paper (2016); Draft Green Transport Strategy 2016-2021 (2016) National Land Transport Strategic Framework (2015); PRASA National Strategic Plan (2012); Non-Motorised Transport Policy (2012); Transnet Long-term Planning Framework (2012); Road Freight Strategy for South Africa (2011); Transport Action Plan (2010); Public Transport Strategy (2007); National Ports Act, 2005 (Act 12 of 2005) National Roads Act,1972 (Act 54 of 1971) Road Transportation Act, 1977 (Act 74 of 1977) Urban Transport Act, 1977 (Act 78 of 1977) Road Traffic Act, 1989 (Act 29 of 1989) National Road Traffic Act, 1996 (Act 93 of 1996) National Land Transport Act, 2009 (Act 05 of 2009) Vehicle Emissions Fuel Economy and CO2 Emissions Labelling Scheme in terms of the Standards Act 1993.
Energy efficiency	Green buildings	Low Carbon, Climate Resilient Built Environment, Communities and Human Settlements	Climate Change Adaptation Sector Strategy for Rural Human Settlements (2013) Spatial Planning and Land Use Management Act (Act No. 16 of 2013) (2013) Regulations in terms of the Spatial Planning and Land Use Management Act, 16 of 2013 (2015) National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977)
Cleaner Production	Capture of PFC in aluminium plants Cleaner production interventions in industry	None	Green Economy Model (2013) Draft Climate Change Bill (2018) Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry (2017) National Greenhouse Gas Emission Reporting Regulations (2017) National Pollution Prevention Plans Regulations (2016) National Atmospheric Emission Reporting Regulations (2015) National Environmental Management: Air Quality Act No 39 of 2004 (NEM:AQA) Industrial Policy Action Plan (IPAP) 2012/13 – 2014/15; National Industrial Policy Framework (NIPF) (2007); Industry Incentive Schemes

Sector / Thematic Area	Actions	Government Programme	Supporting Legislation, Policies and Measures
Waste Management	National Organic Waste Composting Strategy (NOWCS) (DEA, 2013a) Municipal Solid Waste Tariff Strategy (DEA, 2012a) Recycling and Economic Development Initiative of South Africa (REDISA) (DEA, 2012b) National Waste Management Strategy (NWMS) (DEA, 2011b)	The Waste Management Flagship Programme	Waste Tyre Regulations (2008) National Policy for the Provision of Basic Refuse Removal Services to Indignant Households (2011) White Paper on Integrated Pollution & Waste Management for RSA (2000) National Environmental Management: Waste Amendment Act, 2014 (Act No. 26 of 2014) Waste Classification and Management Regulations (2013) National Norms and Standards for the Assessment of Waste fort Landfill Disposal (2013) National Waste Management Strategy (2011) Municipal Solid Waste Tariff Strategy (2012) The National Organic Waste Composting Strategy (2013)
Land, Biodiversity and Ecosystems	Working for Energy Working for Land Working for Ecosystems Green Transport Strategy (DoT, 2017a); Conservation Agriculture Policy (DAFF, 2017)	The Climate Change Response Public Works Flagship Programme	Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) National Forests Act, 1998 (Act No. 84 of 1998) Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries (2013) Draft Climate Change Adaptation and Mitigation Plan for The South African Agricultural and Forestry Sectors (2015) Draft Climate Smart Agriculture Strategic Framework for Agriculture, Forestry and Fisheries (2018) Draft Conservation Agriculture Policy (2017) South African National Terrestrial Carbon Sink Assessment (2015) Unlocking Barriers and Opportunities for Land Use for Land Use Based Climate Change Mitigation (2017) Revised National Biodiversity Strategy and Action Plans and the Strategic Framework and Overarching Implementation Plan for Ecosystem-Based Adaptation (EbA) in South Africa (2015) Strategic Plan for Measurement, Reporting and Verification: AFOLU Sector 2016 to 2020 Biodiversity Sector Climate Change Response Strategy (2014) Draft South Africa's National Adaptation Strategy (2016) Long-Term Adaptation Scenarios (2013) Green Economy Model (2013) Draft Green Transport Strategy 2016-2021 (2016)

3.4.1.1 Mitigation Actions in the Energy Sector

The mitigation actions undertaken by the country in the Energy Sector are indicated in **Table 3.2**.

Table 3.2: Update on Mitigation Actions for the Energy Sector Reported in BUR-2

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action		Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017	Methods	Assumptions
Integrated Resource Plan (IRP) 2018 (DoE, 2018a)	The IRP is the electricity plan for SA. It is a subset of the Integrated Energy Plan	Regulatory/ promulgated	CO_2, CH_4, N_2O	Adopted. Time line 2018- 2030. By 2030 Total Installed Capacity: Coal with 33847 MW, Nuclear with 1860 MW, Hydro with 4696 MW, Pumped Storage with 2912 MW, Solar PV with 7958 MW, Wind with 11442 MW, CSP with 600 MW, Gas with 11930 MW, Other (Co Generation, Biomass, Landfill) with 499 MW and Embedded Generation 2600 MW.	Directs the expansion of the electricity supply over the long term. Various scenarios of the country's power supply system were simulated including demand-growth scenarios where the impact of projected load demand on the energy mix was tested. (DoE, 2018a)		Annual CO_2 emissions (Mt CO_2e) Water Usage (bn ℓ/yr) Unit cost (c/kwh) Cumulative Cost Difference (R' million) Grid Stability and Fuel Supply Exposure (Qualitative)	The draft IRP is to be finalised within the 2018/2019 year (Parliament of the Republic of South Africa, 2018). Examples of recommendations received from the Portfolio Committee on Energy in November 2018 included to review the IRP every 2 years, ensure that externalities/environmental impacts of the proposed energy mix are considered in a meaningful way and to direct the DoE to conduct a thorough socio-economic impact assessment of various energy mix scenarios in preparation for the review of the IRP by 2020.	111.97	Total Electricity Generated from Renewables (Hydroelectric; Pumped Storage; Gas Turbine; Wind Energy) for 2007/8: 4884 GWh 2008/9: 3999 GWh 2009/10: 4066 GWh 2010/11: 5112 GWh 2011/12: 5577 GWh 2012/13: 5988 GWh 2013/14: 7540 GWh 2014/15: 7668 GWh 2015/16: 7854 GWh (Eskom, 2017) 2016/2017: 4247 GWh (Eskom, 2017)	Grid Emission factor method adapted from Mac Consulting (2013). 2007/8: 0.98 t CO_2e/MWh 2008/9: 1.02 t CO_2e/ MWh 2009/10: 1.01 t CO_2e/ MWh 2010/11: 0.99 t CO_2e/ MWh 2011/12: 0.99 t CO_2e/ MWh 2012/13: 1.00 t CO_2e/ MWh 2013/14: 1.03 t CO_2e/ MWh 2014/15: 1.01 t CO_2e/ MWh 2015/16: 1.00 t CO_2e/ MWh 2016/17: 0.98 t CO_2e/ MWh GWP: Myhre et al. 2013
Integrated Energy Plan (IEP) (DoE, 2016b)	The over-arching co-ordinated energy plan when combining the constraints and capabilities of alternative energy carriers to meet the country's energy needs	Regulatory/ promulgated	CO_2, CH_4, N_2O	A technical plan without quantitative goals that makes key assumptions about the macro-economy and other factors to project future energy demand and the supply side implications.	Objective 1: Ensure security of supply; Objective 2: Minimise the cost of energy; and localisation; Objective 3: Minimise negative environmental impacts from the energy sector; other objectives indicated in DoE, 2016b, The IEP analyses current energy consumption trends within different sectors of the economy (i.e. agriculture, commerce, industry, residential and transport) and uses this to project future energy requirements, based on different scenarios. The IEP then determines the optimal mix of energy sources and technologies to meet those energy needs in the most cost-effective manner for each of the scenarios. The associated environmental impacts, socio-economic benefits and macroeconomic impacts are also analysed. (DoE, 2016b)		GDP Number of Solar Water Heater Installations Energy efficiency Vehicle efficiency (new vehicle improvement per annum) Electric vehicle penetration rate (% per annum) Prices of energy commodities CO_2 emissions limit CO_2 externality costs Carbon tax	The IEP was published in 2016. The plan was recommended for revision by cabinet in December 2017.The IEP is still to be finalised (Parliament of the Republic of South Africa, 2018)	Not yet quantified[a)]	-	-

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action		Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017	Methods	Assumptions
Independent Power Producers (IPP) Programme including the South African Wind Energy Programme	To secure electrical energy from private sector via renewable energy sources to add to the national grid. - e.g. Solar PV, Onshore Wind, CSP, Small Hydro, Biomass, Landfill Gas	Social/ Existing measure	CO_2	Contribute to the renewable energy generation target of the IRP 2018.	The South African REIPPPP is a competitive tender process that has been designed to facilitate private sector investment into grid-connected renewable energy (RE) generation in South Africa. Independent power producers (IPPs) are invited to submit bids for onshore wind, solar photovoltaic (PV), concentrated solar power (CSP), small hydro, biomass, biogas or landfill gas projects. Submitted bids must first qualify for evaluation by meeting minimum compliance requirements, after which they are evaluated based on price (bid tariff) and economic development criteria.		Electricity generation capacity commissioned (MW) Electricity generation reserve margin (%) GHG emission reductions per annum	Renewable energy projects in 2018 which are part of the independent power producers program includes 62 projects that are operational, 2 projects under construction and 48 projects which have not been financially closed (DoE et al. 2018)	40	IPP Purchases by Eskom: 2010/2011: 1833 GWh 2011/2012: 4107 GWh 2012:2013: 3516 GWh 2013:2014: 3671 GWh 2014:2015: 6022 GWh 2015:2016: 9033 GWh 2016:2017: 11529 GWh (Eskom, 2017)	Grid Emission factor method adapted from Mac Consulting (2013). 2007/8: 0.98 t CO_2e/MWh 2008/9: 1.02 t CO_2e/ MWh 2009/10: 1.01 t CO_2e/ MWh 2010/11: 0.99 t CO_2e/ MWh 2011/12: 0.99 t CO_2e/ MWh 2012/13: 1.00 t CO_2e/ MWh 2013/14: 1.03 t CO_2e/ MWh 2014/15: 1.01 t CO_2e/ MWh 2015/16: 1.00 t CO_2e/ MWh 2016/17: 0.98 t CO_2e/ MWh GWP: Myhre et al. 2013
National Solar Water Heating (SWH) Programme (DoE, 2014)	This programme involves the installation of solar water heaters in residential dwellings.	Social/ Existing measure;	CO_2	Current, new cumulative target of 1.75 million units by 2019, and 5 million by 2030 (DoE, 2018c)	Implemented. Procure and install SWH systems throughout South Africa. The implementation plan for 2018/19 was revised to take into account: Updated procurement guidelines which were verified by the South African Bureau of Standards (SABS) that set a 70% local content threshold for SWH systems; Central Energy Fund to undertake Repair and Replace Programme to fix problematic SWHs; appointment of Accredited Training Institutions to train Installation Assistants. (DoE, 2018b).		Number of SWH installations.	In 2015 the DoE took over the programme and changed the focus to providing solar water heaters to state-subsidised and un-electrified homes, (DoE, 2018c). In 2015 and 2016 the DOE conducted two workshops with municipalities in order to forge and strengthen the relationship between the two spheres of government. Municipalities started responding to the Request for Information as was disseminated by the DoE in the past years to confirm the state of readiness (DoE, 2018b).	Not yet quantified[a)]	Data not immediately available.	-

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Private Sector Energy Efficiency (PSEE) Project	The National Business Institute (NBI) implemented the PSEE project, which aimed to improve energy efficiency in commercial and industrial companies in South Africa, through the provision of various services to assist companies to identify and implement energy saving measures (NBI, 2015).	Economic / Existing measure	CO_2	December 2013 to November 2015. The PSEE planned to support 60 large, 1 000 medium and 2 500 small companies by March 2015.	Implemented. Improve energy efficiency in commercial and industrial companies in South Africa. The PSEE supported companies towards achieving energy savings and energy-intensity reductions (NBI, 2015).		Number of companies registered on the PSEE website,and number of companies receiving advice over the phone Number of participants at workshops, reported by gender and race Number on-site surveys implemented at sites of medium-sized firms Number of follow-up services that have been provided Number of large companies (annual energy spend in excess of R45 million) engaged in strategic energy management interventions Number of sites Number of opportunities identified Annual energy savings (GWh) Lifetime energy savings (GWh) Lifetime carbon savings (Mt CO_2e) Capex leveraged Average payback of opportunities Average capacity usage (MW)	The PSEE concluded its activities on 30 November 2015. Within a relatively short period of time, the programme has supported 37 large firms across a variety of sectors in developing comprehensive strategic energy-management plans. The target for energy savings was 2087 GWh per annum. It has also conducted more than 950 energy site surveys at medium-sized companies – the starting point for any company wishing to identify its energy-use profile and prioritise actions to reduce energy consumption. In addition, almost 4 000 small businesses have been assisted through telephonic services, web-based tools and free training workshops. (NBI, 2015)	0.77	Mean annual energy savings due to the project = 129.3 GWh (NBI, 2015)	Grid Emission factor method adapted from Mac Consulting (2013). 2013/14: 1.03 t CO_2e/Mwh 2014/15: 1.01 t CO_2e/Mwh 2015/16: 1.00 t CO_2e/Mwh GWP: Myhre et al. 2013 The annual energy savings each year remained the same.
Energy Efficiency Leadership Network (EELN)	The main objective of the EELN is to promote energy efficiency in the South African business sector, through a platform for knowledge sharing and capacity development. The EELN is also intended to support the business commitment to the 2006 Green Accord and in supporting government's target of a 12% reduction in energy consumption by 2015 (NBI, 2014).	Economic / Existing measure.	CO_2	Current, launched in December 2011. No quantitative goals.	Implemented. The Energy Efficiency Leadership Network (EELN) aims to promote energy efficiency in the broader South African business sector through a platform for knowledge sharing and capacity development. Members of the EELN financially invest in energy efficiency through the companies' own resources and useful application of Eskom's Integrated Demand Management (IDM) scheme (NBI,2014)		No progress indicators	Members of the EELN learn through engaging with government and other important stakeholders responsible for energy policy formulation and EELN case studies have been used by private sector and government planners to design future projects and policy objectives. The next ten years will see the EELN increase its scope to include a link between energy and water, waste management, renewable energy and all aspects of the green economy principles that are starting to emerge from government and business initiatives (NBI, 2018)	Not yet quantified[a)]	-	-

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Energy Efficiency Standards and Appliance Label- ling Programme: SANS 941 for Energy Efficiency of Electrical and Electronic Equipment.	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.	Policy & Standards / Existing and proposed measures	CO_2	Current, from 2005/6. No quantitative goals.	Adopted. The purpose of the South African Energy Efficiency Label is to ensure that consumers are informed about the relative energy efficiency of an appliance before they decide to purchase. 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)	No progress indicators.		Appliance Standards and Labelling Regulations have been put in place. A key component of these regulations is that a number of appliances are now required to be labelled with a South African Energy Efficiency Label. The South African Energy Efficiency Label must therefore be visible on any appliances identified as requiring a label in both physical and online stores. (DoE, 2017)	Not yet quantified[a)]	-	-

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Passenger Rail Agency of South Africa (PRASA): Passenger Rail Modal shift from private vehicles to rail, Gautrain Rail System and Luxury Commuter Trains	Upgrading passenger rail infrastructure and services for an Integrated Public Transport System that reduces vehicle emissions (DEA, 2016d).	Economic / Existing measure;	CO_2	Current. For PRASA rail, by 2020, 2021 being able to complete 400 to 500 million passenger trips in 2020/21 with at least 291 train sets at full capacity configuration with 12 coaches with a target of 88.1% on time performance. The medium to long-term objective is for Rail Operations to have 3 840 to 4 600 coaches in service and increase its on-time performance to above 90% and availability in excess of 95% in order to fulfil the current travel demand. (PRASA, 2018). No quantitative goals for Gautrain rail.	Implemented. Decrease use of private vehicles and increased use of improved passenger rail services. The need for investment in the passenger rail sector is highlighted in the revised white paper on National Transport Policy (DoT, 2018a). Municipalities are responsible for service level planning for passenger rail on a corridor network basis in consultation with PRASA.	Project and Baseline Scenario GHG Emissions. CO_2e reductions associated with the modal shift. Number of short-term jobs created during the construction phase. Cost-effectiveness associated with the implementation of the system. Job-creation effectiveness associated with the implementation of the system.		The Gautrain project was announced in 2000 and the construction of this system started on the 28th of September 2006. The first phase of the system took 45 months to complete and the second phase was completed in 54 months. Construction of the third phase also occurred concurrently. The luxury commuter trains include the Soweto Business Express, the Tshwane Business Express and the Gauteng Business Express in Gauteng and the Boland (Huguenot) Business Express in the Western Cape. The Soweto Business express was launched in 2007 and consists of a network linking Soweto to Johannesburg. The Tshwane Business Express went into operation in 2008 and services areas within Tshwane and Johannesburg. The Gauteng Business Express was opened for commercial use in 2009 and covers a network between Johannesburg and Tshwane, with the same station stops as that of the Tshwane Business Express. The Boland Business Express was initially launched in 2007 as the Khayelitsha Express but has subsequently been reassigned to service areas further north in 2008. (DEA, 2016d)	Not yet quantified	Gautrain Rail electricity consumption- 2010: 6805704 kWh 2011: 21387683 kWh 2012: 37479719 kWh 2013: 40544498 kWh 2014: 43670535 kWh Total distance travelled by road instead of Gautrain- 2010: 22308826 km 2011: 65694309 km 2012: 128657425 km 2013: 163892582 km 2014: 189927009 km Gautrain users' alternative transport mode- private car: 56%; Minibus taxi: 28%; bus: 14%; train: 2% Luxury Commuter Rail electricity consumption- 2007: 668 MWh 2008: 2315 MWh 2009: 3520 MWh 2010: 4913 MWh 2011: 4913 MWh 2012: 4913 MWh 2013: 4913 MWh 2014: 4913 MWh Total distance travelled by road instead of Luxury Commuter Rail- 2007: 1258053 km 2008: 5730659 km 2009: 8184842 km 2010: 11473153 km 2011: 11473153 km 2012: 11473153 km 2013: 11473153 km 2014: 11704948 km All other data reported in DEA (2016d)	Fuel emission factors: Diesel: 74100 kg CO_2/TJ Diesel: 3.9 kg CH_4/TJ Diesel: 3.9 kg N_2O/TJ Petrol: 69300 kg CO_2/TJ Petrol: 33 kg CH_4/TJ Petrol: 3.2 kg N_20/TJ Grid electricity emission factors: 2007/8: 0.98 t CO_2e/MWh 2008/9: 1.02 t CO_2e/ MWh 2009/10: 1.01 t CO_2e/ MWh 2010/11: 0.99 t CO_2e/ MWh 2011/12: 0.99 t CO_2e/ MWh 2012/13: 1.00 t CO_2e/ MWh 2013/14: 1.03 t CO_2e/ MWh 2014/15: 1.01 t CO_2e/ MWh Post 2014, the electricity consumed by Gautrain Rail remains the same and the distance travelled by vehicles on the road as an alternative remains the same. Luxury Commuter Rail users' alternative transport mode- private car: 56%; Minibus taxi: 28%; bus: 14%; train: 2% All other assumptions reported in DEA (2016d)

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Roadmap to Cleaner Fuel- The Clean Fuels 2 specification	The aim is to decrease the content of aromatics in petrol (from 50% to 35%) and benzene (from 5% to 1%), to align with emission standards. The sulphur content of petrol will also be reduced from 500ppm to 10ppm (SAPIA, 2016).	Regulatory / Planned; Not implemented.	CO_2	To implement the regulations by 2017.	Planned. Changing vehicle fuel specifications to be largely in line with the Euro V emission standard. Indicated in the Green Transport Strategy (DoT, 2017a), that should the automotive industry drive and support initiatives pertaining to clean fuels, it will have a major impact on the transport sector. This support will not only pave the way for clean fuel uptake in the transport sector but pro-actively enable a regulatory context for large-scale transport sector interventions		No progress indicators	Draft Regulations for Clean Fuels II Specification were gazetted in June 2012, indicating regulations would come into force on 1 July 2017. The target date of July 2017 has been postponed to a date to be determined in the future, once various aspects relating to the financial implications of producing the cleaner fuels have been finalised. In the meantime, in order to provide cleaner fuels for those new technology vehicles that require this fuel, initiatives are being investigated to determine whether it is possible to bring in fuels with certain upgraded specifications at an earlier date (SAPIA, 2018).	Not yet implemented	-	-
Integrated Public Transport Network (IPTN)	To ensure sustainable, equitable and uncongested mobility and accessibility through IPTNs (DoT, 2007). The programme includes dedicated lanes for public transport, inner-city distribution system, integrated ticketing, pedestrian and bicycle facilities (DoT, 2016).	Economic / Existing measure;	CO_2	Current, since 2008. Based on the DoT revised strategic plan (Dot, 2017). By 2021/2022 Develop IPTNs in two district municipalities. By 2021/2022, fund and implement IPTNS in thirteen local municipalities.	Implemented. The IPTN aims to integrate urban public transport modes including: Bus Rapid Transport, Metro Buses and Minibus Taxis. The Integrated Public Transport Turnaround Plan was developed in response to address development challenges. The plan outlines and evaluates appropriate interventions for the improvement and further development of public transport systems in South Africa. Key steps envisaged include 1. Improve the planning and implementation capacity of municipalities; 2. Rationalise and streamline financial resource allocations for public; transport service delivery; 3. Develop a public transport subsidy policy; 4. Transform old order contracts to quality public transport contracts; including the transformation of the taxi industry; 5. IPTN implementation using the principle of differentiated approach; 6. Develop national norms and standards for public transport service delivery (DoT, 2017b).		Number of average weekday passenger trips carried on PTN Grant funded networks Number and percentage of municipal households within a 500m walk to an Integrated Public Transport Network (IPTN) station or stop that has a minimum peak period frequency of 15 minutes or better Percentage uptime for network operating systems Passengers per network vehicle per average weekday Public transport network infrastructure including dedicated lanes, routes and stops/shelters, stations, depots, signage and information displays, control centres and related information technology, fare systems and vehicles Non-motorised transport (NMT) infrastructure that supports network integration (e.g. sidewalks, cycle ways, cycle storage at stations, etc.	IPTN plans implemented in the City of Cape Town, Johannesburg, Tshwane and Ekurhuleni. Development challenges experienced to the complete roll out of IPTN programmes (DoT, 2017a)	Not yet quantified[a)]	-	-

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Bus Rapid Transport (BRT) System; a component of Public Transport Strategy (DoT, 2007)- Rea Vaya and MyCiti BRT	The aim of the BRT is to quickly and safely transport people to all parts of the city, and to link different parts of the city in a network. Re Yang and Go Durban BRT not included.	Economic / Existing measure ;	CO_2	Current since 2006. Linked to the Public Transport Strategy goals (DoT, 2016), by 2020 the goal was to place nearly all residents of the large cities within 1km walking distance of the Network. By 2014 network implementation would have taken place in six metropolitan cities, six smaller cities and six rural districts. Accelerated Recovery and Catalytic Projects (2007-2010): This period was intended to "stabilise" passenger transport service delivery environment and to "recover" from the accumulated neglect of decades of under-investment in infrastructure and operations. This also includes the enhancement of the institutional responsiveness.	Implemented. Improve the efficiency of the public passenger transport system by introducing BRT systems. The Green Transport Strategy (DoT, 2017a), prioritises the BRT systems which need to be significantly expanded throughout the large cities and the security, reliability and frequency of BRT systems improved.	Project and Baseline Scenario GHG Emissions. CO_2e reductions associated with the modal shift. Number of short-term jobs created during the construction phase. Cost-effectiveness associated with the implementation of the system. Job-creation effectiveness associated with the implementation of the system.		The Rea Vaya BRT system was launched in 2009 and to date, construction has occurred in three separate phases. Phase 1A of the Rea Vaya BRT system has been completed and was rolled-out between August 2009 and May 2010. Phase 1B extends the Rea Vaya network by an additional 18 kilometres of trunk route and started operating in October 2013. The construction of phase 1C began in July 2014 and is still currently underway, with plans to include additional routes to this phase well into 2019. The My Citi BRT service began operating in May 2010 shortly before the 2010 FIFA World Cup, providing a shuttle service from the Civic Centre to Cape Town International Airport. Phase 1A includes the Inner City, Hout Bay, Table View and the low income communities of Atlantis, Mamre, Dunoon and Doornbach. The system started operating between CBD and Table View in May 2011.Phase 1B covers Montague Gardens, Century, Summer Greens, Edgemead, Bothasig, Maitland and Salt River. By April 2015 the service was still being rolled out but nearly complete. (DEA, 2016d)	0.26	Total distance travelled of MyCiti buses: 2011/12: 2240000 km 2012/13: 60000 km 2013/14: 4920000 km 2014/15: 4700000 km Total distance travelled of Rea Vaya buses: 2009/10: 3387626 km 2010/11: 8612609 km 2011/12: 10335131 km 2012/13: 12344739 km 2013/14: 14354348 km Fuel efficiencies of MyCiti Buses: Articulated: 64.94 ℓ/100km Standard : 39.11 ℓ/100km Midibus: 31.65 ℓ/100km Fuel efficiencies of Rea Vaya Buses: Articulated: 67 ℓ/100km Standard : 51 ℓ/100km Re Yang and Go Durban BRT not included since the activity data were not immediately available. More information available in DEA (2016d)	Diesel: 74100 kg CO_2/TJ Diesel: 3.9 kg CH_4/TJ Diesel: 3.9 kg N_2O/TJ Petrol: 69300 kg CO_2/TJ Petrol: 33 kg CH_4/TJ Petrol: 3.2 kg N_20/TJ GWP: Myhre et al. 2013 All of the BRT buses were assumed to be diesel. 63% of MyCiti Passengers previously used minibus taxis Modal share for of Rea Vaya Passengers who previously used cars was assumed to be 10% and 20% 6% of MyCiti Passengers previously used conventional buses; however they would still be operational after modal shift and thus not impact GHG emissions. 61% of Rea Vaya Passengers previously used minibus taxis 10% of Rea Vaya Passengers previously used cars 8% of Rea Vaya Passenger previously used buses; however they would still be operational after modal shift and thus not impact GHG emissions. Additional assumptions in DEA (2016d)
National Hydrogen and Fuel Cell Technologies Research, Development and Innovation Strategy (HySA Strategy)	The HySA Strategy is in the second phase of implementation. The key goal of the HySA Programme Phase II is the deployment of 25 National Hydrogen and Fuel Cell Technologies (HFCT) by 2020 using HySA technology (Campbell, 2017). Hydrogen power (generated in fuel cells) is used successfully to provide stand-by power in some schools in the Eastern Cape Province.	Research & Develop-ment	CO_2	Current – 2020. Overall goal of the HySA Strategy is to develop and guide innovation along the value chain of HFCT in South Africa and to capture 25% of the global hydrogen and fuel cell catalyst demand by 2020	Implementation of Phase II; The purpose is the deployment of National HCFTs. The HySA phases- 2008-2013: Establish R&D Capability; 2014-2018: Demonstrate and validate technology; 2019-2013: Commercialise South African Innovation (DST, 2018).	No progress indicators		HySA Catalysis is responsible for the development of platinum-based catalysts and the associated technologies. HySA Catalysis has already developed a spin-off company, HyPlat, which has commercialised and is selling some of its products for both commercial and R&D use. HySA Infrastructure have developed state-of-the-art laboratories for the synthesis and characterisation of storage materials. The CSIR is developing purely composite cylinders made up of a polymeric liner covered by a carbon-fibre matrix.	Not yet quantified[a)]	-	-

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Energy and Environment Partnership (EEP) Programme of Southern and East Africa, 2010	The EEP Programme is funded by the Ministry of Foreign Affairs of Finland (lead donor), UK Department for International Development (DFID) and the Austrian Development Agency (ADA). Promotes renewable energy, energy efficiency and clean technology investments.	Economic, Existing measure	CO_2	Current, No quantitative goals.	Implemented. Provide funding for early stage grant and catalytic financing to innovative clean energy projects, technologies and business models. The first phase of the funding programme ended in 2013. The second phase ended in 2017. (Energy and Environment Partnership Programme in Southern and East Africa, 2018b).		Annual cumulative CO_2 emission reductions achieved (tonnes/CO_2) Number of rural and urban households with improved access to off grid clean energy Economic time saved by households (euro/year) Number of direct jobs created for women, men and youth Newly installed electricity generation by demonstration projects (MW). Amount of energy generated disaggregated by heat and electricity (MWh/yr) Absolute amount of energy saved through installation of energy efficient technologies/ projects (MWh)	EEP S&EA programme has been running since April 2010 and is currently supporting thirteen Southern and East African countries. By 2017, 37 projects were funded in South Africa (Energy and Environment Partnership Programme in Southern and East Africa, 2018a). Currently two projects are still ongoing whilst the latter have been completed (Energy and Environment Partnership Programme in Southern and East Africa, 2018b).	Not yet quantified[a)]	-	-
Diversification of electricity generation sources: Bio2watt Project	The Bio2watt project utilizes cattle and poultry manure in an animal management waste system in order to generate 3MW electricity. The project is in the process of being registered as a CDM project.	Economic, Existing measure.	CO_2, CH_4	Current since 2015. The generating license obtained from NERSA allows for the export of 4.2 MW of power with the possibility of increasing that to 5MW should feedstock resources prove sufficient to support such capacity	Implemented. Conversion of livestock waste to energy. Total project costs were estimated to amount to R135m. Debt financing for the project was structured as a limited recourse finance transaction. For the construction phase, IDC provided a commercial loan equal to 70% of total project costs. (GIZ and SALGA, 2016)		Number of mid income households supplied with electricity Average output per MW installed (MWh/MW installed/year) Capacity factorCapital cost per MW installed (MZAR/MW installed)Operational cost per MW installed ((ZAR/MW installed/month) Operational costs per MWh (ZAR/MWh)	Bio2Watt built the first commercially viable biogas project in South Africa, the Bronkhorstspruit Biogas Plant, which it owns and operates. The plant produced its first power into the national grid on 10 October 2015. Another biogas facility is being constructed in Malmesbury in the Western Cape.	Not yet quantified[a)]	-	-
The Department of Trade and Industry's Incentive Schemes, (DTI, 2013)	The incentive schemes that cover green technologies include the Capital Projects Feasibility Programme; Critical Infrastructure Programme; and the Manufacturing Competitiveness Enhancement Programme. In line with the Industrial Policy Action Plan and the National Industrial Policy Framework	Economic, Existing measure	CO_2, CH_4, N_2O	Current since 2005. No quantitative goals	Implemented. Drive growth, direct foreign investment and promote competitiveness in the manufacturing sector. The programme aims to provide funding for incubators that can generate revenue through the provision of services and initiatives that can be self-sustainable; It is available for infrastructure and business development services necessary to mentor and grow enterprises to ensure that within two to three years they will graduate to a level of self-sustainability by providing products and services to the market. (DTI, 2013)		Number of projects approved. Amount of investment leveraged. Value of approvals. Total value of the incentive Disbursed /Claims Paid Number of Jobs Supported	Fully implemented. New incentive scheme proposed in 2018, to support the metals and engineering sector particularly foundries (Omarjee, 2018).	Not yet quantified[a)]	-	-

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Green Economy Initiative	Implement green economy programmes in conjunction with the private sector, civil society and all levels of government.	Economic/ Implemented	CO_2	Current since 2008. Information not readily available.	Implemented. Advise countries in greening their economies by working with a wide range of partners to provide cutting edge economic analysis and research products. Build on strong sectoral expertise in key areas: cleaner production, smart buildings, resource efficiency, and sustainable tourism. Complement work of the International Resource Panel. Deepen ongoing partnerships in key countries: Mexico, Indonesia, South Africa (UNEP, 2010).		Information not readily available.	Launched in late 2008. No information readily available about projects funded through this mechanism.	Not yet quantified[a)]	-	-
National Energy Efficiency Strategy[a)] (excluding IDM, municipal EE, IEE projects and SASOL EE projects)	The NEES is intended to support the exploration of the potential for improved energy utilisation through reducing the country's energy intensity (thus reducing greenhouse gas emissions). The DoE has established an Energy Efficiency target Monitoring System (EETMS), in order to progress with the targets set out in the strategy.	Regulatory / Existing measure;	CO_2	Current, since 2001. The first EETMS report was released in 2014 covering the period 2001–2011. The NEES set an overall reduction target in energy intensity of 12% by 2030 relative to the 2015 baseline, and sectorial energy intensity improvements as follows: industry and mining (15%), power generation (10%), transport (9%), commercial and public building sector (15%), and residential (15%).	Adopted. The strategy aims to stimulate further energy efficiency improvements through a combination of fiscal and financial Incentives, a robust legal and regulatory framework, and enabling measures. The draft Post 2015 NEES proposes reduction targets for 2030 based on the 2015 baseline. (DoE, 2016d).		Examples- Public buildings: Reduction in the specific energy consumption (measured as GJ annual energy consumption per m2 of occupied floor area); Municipal services: Energy intensity (measured as energy consumption per head of population served) of municipal service provision, Residential household appliances: Average specific energy consumption of new household appliances; Commercial buildings: Energy consumption (measured as GJ annual energy consumption per m2 of lettable / habitable floor area;, Industry and Mining: Weighted mean specific energy consumption; Agriculture: Total electricity saving; Transport: Average vehicle energy intensity (measured in MJ/km);	An update to the NEES was published by the Department of Energy in November 2016 for comment (DoE, 2016d). This policy indicates revised energy efficiency targets for energy demand sectors.	723.00	Annual energy savings per sector- 2001- Industry : 40942 TJ 2002- Industry: 76855 TJ 2003- Industry: 20842 TJ 2004- Commerce and Public Services: 20 TJ 2005- Industry: 206338 TJ; Commerce and Public Services: 40 TJ 2006- Industry: 178119 TJ; Commerce and Public Services:246 TJ 2007- Industry: 310164 TJ 2008- Industry: 206170 TJ; Residential: 15211 TJ 2009- Industry: 267802 TJ; Residential: 52658 TJ 2010- Industry: 186262 TJ; Residential: 73 598 TJ 2011- Industry: 216178 TJ; Residential: 118928 TJ	Coking Coal: 94600 kg CO_2/TJ Bituminous Coal: 94600 kg CO_2/TJ Coke oven coke: 107 000 kg CO_2/TJ Gasworks & Coke oven gases: 44 400 kg CO_2/TJ Blast furnace gas: 260 000 kg CO_2/TJ NG: 56 100 kg CO_2/TJ LPG: 63 100 kg CO_2/TJ Petrol: 69 300 kg CO_2/TJ Other Kerosene: 71 900 kg CO_2/TJ Diesel: 74 100 kg CO_2/TJ Residual Fuel: 77 400 kg CO_2/TJ Grid emission factor: 0.964 Gg/GWh GWP: Forster et al. 2007 Annual energy savings post 2011 remained the same.

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action		Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017	Methods	Assumptions
Integrated Demand-side Management (IDM)	The IDM covers a range of funding and awareness programmes, which promote energy efficiency and load management.	Economic, Existing measure;	CO_2	Current. Information not readily available.	Implemented. Since its inception, the focus of the IDM programme changed from a predominantly small-scale demonstration and awareness creation initiative to a concerted drive to measurably impact energy consumption in response to the projected supply shortfall while building a sustainable, energy efficient society in the longer term . The focus of IDM has changed, but the role it plays remains a vital mechanism to manage the electricity supply and demand balance. A multi-pronged energy management approach is used to achieve this. (Eskom, 2018a).		Generation capacity installed (Megawatts); Transmission lines installed (km of line); Transmission MVA installed; National Load Shedding (Generation Induced) or Un-served energy (system minutes); DSM energy efficiency annualised (GWh); Cost of electricity – (rand/MWh)(before embedded derivatives and depreciation); Internal energy efficiency – annualised current savings (GWh); Water usage (L/KWh sent out); Debt: equity ratio (company); Interest cover (company); Percentage of local content in new build projects; Number of Eskom trainees/bursars; Number of engineering trainees/ apprentices; Additional number of non-Eskom learners on Eskom sponsored learning.	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 energy efficiency projects. As part of the residential energy efficiency projects rolled out, a total of 4 922 700 compact fluorescent lamps have been installed (Eskom, 2016).	90.21	Annual energy savings: 2004/05: 126 GWh 2005/06: 285 GWh 2006/07: 1004 GWh 2007/08: 2658 GWh 2008/09: 4343 GWh 2009/10: 4906 GWh 2010/11: 6240 GWh 2011/12: 7590 GWh 2012/13: 9417 GWh 2013/2014: 10780 GWh 2014/2015: 11596 GWh	Grid emission factor: 0.964 Gg/GWh GWP: Forster et al. 2007 The annual energy savings each year remained the same post 2014/15
Municipal Energy Efficiency Programme	The EEDSM programme is a grant fund disbursed to 68 municipalities since 2009, to implement energy efficient retrofits within the municipal infrastructure. The cumulative energy saved as a result of the programme based on projected targets is approximately 1.8 PJ, mainly through street lighting retrofits (DoE, 2016c).	Economic, Existing measure	CO_2, NO_x	Current. By 2020 to have 0.5 TWh of energy savings realised and verified.	Implemented. The EEDSM program is aimed at promoting the implementation of more energy-efficient technologies, processes and behaviours for municipalities. Municipalities interested in the EEDSM programme have to respond to the request for proposals issued by DOE in the beginning of October each year. DOE will evaluate these proposals based on their energy savings potential, cost and payback period. The selected municipalities will then receive grants. (DoE, 2018)		Percentage of new build that is renewable power generation Electricity demand savings in MW	Fully implemented. Proposal requests for the 2018/2019 year were sent out in 2017.	0.81	Energy savings achieved: 2010/11: 22 GWh 2011/12: 58 GWh 2012/13: 103.6 GWh 2013/14: 142.8 GWh 2014/15: 173.5 GWh	Grid emission factor: 0.964 Gg/GWh GWP: Forster et al. 2007 The annual energy savings each year remained the same post 2014/15
Industrial Energy Efficiency Improvement (IEE) Project	The NCPC develops programmes that reduce pollution and improve resource efficiency in the private sector.	Economic, Existing measure	CO_2, NO_x	Current. Information not readily available.	Implemented. Improve the capacity of South African industry to use energy resources more efficiently and productively. The IEE Project assists companies in developing and implementing an energy management system in line with SANS/ISO 50001. (UNIDO and NCPC, 2014).		Annual electricity savings (KWh) Total investment cost Total monetary saving Payback period	Fully implemented.	2.65	Energy savings: 2010/11: 90255231 KWh 2011/12: 90356484 KWh 2012/13: 248616273 KWh 2013/14: 430710894 KWh 2014/15: 481684253 KWh	Grid emission factor: 0.964 Gg/GWh GWP: Forster et al. 2007 The annual energy savings each year remained the same post 2014/15

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action		Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017	Methods	Assumptions
SASOL energy efficiency projects	Since 2003 SASOL has implemented a series of energy efficiency programmes, including waste energy utilization, steam compressor upgrades and heat recovery, new energy efficient equipment, and process improvements.	Economic, Existing measure.	CO_2	Current. A carbon budget was set for the 2016-2020 period of 301, 7 Mt CO_2e. To reduce electricity consumption by 15% by 2015 and by 1% each year thereafter.	Implemented. Improve the energy efficiency of SASOL Industrial Operations. . (Sasol, 2017)		Select list of Sasol progress indicators based on Sustainability report (Sasol, 2018): Direct CO_2) (kilotons; Nitrogen oxide emissions (kilotons); Total waste generated (kilotons); Surface area affected by operations (hectares); GHG intensity (CO_2 equivalent/ton product). No progress indicators specific to the action.	Embedded the process of incorporating carbon pricing into the financial and economic assessments of all new projects. (Sasol, 2017)	9.78	Energy savings data not available. Annual GHG emission reductions: 2008: 0.36 Mt CO_2e 2009: 0.36 Mt CO_2e 2010: 0.68 Mt CO_2e 2011: 0.68 Mt CO_2e 2012: 1.20 Mt CO_2e 2013: 1.30 Mt CO_2e 2014: 1.30 Mt CO_2e	No new energy efficiency interventions were implemented after 2014. The annual emission reductions remained the same post 2014.
Eskom Open Cycle Gas Turbines (OCGT)	Two open cycle gas turbine (OCGT) power plants were opened in 2007. The power plants are meant to help meet peak demand in times of constrained electricity supply.	Economic, Existing measure	CO_2	Current. A carbon budget was set for the 2016-2020 period of 301, 7 Mt CO_2e. To reduce electricity consumption by 15% by 2015 and by 1% each year thereafter.	Implemented .Construction of open cycle turbine power plants in Mossel Bay and Atlantis. This is completed. As part of Eskom's Recovery Plan, there is increased use of OCGT plants to fix partial load losses and to minimise risk of load shedding or reduce degree of load shedding if unavoidable. (Eskom, 2018b)		Select list of Sasol progress indicators based on Sustainability report (Sasol, 2018): Direct carbon dioxide (CO_2) (kilotons); Nitrogen oxide emissions (kilotons); Total waste generated (kilotons); Surface area affected by operations (hectares); GHG intensity (CO_2 equivalent/ton product). No progress indicators specific to the action.	Project undertaken in 2016 to convert the open cycle gas turbines to dual fuel facilities to enable them to operate on both diesel and gas.	1.92	Gas turbines electricity generation: 2007: 62 GWh 2008: 1153 GWh 2009: 143 GWh 2010: 49 GWh 2011: 197 GWh 2012: 698 GWh 2013: 1904 GWh 2014: 3621 GWh Liquid fuels consumption: 2007: 11 Mℓ 2008: 346 Mℓ 2009: 29 Mℓ 2010: 16 Mℓ 2011: 64 Mℓ 2012: 226 Mℓ 2013: 610 Mℓ 2014: 1149 Mℓ	Gas/Diesel Oil: 74100 kg/TJ Gas/Diesel Oil: 0.002688919 Mt/ML GWP: Forster et al. 2007 Gas turbine electricity generation and liquid fuels consumption remained the same post 2014
SASOL gas turbines	SASOL installed 420 MWs of combined cycle gas turbines between 2010 and 2011.	Economic, Existing measure ;	CO_2	Current. A carbon budget was set for the 2016-2020 period of 301, 7 Mt CO_2e. To reduce electricity consumption by 15% by 2015 and by 1% each year thereafter.	Implemented Construction of open cycle turbine power plants completed. Sasol has invested R2.4 billion in the gas turbine project which is operational at Secunda (Sasol, 2017)		Select list of Sasol progress indicators based on Sustainability report (Sasol, 2018): Direct carbon dioxide (CO_2) (kilotons); Nitrogen oxide emissions (kilotons); Total waste generated (kilotons); Surface area affected by operations (hectares); GHG intensity (CO_2 equivalent/ton product). No progress indicators specific to the action.	Fully implemented (Sasol, 2017)	10.71	Gas turbines GHG emission reductions: 2010: 0.86 Mt CO_2e 2011: 0.86 Mt CO_2e 2012: 1.498 Mt CO_2e 2013: 1.498 Mt CO_2e 2014: 1.498 Mt CO_2e	Additional gas turbine electricity generation not introduced post 2014. GHG emission reductions remained the same post 2014.

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action		Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017	Methods	Assumptions
SASOL coal-to-gas switch	From 2004 Sasol, together with its partners, have invested in natural gas; including in wells, a central processing and an-865 kilometre cross-border pipeline that delivers natural gas from gas fields in Mozambique to Sasol's operations in Secunda and Sasolburg.	Economic, Existing measure ;	CO_2	Current. A carbon budget was set for the 2016-2020 period of 301, 7 Mt CO_2e. To reduce electricity consumption by 15% by 2015 and by 1% each year thereafter.	Implemented. The project included the switching the Sasolburg facility to gas from coal as its primary feedstock and the conversion of the Secunda operations to utilise gas as a supplementary feedstock to coal. (Sasol, 2017)		Select list of Sasol progress indicators based on Sustainability report (Sasol, 2018): Direct carbon dioxide (CO_2) (kilotons); Nitrogen oxide emissions (kilotons); Total waste generated (kilotons); Surface area affected by operations (hectares); GHG intensity (CO_2 equivalent/ton product). No progress indicators specific to the action.	Fully implemented (Sasol, 2017)	102.93	Estimated GHG emission reduction: 2004: 7.35 Mt CO_2e	No further interventions implemented post 2004. GHG emission reductions remained the same post 2004.
Compressed Natural Gas (CNG) industry fuel switch	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.	Economic, Existing measure	CO_2	Current, from March 2014. Information not immediately available about goals.	Implemented. 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. (DEA, 2017c)		Reference to the intended MRV indicators for the Energy sector to be compiled	The pilot project, a bakery (using 1,2M litres of paraffin per year) was converted to CNG.	0.03	Paraffin consumption: 40.3 TJ/yr CNG consumption instead of paraffin: 26.1 TJ/yr HFO consumption: 155.2 TJ/yr Natural Gas consumption instead of HFO: 100 TJ/yr	Paraffin: 71900 kg/TJ CNG: 56100 $kgCO_2$/TJ Natural Gas: 56100 $kgCO_2$/TJ HFO: 77400 $kgCO_2$/TJ GWP: Forster et al. 2007 Post 2014, CNG, Natural gas consumption and liquid fuels consumption remained the same each year.
DEA Green vehicles	Electric vehicles with zero-emission used by the Department of Environmental Affairs to phase out fossil fuel vehicles.	Economic / Existing measure	CO_2, CH_4, N_2O	Current, from 2011	Implemented .Use of electric vehicles		Number of vehicles	The DEA started its green cars pilot programme in 2011 with three vehicles. By 2015 eight green cars, one fast charging station and two slow charging stations made up the fleet. Currently there are a fleet of 14 electric vehicles composed of 12 Nissan Leafs and 2 BMW i3 's.	0.05	Distance travelled by electric vehicles: 2013: 14789 km 2014: 37865 km Efficiency of electric vehicle: 0.15 kwh/km Efficiency of petrol vehicle: 7.5 ℓ/100 km Linear interpolation of GHG emission reduction for 2013.	Grid emission factor: 0.9488 Gg/GWh Petrol: 69300 kg CO_2/TJ GWP: Forster et al. 2007 Post 2014, the annual distance travelled by electric vehicle remained the same.

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action	Progress indicators		Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017	Methods	Assumptions
Transnet Road-to-Rail Programme	Transnet's most significant energy efficiency gains have been made in freight rail as the new locomotive technology, with regenerative braking capability, was introduced into operations.	Economic / Existing measure ;	CO_2	Current, from 2011. Transnet's Market Demand Strategy focuses on increasing rail's market share from 25% in 2011/2012 to 35% by 2018/19.	Implemented .A modal shift from mainly road based freight transport to rail based freight transport. The road-to-rail shift forms part of Transnet's Market Demand Strategy. (Transnet, 2017b)	Select list from the Transnet Sustainability Outcomes Report (Transnet, 2018): Fuel distribution (Litres); Energy efficiencies (Efficiency rates); Carbon emissions intensity; Total fuel consumption (Litres); Carbon emissions savings in road-to-rail volume gains		Transnet took delivery of its first new locomotive in April 2015 with the last locomotive due to be delivered in late 2018. All but 70 will have been assembled by Transnet Engineering's facilities in Pretoria and Durban. Purchases of locomotives from international companies includes 591 electric locomotives from China, 240 electric locomotives from Canada and 233 diesel locomotives from the US Transnet has also launched new services since 2012, including a dedicated service targeting motor manufacturers. To provide the service, 350 specialised enclosed wagons built by Transnet Engineering's Uitenhage facility in 2013 and 2014 are serving motor industry players including BMW, Volkswagen, Ford, Nissan and Toyota. SA-built 40 wagon Rail Runner test trains will begin operating on the Cape Town to Gauteng route in 2018 between terminals in Bellville and Isando. (Financial Mail, 2017)	3.8	GHG emission reductions: 2010: 0.22 Mt CO_2e 2011: 0.22 Mt CO_2e (Transnet, 2012) 2012: 0.21 Mt CO_2e (Transnet, 2013) 2013: 0.84 Mt CO_2e (Transnet, 2014) 2014: 0.48 Mt CO_2e (Transnet, 2015) 2015: 0.31 Mt CO_2e (Transnet, 2016) 2016: 0.64 Mt CO_2e (Transnet, 2017) 2017: 0.86 Mt CO_2e (Transnet, 2018)	The same quantity of GHG emissions were reduced in 2010 relative to 2011.
National Industrial Biofuels Strategy (NIBS)	Support the Biofuels Industrial Strategy 2007 by developing the national technical capability (bio-fuel technology development), capacity (HCD) and facilitate commercialization through demonstrations.	Regulatory, planned	CO_2	Planned. 2% penetration level of biofuels in the national liquid fuel supply, or 400 million litres pa. 50% fuel levy exemption for biodiesel from 2008. 100% fuel tax exemption for bioethanol.	Adopted. The aim of this strategy is to create a market for biologically produced fuels, so that they can be used as a blending component in petrol/diesel production. The immediate focus is on incubating the industry to a 2% biofuels penetration level and encouraging the use of agricultural feedstock from currently underutilised lands. The support level should be fixed for the first 2% biofuels investment through to 2020 to give investors some certainty and a decent rate of return on their assets. (DME, 2007)	Reference to the intended MRV indicators for the Energy sector to be compiled		The Biofuels Industrial Strategy has adopted a short-term focus and aims to achieve 2% penetration of biofuels in the national liquid fuel supply, which is equivalent to 400 million litres per annum. DST supported a biofuels technology demonstration programme in 2017 at the Nelson Mandela University (NMU), which had led to the consequent production of coalgae, a mixture of coal dust and algae biomass. Two other projects are supported including biocrude oil- Produce crude oil from renewable sources - through pyrolysis producing bio-crude oil from algae at laboratory scale and Coalgae gasification- leveraging existing refineries – use of cleaner coal in the existing coal/gas to liquid process (Maserumule. 2018)	Not yet quantified[a)]	Annual biodiesel consumption- 2008: 290152 ℓ 2009: 580304 ℓ 2010: 1740911 ℓ Annual ethanol consumption: 2008: 1740911 ℓ 2009: 1740911 ℓ 2010: 5803034 ℓ	Biodiesel: 70800 kg CO_2/TJ Ethanol: 70800 kg CO_2/TJ Diesel: 74100 kg CO_2/TJ Petrol: 69300 kg CO_2/TJ GWP: Forster et al. 2007 Biodiesel and ethanol fuels replaced the same quantities of petrol and diesel. Post 2010, biodiesel and ethanol fuel consumption remained the same.

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action		Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO^2e$) till 2017	Methods	Assumptions
CNG vehicle fuel switch (Data source: Industrial Development Corporation-IDC)	To provide an economical and eco-friendly energy, by supplying natural gas to CNG refuelling stations, gas distribution networks, industries and power generation systems, to customers who are not on the existing gas network.	Economic / Existing measure	CO_2	Current, from March 2014. 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.	Adopted. The use of CNG as an alternative fuel for vehicles (DEA, 2017d)		Reference to the intended MRV indicators for the Energy sector to be compiled	The programme started in March 2014 with the focus on: Developing a Mother Station & 15 Industrial Customers; Industrial Fleet Conversion and in-house filling stations; Establishment of 5 CNG Filling Stations, capable of servicing 3000 vehicles per day (in Langlaagte, Dobsonville, Soweto, Rustenburg and Mamelodi); Budgeted to convert 1000 minibus taxis; and Facilitated & trained independent companies to establish 3 Workshops for CNG conversion of vehicles. (Randburg, Langlaagte and Soweto) and potentially 2 additional workshops in Pretoria and Rustenburg	0.02	Total number of cars using CNG fuel: 3143 Total CNG consumed: 52 TJ Total distance travelled: 13787524 km Fuel efficiency of petrol vehicle: 0.18 ℓ/km Monthly GHG emissions due to fuel switch: 0.00049 Mt CO_2e	Petrol: 69300 kg CO_2/TJ CNG: 56100 kg CO_2/TJ GWP: Forster et al. 2007 Post 2014, the GHG emission reductions each month remained the same as the monthly GHG emission reduction in 2014.
DEA Green building	The Green Building is designed to maximise and demonstrate energy efficiency. The DEA's new head office, in Pretoria, has become the first government building, as well as the first in Tshwane, to be awarded a six-star Green Star rating.	Economic / Existing measure ;	CO_2	Current from 2013. No quantitative goals immediately available.	Implemented Construction of a green building for the DEA Head office (DEA, 2017d)		Reference to the intended MRV indicators for the Energy sector to be compiled	Achieved a six-star Green Star South Africa (SA) Office Design v1 certification. Overall energy consumption in the building will be to a maximum of 115kWh/m2/annum. 10% of the overall energy consumption will be from a renewable energy	Not yet quantified[a)]	-	-

Name	Description	Nature of the action	Coverage – gases	Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action		Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO^2e$) till 2017	Methods	Assumptions
Taxi Recapitalisation	The Taxi Recapitalisation Programme is a national intervention, undertaken by the National Department of Transport to address issues of safely, reliability, accessibility and affordability amongst others, within the taxi industry.	Economic / Existing measure;	CO_2, CH_4, N_2O	Current from 2006. No quantitative goals set in DoT's Performance Plan.	Implemented Replacement of old MTB stock with new vehicles. The programme was implemented in 2006 as a 7-year programme, at an initial cost of R7.7 billion. This budget was to be split two ways, with the R5.5 billion allocated to the scrapping of the vehicles and R2.2 billion allocated to regulation of the programme. After constraints in the allocation of funds, a funding strategy was developed for the programme to move forward.		Number of vehicles scrapped.	Total number of minibus taxis scrapped- 2014/15: 4049; 2015/16: 3226 (DoT, 2018c)	1.98	Number of old minibus taxis: 2007: 59668 2008: 48240 2009: 39032 2010: 27495 2011: 21587 2012: 13957 2013: 7500 2014: 0 Number of new minibus taxis to replace old taxis: 2007: 1991 2008: 13419 2009: 22627 2010: 34164 2011: 40072 2012: 47702 2013: 54159 2014: 61659 Total distance travelled per annum for each minibus taxi: 113100 km	Diesel: 74100 kg CO_2/TJ Diesel: 3.9 kg CH_4/TJ Diesel: 3.9 kg N_2O/TJ Petrol: 69300 kg CO_2/TJ Petrol: 33 kg CH_4/TJ Petrol: 3.2 kg N_20/TJ GWP: Myhre et al. 2013 It was assumed that the fuel efficiency of old petrol fuelled minibus taxis was 15.1 ℓ per 100 km and the fuel efficiency of old diesel fuelled minibus taxis was 11.8 ℓ per 100 km. Since the old minibus fleet population remained constant over time, it was assumed that the fuel split of the old minibus taxi population also did not change. It was assumed that 92% of the old minibus taxis were petrol fuelled and that 8% of the old minibus taxis were diesel fuelled. It was assumed that the number of old minibus taxis that were scrapped equalled the number of new taxis that were introduced. It was assumed that all new minibus taxis were diesel fuelled It was assumed that the fuel efficiency of the new minibus taxis was 11.4 ℓ per 100 km
Working for Energy EPWPs	This purpose of this programme is to develop and implement labour intensive programmes with strong environmental and socio-economic benefits. The Working for Energy project focuses on interventions aimed at demand-side management and the provision of electricity from biomass-based resources.	Economic / Existing measure;	CO_2	2008-2018. EPWP Phase 1 (2004 – 2009) Create 1,000,000 Jobs; EPWP Phase 2 (2009 – 2014) Create 4,500,000 Jobs Phase 3 (2014 – 2019) Create 6,000,000 Jobs	Implemented Provide sustainable clean energy solutions to rural and low income urban communities. Awareness and capacity building programmes targeting schools, cooperatives and community structures are being implemented. The development of community based cooperatives is promoted with the help of relevant departments and state owned companies. . (SANEDI, 2018)		Reference to the intended MRV indicators for the Energy sector to be compiled.	Energy brought to communities in the Eastern Cape, Limpopo and the North West Provinces. 100 biogas digesters were installed in Limpopo in 2016/17. Four schools in Gauteng retrofitted with energy efficient LEDs, solar water heaters and 2 treated with Cool Surfaces preparation to improve the ambient air quality. Biogas programme in Mpfuneko is at a stage of operationalising the completed digesters. Partnership agreement with the University of Venda is being finalised for the research and roll out of greening projects in the Limpopo province.	0.04	Annual GHG emission reduction in 2014: 0.0000148 Mt CO_2e	Post 2014, the annual GHG emission reductions the same.

a) Cumulative emission reductions could not be estimated as the activity or annual emissions reduction data were not immediately available or arrangements for monitoring and evaluation were not implemented to quantity emission reductions.

3.4.1.2. Mitigation Actions in the IPPU Sector

The mitigation actions undertaken by the country in the IPPU Sector are indicated in **Table 3.3**.

Table 3.3: Update on Mitigation Actions for the IPPU Sector Reported in BUR-2

Name	Description	Nature of the action	Greenhouse Gas Targeted		Quantitative goals	Objectives of the action and steps taken or envisaged to achieve that action.	Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017
Capture of PFC in aluminium plants	This initiative covers capture of PFCs at existing aluminium plants. (DEAT, 2007). The Long Term Mitigation Scenarios (LTMS) were used as an analytical tool to assess the potential for the capture of PFC in aluminium plants.	Economic / Existing measure	PFCs		Planned. Current. Quantitative goals to be set by industry in accordance with the carbon budget and PPP requirements (DEA, 2016b, DEA 2018b)	This initiative covers that capture of PFCs at existing aluminium plants. (DEAT, 2007).	Reference to the intended MRV indicators for the IPPU sector to be compiled.	Industry will have the opportunity to report on the progress of implementation via the reporting of carbon budgets and PPPs.	Not yet quantified[a)]
Various GHG mitigation initiatives in the IPPU sector	Mitigation in the IPPU sector. The MPA was used as an analytical tool to assess the potential for mitigation in the IPPU sector. (DEA, 2014b).	Economic / Existing measure	CO_2, N_2O		Planned Current. Quantitative goals to be set by industry in accordance with the carbon budget and PPP requirements (DEA, 2016b, DEA 2018b)	Reduction of GHG emissions from processes and product use. (DEA, 2014b)	Reference to the intended MRV indicators for the IPPU sector to be compiled.	Industry will have the opportunity to report on the progress of implementation via the reporting of carbon budgets and PPPs.	Not yet quantified[a)]

a) Cumulative emission reductions could not be estimated as the activity or annual emissions reduction data were not immediately available or arrangements for monitoring and evaluation were not implemented to quantity emission reductions.

The actions reported in Table 3.3 were reported previously in BUR-2. Emission reduction estimates were based on the MPA study (DEA, 2014b) which cannot be used as post implementation estimates as a study has not been completed to evaluate the implementation of IPPU mitigation measures in industry. This research would be required for future biennial update reports. To a limited extent, industry does disclose their emission reductions to the CDP (CDP, 2017) for the IPPU sector. However the methods of emission reduction estimation are not consistent with the national GHG emission reporting regulations (DEA, 2017a). The national regulations for GHG emissions reporting and PPP will mean that industries will need to comply with the reporting of emission reductions in the IPPU sector based on approaches as set out in the national regulations in the future.

3.4.1.3. Mitigation Actions in the Waste Sector

The mitigation actions undertaken by the country in the Waste Sector are indicated in **Table 3.4**.

Table 3.4: Update on Mitigation Actions for the Waste Sector Reported in BUR-2

Name	Description	Nature of the action	Coverage – gases	Quantitative goals		Objectives of the action and steps taken or envisaged to achieve that action.	Progress indicators	Information on the progress of implementation of the mitigation actions and the underlying steps taken or envisaged, and the results achieved	Estimated emission reductions ($MtCO_2e$) till 2017
National Organic Waste Composting Strategy (NOWCS) (DEA, 2013a)	This Strategy has been developed to promote composting as a method to beneficiate organic waste, and to divert organics from landfill disposal.	Economic / Existing measure;	CH_4	Current. No quantitative goals indicated since the goals are determined by local governments.		Implemented. This strategy stipulates that composting of garden waste should be incorporated into municipal planning and recognises the job creation, SMME establishment and partnership opportunities. Long term actions indicated includes the compilation of "good practice" guidelines, implementation of reduction goals, home composting review, communal composting review, development of a National Organic Waste Treatment Strategy and setting up of waste exchange programmes (DEA, 2013a)	Reference to the intended MRV indicators for the Waste sector to be compiled.	Department of Environmental Affairs published draft Norms and Standards for Organic Waste Compositing in 2014. Organic Waste Composting pilot projects are underway in and Mpumalanga Gauteng Province	Not yet quantified[a)]
Municipal Solid Waste Tariff Strategy (DEA, 2012a)	The Municipal Solid Waste Tariff Strategy was developed in 2011.	Economic / Existing measure;	CH_4	Current. No quantitative goals indicated since the document is a guideline document for tariff setting, since municipal tariff setting remains a local government function.		Implemented The purpose of the Municipal Solid Waste Tariff Strategy is to provide a framework and guidance for municipalities in setting solid waste tariffs that align with the intentions of the National Waste Management Strategy (DEA, 2012a).	Reference to the intended MRV indicators for the Waste sector to be compiled.	The Solid Waste Tariff Setting Guidelines for Local Authorities was published in May 2012; in line with the intentions of the National Waste Management Strategy. The Solid Waste Tariff Model was published in 2015. No public information readily available about implementation.	Not yet quantified[a)]
Recycling and Economic Development Initiative of South Africa (REDISA) (DEA, 2012b)	The main project has been the recovery and recycling of tyres.	Economic / Existing measure;	CO_2	Waste tyre targets were set as follows 2014- 59 000; 2015- 90 000; 2016- 120 000; and 2017- 175 000		Implemented The purpose of this initiative is to increase recycling, reuse of materials, and energy recovery. In 2017, the Integrated Industry Waste Tyre Management Plan of the Recycling and Economic Development Initiative of South Africa was withdrawn (DEA, 2017e).	Number of waste tyres recycled, reused for energy or Recovered. Number of jobs created Number of Small Medium and Micro Enterprises and Cooperatives established.	Waste tyre targets were set as follows in the DEA 2013 Annual Report: 2014- 59000; 2015- 90 000; 2016- 120 000; and 2017- 175 000. In 2014, the target was 10% of tyres, however 25% of all tyres were recycled. In 2015, the target was 25% of tyres, however 42% of all tyres were recycled. In the DEA's 2018 annual performance plan, the target is 30% of tyres (Parliament Monitoring Group, 2018). REDISA is dissolved.	Not yet quantified[a)]

Name	Description	Nature of the action	Coverage – gases	Quantitative goals		Objectives of the action and steps taken or envisaged to achieve that action.	Progress indicators	Information on the progress of implementation of the mitigation actions and the underlying steps taken or envisaged, and the results achieved	Estimated emission reductions (MtCO2e) till 2017
National Waste Management Strategy (NWMS) (DEA, 2011b)	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.	Economic / Existing measure;	CO_2, CH_4, N_2O.	Existing. 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.(Selected list of goals)		Implemented. Seeks to mainstream waste management priorities and measures within government planning. The DEA and its provincial counterparts are responsible for the overall implementation of the Waste Act. However the implementation of the NWMS requires coordinated action by many players, including households, businesses, community organisations, NGOs, parastatals and the three spheres of government. Partnerships between these actors will lay the basis for waste awareness campaigns, recycling initiatives, and compliance monitoring, amongst others. The NWMS sets out the roles, responsibilities, coordination and review mechanisms that will give effect to the approach and instruments leading to implementation (DEA, 2011b).	Select list of indicators (DEA, 2011b): Percentage of waste management activities above required threshold which have been licensed ; Percentage of households that receive basic waste collection services; Percentage of recyclable material going to landfill; Total volume of waste disposed to landfill; Percentage of schools that have waste awareness or recycling programmes	Third NWMS to be completed in 2018. The National Pricing Strategy for Waste Management was gazetted in 2016 and gives legal effect to the NWMS through the consideration of economic instruments and extended producer responsibility schemes (DEA, 2016e).	3.22[b)]
Waste Management Flagship Programme 2015	Determine the waste-related GHG Emissions Mitigation Action Plan, including investigating waste-to-energy opportunities available within the solid-, semi-solid and liquid-waste management sectors, especially the generation, capture, conversion and or use of methane emissions.	Economic / Existing measure ;	CH_4	Current. Phase 1 (2012-2016): Conceptualisation / Preparation; Phase 2 (2014): Flagship Programme Design; Phase 3 (2015-2016): Implementation: Diversion of solid waste from landfills in six municipalities; Phase 4 (2017 onwards): Scale up: Diversion of solid waste from landfills in 10-20 municipalities. Information of targets for other goals not readily available. .		Implemented. The Waste Management Flagship Programme places emphasis on mitigation projects that are at implementation stage or at advanced design stages in local municipalities. Plans for 2017 onwards includes: Diversion of solid waste from landfills (scaling up the NAMA to 10–20 municipalities); Implementation and scaling of wastewater treatment biogas combined heat and power projects; Web-based alternative waste treatment tool and training; development of other tools to support diversion of waste from landfills; Supporting scale up of landfill gas to energy projects; Prefeasibility studies for waste-to-energy projects; Development of IWMPs. (DEA, 2016c)	Reference to the intended MRV indicators for the Waste sector to be compiled	A study on a waste diversion strategy was six municipalities was undertaken from September 2015 to August 2016. The six municipalities included; Rustenburg, Emfuleni, uMhlathuze, Msunduzi, Mbombela Local Municipalities and Mangaung Metro Municipality.	Not yet quantified[a)]

a) Cumulative emission reductions could not be estimated as the activity or annual emissions reduction data were not immediately available or arrangements for monitoring and evaluation were not implemented to quantity emission reductions.
b) Refer to Annexure B.1

3.4.1.4. Mitigation Actions in the AFOLU Sector

The mitigation actions undertaken by the country in the AFOLU Sector are indicated in **Table 3.5**.

Table 3.5: Update on Mitigation Actions for the AFOLU Sector Reported in BUR-2

Name	Description	Nature of the action	Coverage – gases	Quantitative goals		Objectives of the action and steps taken or envisaged to achieve that action.	Progress indicators	Information on the progress of implementation of the mitigation actions	Estimated emission reductions ($MtCO_2e$) till 2017
Working for Land	Working for Land is all about encouraging and supporting sustainable land use practices, raising awareness and promoting resource conservation ethics. It is a sustainable resource utilisation programme based on community partnerships and cooperation.	Aims to restore and rehabilitate degraded land as well as the composition structure of environment leading to better performing ecosystems.	CO_2	Economic/ Implemented. EPWP Phase 1 (2004 – 2009) Create 1,000,000 Jobs; EPWP Phase 2 (2009 – 2014) Create 4,500,000 Jobs Phase 3 (2014 – 2019) Create 6,000,000 Jobs		Implemented. Rehabilitation of degraded land in order to improve and increase productivity. Land rehabilitation and restoration projects include: Gabion construction; Planting of vetiver grass; Tree planting; Storm water channels; Education and awareness. Curtailment of bush encroachment projects include small scale removal of invasive shrubs, weeds or grasses; Treatment of infested areas with herbicide and demarcation of fire breaks on the perimeter. (DEA, 2018f).	Hectares of land rehabilitated Volume of gabions constructed Number of trees planted Ha of land curtailed of bush encroachment	EPWP Phase III commenced on 01 April 2014 and it is ending on 31 March 2019. By 2018 269 380 Ha of land were under rehabilitation. 3 525 002 Jobs were created so far in EPWP Phase III. More information about progress achieved for the working for land program not immediately available.	0.16[a)]
Working for Ecosystems	The Working for Ecosystems Programme plays a critical and innovative role in increasing the functionality of ecosystem goods and services, improving the lives of the local communities, and helping them adapt to inevitable climate change impacts.	Working for Ecosystems aims to reverse environmental degradation through ecological restoration and maintenance programmes.	CO_2	Economic/ Implemented. EPWP Phase 1 (2004 – 2009) Create 1,000,000 Jobs; EPWP Phase 2 (2009 – 2014) Create 4,500,000 Jobs Phase 3 (2014 – 2019) Create 6,000,000 Jobs		Implemented To have intact ecological infrastructure, goods and services. The approaches to restoration will differ depending on the levels of degradation, and is very context specific (DEA, 2018g)	Areas treated Employment Training Hectare regenerating Habitat recovery Carbon sequestration Improved biodiversity Compositional and structural regeneration, recovery and ecosystem functionality Water retention and landscape stability (erosion, combating desertification)	EPWP Phase III commenced on 01 April 2014 and it is ending on 31 March 2019. By 2018 84 community parks were created or rehabilitated. 3 525 002 Jobs were created so far in EPWP Phase III. More information about progress achieved for the working for ecosystems program not immediately available.	0.04[a)]
Green Transport Strategy (DoT, 2017a); Conservation Agriculture Policy (DAFF, 2017)	Various land use activities that have contributed to the development of grasslands	Grassland Rehabilitation	CO_2	Economic/Implemented. Green Transport Strategy: Substantially reduce the GHG emissions and other environmental impacts from the transport sector by 5% by 2050. No quantitative goals for the Conservation Agriculture Policy		Implemented Conversion of human settlements to grassland. The Green Transport Strategy (DoT, 2017a) prioritises the expansion of non-motorised transport infrastructure which would also require an increase in green spaces including grasslands. The Conservation Agriculture Policy is a policy which supports grassland rehabilitation by providing a framework to promote sustainable grazing management that limits topsoil loss and disturbance, enhance forage production and cover and maintain key forage species diversity amongst others. The policy document outlines an implementation plan which starts with the convening of a stakeholders' forum that includes key private and public sector partners by DAFF (DAFF, 2017).	No progress indicators readily available for the Green Transport Strategy Conservation Agriculture Policy: An increase in soil organic matter; Reduced green-house gas emissions due to less external inputs and more carbon sequestration; Increased water infiltration that reduces runoff, soil erosion and sedimentation, and improves surface and groundwater levels and quality – land rehabilitation; Increased commodity and livestock production, performance and resilience; Compliance to environmental legislation; Improved biodiversity and ecosystem functioning; Lower production costs	Green Transport Strategy released for public comment in 2017. The implementation plan for the Green Transport Strategy was completed. The Conservation Agriculture Policy was released for public comment in 2018. No further information immediately available on progress.	0.33[a)]

a) Refer to Annexure B.2

3.4.2. International Market Based Mechanisms

Currently there are five carbon credit mechanisms including the CDM, Verified Carbon Standard, Gold Standard, Verified Emission Reductions (VER+) and the Voluntary Carbon Units. The project information from the CDM portal (UNFCCC, 2018) provides information about each CDM project which enables an assessment of emission reductions through the CDM. Information is not readily available about projects registered through the VCS, Gold Standard, Voluntary Carbon Standard Units and Verified Emission Reductions mechanisms. There are 56 registered CDM projects in South Africa (Figure 3.2).

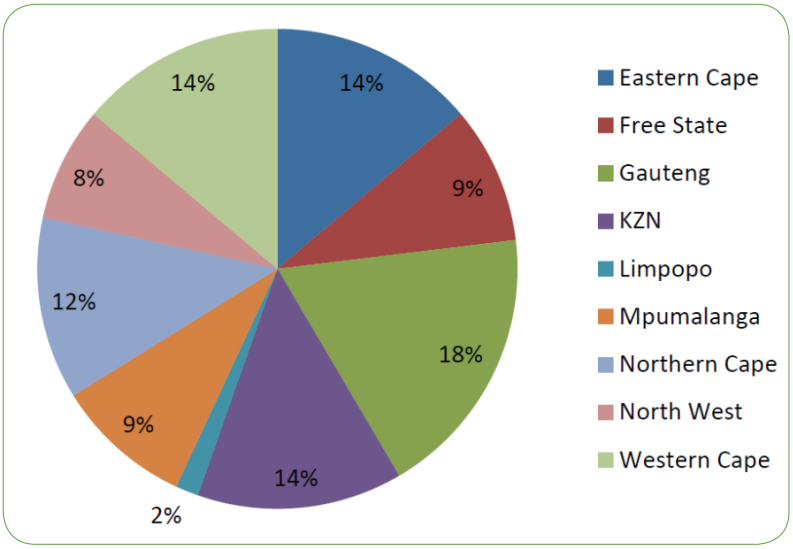

Figure 3.2: CDM projects registered in each province. (Steenkamp, 2017).

Table 3.6: CDM Actions in the Energy Sector (UNFCCC, 2018)

Name of Policy/ Instrument/ Strategy/ Plan	Project description	Time Horizon	Amount of CERs issued	Actual emission reductions ($MtCO_2e$) i.e. results achieved till 2017	Coverage (Sectors and Greenhouse Gas Targeted)	Co-benefits	Status and Progress (Steps taken to achieve the action or envisaged)
Bethlehem Hydroelectric project	Generate hydroelectricity, which will be distributed into the currently coal intensive South African grid	From 2009-2023	0	0.03	CO_2	Job creation	Approved by the DNA · The project was registered on 08 Oct 2009
Coega IDZ Windfarm	Construction and operation of 25 wind turbines which will generate 141.7 GWh annually	From 2013-2020	0	0.11	CO_2	Job creation	Project Idea approved by the DNA
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	0.02	CO_2	Job creation	Project approved by the DNA
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	0.01	CO_2	Skills and technology transfer	Project approved by the DNA · Project registered by the CDM EB on 29 Dec 12
Grahamstown Invasive Biomass Power Project	Involves the utilization of wood chips from Invasive Alien Plants as the sustainable biomass feedstock	From 2013-2022	0	0.03	CO_2	Job creation	PDD approved by the DNA. Project registered by the CDM EB on 27 Dec 2013
Dassieklip Wind Energy Facility in 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	0.07	CO_2	Job creation, skills transfer	PDD approved by the DNA. Project has been registered by the CDM EB on the 23 11 2012

Name of Policy/ Instrument/ Strategy/ Plan	Project description	Time Horizon	Amount of CERs issued		Actual emission reductions ($MtCO_2e$) i.e. results achieved till 2017	Coverage (Sectors and Greenhouse Gas Targeted)	Co-benefits	Status and Progress (Steps taken to achieve the action or envisaged)
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		0.04	CO_2	Job creation	Project idea approved by the DNA
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		0.07	CO_2	Job creation, skills transfer	PDD approved by the DNA. Project has been registered by the CDM EB on the 05 11 2012
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 2014-2023	0		0.24	CO_2	Job creation, skills transfer	Project approved by the DNA. Project registered by CDM EB on 13 Dec 2012
Cookhouse Wind Farm in 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	0		0.34	CO_2	Job creation, skills transfer	PDD approved by the DNA. Project registered by the CDM EB on 24 Dec 12
Red Cap Kouga Wind Farm	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	0		0.26	CO_2	Job creation	PDD approved by the DNA. Project registered by the CDM EB on the 10 Oct 2012
Hopefield wind energy facility in 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		0.17	CO_2	Job creation	Project approved by the DNA. Project registered by CDM EB on 14 Nov 2012
Fuel Switch at Corobrik's Driefontein Brick Factory in 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		0.04	CO_2	Reliable fuel supply, improve occupational environmental health	Approved by the DNA. Project registered by CDM EB 11 October 2011
TWE Golden Valley Wind Power Project	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	0		0.44	CO_2	Job creation, skills transfer	PDD approved by the DNA. Project registered by the CDM EB on 03 Jan 13
Lomati Biomass Power Generation Project in Mpumalanga Province	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		0.06	CO_2	Job creation, skills transfer	Project approved by the DNA. The PoA has been registered by the CDM EB on 20 Dec 2012

Name of Policy/ Instrument/ Strategy/ Plan	Project description	Time Horizon	Amount of CERs issued		Actual emission reductions ($MtCO_2e$) i.e. results achieved till 2017	Coverage (Sectors and Greenhouse Gas Targeted)	Co-benefits	Status and Progress (Steps taken to achieve the action or envisaged)
West Coast 1 Wind Farm in 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	0		0.27	CO_2	Job creation, skills transfer	Project Idea approved by DNA
Karoo Renewable Energy Facility (Nobelsfontein Solar PV)	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	0		0.86	CO_2	Job creation, skills transfer	PDD approved by the DNA. Project registered by CDM EB on 14 Nov 2012
Rheboksfontein Wind Energy Facility	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	0		0.31	CO_2	Job creation	PDD approved by the DNA. Project registered by CDM EB on 13 Dec 2012
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	0		0.37	CO_2	Job creation	Project idea approved by the DNA
Bokpoort CSP (Concentrating Solar Power) Project, South Africa	The purpose of the proposed project activity is to reduce greenhouse gas emissions by installing a greenfield grid-connected parabolic trough concentrated solar thermal power (CSP) 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		0.21	CO_2	Job creation	PDD approved by the DNA. Project registered by the CDM EB on 26 Oct 2012
Lawley Fuel Switch Project	The project entails the conversion from coal to natural gas of the thermal fuel used in clay brick baking kilns at Lawley Brick Factory. The fuel switch project is developed, financed and implemented by Corobrik. After the retrofit Lawley will continue to operate for at least another 15 years.	From 2005-2014	35130		0.02	CO_2, CH_4, N_2O	Reduction in the indoor airborne particulate levels	Approved by the DNA · The project was registered on March 6, 2006. Implementation process started on the same year.
Rosslyn Brewery Fuel-Switching Project	The project activity primarily aims at reducing GHG emissions through fuel switching. The project consists of investment to replace the use of coal by natural gas.	From 2006-2014	0		0.10	CO_2, CH_4, N_2O	Improve air quality, improve occupational health conditions, lower maintenance of the equipment, lower dirtiness and corrosion at the plants, continuous source of fuel	Approved by the DNA · The project was registered on 29 Sep 2006. The implementation process has begun
Transalloys Manganese Alloy Smelter Energy Efficiency Project	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	648606		0.06	CO_2	Maintaining the livelihoods of the workers, effective capture of fugitive dust	Approved by the DNA. The project registered in October 19, 2007
Fuel switch project on the Gluten 20 dryer of Tongaat Hulett Starch Pty (Ltd) Germiston Mill	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		0.01	CO_2	Decrease air pollutant emissions	PDD approved by the DNA. The project was registered on the 25 December 2010.
The Capture and Utilisation of Methane at the Sibanye Gold Owned Beatrix Mine in South Africa	The proposed project activity involves the destruction and utilisation of methane at this mine.	From 2011-2018	36010		0.25	CH_4 CO_2	Create jobs. safer working environment	PDD approved by the DNA on 24 March 2011. Project registered by CDM Executive Board on 10 June 2011

Table 3.7: Emission Reductions of CDM Actions in the IPPU Sector which were not previously mentioned in BUR-2 (UNFCCC, 2018)

Name of Policy/Instrument/Strategy/ Plan	Project description	Time Horizon		Actual emission reductions ($MtCO_2e$) i.e. results achieved till 2017	Amount of CERs issued	Coverage (Sectors and Greenhouse Gas Targeted)	Co-benefits	Status and Progress (Steps taken to achieve the action or envisaged)
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 2007-2017		0.12	67604	N_2O	Technology transfer, upskilling	The project was registered by CDM EB in November 5, 2007. Implementation completed
Sasol Nitrous Oxide Abatement Project	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		0.96	1292678	N_2O	Technology transfer	Approved by the DNA. The project was registered on 25 May 2007
N_2O abatement project at nitric acid plant No. 11 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. 11 Plant") at Modderfontein, South Africa.	From 2008-2018		0.27	332002	N_2O	Technology transfer	Approved by the DNA. The project registered by CDM EB in February 08, 2008.
Omnia N_2O Abatement Project II	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		0.35	0	N_2O, CO_2	Job creation, skills transfer	Project approved by the DNA. Registered by CDM Executive Board on 30 April 2012
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		0.10	0	CO_2	Job creation	PDD approved by the DNA. Project registered by the CDM EB on 28 Dec 12
Use of waste gas at Namakwa Sands in 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		0.08	0	CO_2	Job creation, decrease air pollutant emissions, technology transfer	Project idea approved by the DNA.
IFM Integrated Clean Energy Project	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		0.14	0	CO_2	Job creation, technology transfer	Project idea approved by the DNA
SA Calcium Carbide Furnace Waste Gas to Electricity	SA Calcium Carbide (SACC) (Pty) Ltd in Newcastle, South Africa is to develop an electricity generation project utilizing furnace waste gas that has been flared since the construction of the industrial facility.	From 2013-2023		0.03	0	CO_2	Decrease air pollutant emissions, job creation, skills transfer	PDD approved by the DNA. Project registered by the CDM EB on 02 Jan 13
Hernic's Electricity Generation from Waste Gas Project	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		0.15	0	CO_2	Job creation, technology transfer	PDD approved by the DNA. Project registered by the CDM EB on the 15 July 2013

Name of Policy/Instrument/Strategy/ Plan	Project description	Time Horizon		Actual emission reductions ($MtCO_2e$) i.e. results achieved till 2017	Amount of CERs issued	Coverage (Sectors and Greenhouse Gas Targeted)	Co-benefits	Status and Progress (Steps taken to achieve the action or envisaged)
Samancor Chrome Middelburg Electricity from Waste Gas	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		0.19	0	CO_2	Technology transfer, job creation	PDD approved by the DNA. Project registered by CDM EB on 12 Dec 2012
Samancor Chrome Witbank Electricity from Waste Gas	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		0.14	0	CO_2	Technology transfer, job creation	PDD approved by the DNA. Project registered by CDM EB on 12 Dec 2012
Distributed Energy Generation's Waste Heat to Power Project at XAWO	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		0.26	0	CO_2	Technology transfer, job creation	PDD approved by the DNA.Project registered by the CDM EB on the 27 Dec 12
Omnia Fertilizer Limited Nitrous Oxide (N_2O) Reduction Project	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 Fertilizer nitric acid plant in Sasolburg, South Africa.	From 2008-2022		0.47	2124190	CO_2, N_2O	Job creation, technology transfer	Approved by the DNA. The project was registered in May 3, 2007.

Table 3.8: Emission Reductions of CDM Actions in the Waste Sector which were not previously mentioned in BUR-2 (UNFCCC, 2018)

Name of Policy/ Instrument/ Strategy/ Plan	Project description	Time Horizon		Actual emission reductions ($MtCO_2e$) i.e. results achieved till 2017	Amount of CERs issued	Coverage (Sectors and Greenhouse Gas Targeted)	Co-benefits	Status and Progress (Steps taken to achieve the action or envisaged)
Kanhym Farm manure to energy project	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		0.03	0	CH_4, CO_2	Job creation	Approved by the DNA, The project registered by the CDM EB on 18 July 2008.
EnviroServ Chloorkop Landfill Gas Recovery Project.	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		0.19	183374	CH_4, CO_2	Job creation	Approved by the DNA · The project was registered by CDM EB on April 27, 2007 · Commissioned 19/01/08 · Operational agreement finalized.
Alton Landfill Gas to Energy Project	The objective of the Project is to collect and destruct/utilize 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		0.03	0	CH_4, CO_2	Job creation	Approved by the DNA · The project has been registered by the CDM EB on 24 Aug 09
Durban Landfill-Gas Bisasar Road	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		0.34	65711	CH_4, CO_2	Job creation	Approved by the DNA · The project was registered in December 15, 2006. · Technology has been installed. · Project operational · First verification done
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		0.28	0	CH_4, CO_2	Job creation	Approved by the DNA · The project has been registered by the CDM EB on 26 October 2010
Joburg Landfill Gas to Energy Project	The objective of the project is to collect and destroy/utilise the LFG generated at the Johannesburg landfill sites.	From 2012-2019		0.54	0	CH_4, CO_2	The integration of infrastructure which will improve environmental conditions. Disposal of these perilous constituents, particularly methane, safely, and to control and reduce odour nuisance and health risks. Minimisation of environmental damage through reduced methane emissions providing short- and long-term employment opportunities.	The Robinson Deep was constructed between February 2011 and May 2011 and the site was commissioned on the 27 May 2011 and was in continuous operation from the 27 May 2011. The Marie Louise landfill site was constructed from February 2012 to May in 2012 and was commissioned on the 04 May 2012 and remained operational ever since. The other thee landfill sites have not been constructed or commissioned to date.
Nelson Mandela Bay Metropolitan's Landfill Gas Project	The project activity will generate Renewable electricity through the collection and combustion of landfill gas (LFG) from Arlington and Koedoeskloof landfill sites.	From 2012-2022		0.11	0	CH_4, CO_2	Job creation	Project Idea approved by the DNA

Name of Policy/ Instrument/ Strategy/ Plan	Project description	Time Horizon		Actual emission reductions ($MtCO_2e$) i.e. results achieved till 2017	Amount of CERs issued	Coverage (Sectors and Greenhouse Gas Targeted)	Co-benefits	Status and Progress (Steps taken to achieve the action or envisaged)
Dundee Biogas Power (Pty) Ltd	The purpose of the project is to install anaerobic digestion (AD) based manure treatment system with methane recovery equipment. The biogas produced will be applied as fuel for electricity generation, surplus of biogas will be destroyed by flaring or combustion.	From 2014-2024		0.03	0	CH_4, CO_2	Job creation	PDD approved by the DNA Project registered on 15 Nov 2012
Manufacture and utilization of bio-coal briquettes in Stutterheim,	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		0.13	0	CO_2, N_2O	Solid waste disposal avoided, job creation, economical and safer sources of energy for heat generation	PDD approved by the DNA Project registered by the CDM Executive Board on the 22 May 2014
Mondi Richards Bay Biomass Project	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		0.18	0	CO_2, CH_4	Knowledge transfer, biomass waste to landfill avoided, job creation	The project was registered on the 20th May 2007 · Approved by the DNA on the 22 November 2011
PetroSA Biogas to Energy Project	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		0.03	32730	CH_4, CO_2	Job creation, poverty alleviation	Approved by the DNA · The project was registered in September 29, 2006. · The implementation process completed
Tugela Mill Fuel Switching Project	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		0.06	23081	CH_4, CO_2	Long-term sustainability of the mill	Approved by the DNA The project was registered in February 12, 2007. The construction process for the project started January 2007. 23081 CERs issued for the monitoring period 16 January-28 February 2009. Issued on 21 April 2011

3.4.3. Annual emissions reduction

The total annual emission reductions were quantified for the period 2000-2015. The baseline for the emission reduction estimation was the National GHG inventory for 2015 (DEA, 2018d). The achieved total annual emission reduction was quantified from the estimated emission reductions of individual mitigation actions, policies and measures mentioned in section 3.4.1 and 3.4.2. The sectoral emission reductions are indicated in **Table 3.9**.

Table 3.9: Baseline GHG emissions and annual emission reductions for the period 2000 – 2015

Emission reductions	Annual GHG emissions in Mt CO_2e															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GHG inventory (incl FOLU)	426.21	423.80	436.97	460.78	479.41	477.80	485.91	514.47	508.70	510.17	524.30	511.38	514.52	527.47	518.25	512.38
Emission reductions achieved in the Energy Sector	0.00	6.48	13.16	4.12	7.53	41.73	37.14	65.49	51.91	62.06	66.36	84.52	87.67	92.73	100.26	104.23
Emission reductions achieved in the IPPU Sector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	1.82	1.82	1.82	1.82	2.16	2.43	3.01	3.01
Emission reductions achieved in the Waste Sector	0.00	0.00	0.00	0.00	0.00	0.18	0.21	0.27	0.49	0.86	1.14	1.60	2.25	2.25	2.41	2.41
Emission reductions achieved in the AFOLU Sector	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.06	0.06
Total Emission reductions achieved	6.48	13.18	4.14	0.03	41.58	36.55	59.30	50.83	63.90	63.51	84.69	92.37	95.95	100.93	111.87	118.96
GHG emissions without mitigation	432.69	436.98	441.11	460.81	520.99	514.35	545.21	565.30	572.60	573.68	608.98	603.75	610.47	628.40	630.12	631.35

3.4.4. Progress Indicators

The approach to tracking South Africa's transition to a lower-carbon economy is based on a tiered approach (DEA, 2017c) (Table 3.10).

Tier 1: country level information that provides a top-down perspective;

Tier 2: indicators and data required to track mitigation at sectoral, sub-sectoral and company levels, including PPPs for companies with carbon budgets and progress towards achieving the SETs in key economic sectors; and

Tier 3: specific data and indicators for individual response measures, such as a programme or an individual project which contributes directly to climate change mitigation.

Core indicators to be tracked for Tier 1 and 2 are listed in **Table 3.10** below. In addition to these core indicators, other indicators may be identified, analysed and reported from time to time, as deemed necessary.

Table 3.10: Core Tier 1 and Tier 2 indicators to be tracked through the M&E system annually (DEA, 2017c)

Indicator Group	Tier 1: Country Level	Tier 2: Sectors, Sub-sectors and Companies
Sustainable carbon levels	National GHG emissions profile	Sector, subsector or company annual GHG profile
	Net change in the national GHG profile	Net change in the GHG profile of the sector, subsector or company
	Collective mitigation impact of all response measures	Collective mitigation impact of response measures
Lower carbon productivity	Carbon intensity of the economy	Carbon intensity of the sector or subsector
	Energy intensity of the economy	Carbon intensity of service or product delivered by the sector, subsector or company
Lower carbon consumption	Per-capita GHG emissions	—
Lower carbon resourcing	Proportion of renewables and carbon-free energy to total primary energy	Proportion of renewables or zero-carbon energy to total energy use
	Carbon intensity of energy supply	Energy use
		Energy intensity of production or service-delivered
Lower carbon sector growth	Growth in green jobs nationally	Growth in green sector or subsector jobs

Progress indicators are currently being identified for each emission sector. The work to identify progress indicators for the AFOLU sector has been completed (DEA, 2015b) as part of the study to inform the design, development and implementation of the National Climate Change Monitoring and Evaluation system of the AFOLU Sector.

3.4.5. Challenges to quantify emission reductions and co-benefits

Due to declaration of greenhouse gases as priority air pollutants, industries undertaking listed production processes must submit PPPs. Furthermore due to the PPP regulations, industries will also have to ensure a baseline emission inventory is compiled and the steps taken to reduce emissions are reported and monitored. As such the fundamental policy instruments to report emission reductions are now in place and the DEA will be able to update the National Climate Change Response Database using the information reported by industries through the PPP regulations in the National Atmospheric Emission Inventory System. The need to improve institutional capacity and monitoring and evaluation systems is further emphasized as a priority in the draft Climate Change Bill.

Information from online databases including the CDM project registry, the CDP reports and the NCPC case studies were used to analyse the extent to which the private sector reported emission reductions of mitigation actions. In the company reports collected from the climate change databases energy usage data were not readily available and thus emission reductions were not quantified. Companies provided the emission reduction statistics in tonnes CO_2 equivalents for each mitigation intervention that was listed.

Information about the challenges experienced to quantify the emission reductions of individual mitigation projects was not reported in the company reports collected from the CDM project registry and the climate disclosure project company responses. Nine of the companies that participated as part of the cleaner production program and submitted reports to the NCPC reported challenges experienced with primary data collection. Companies reported difficulties in terms of centralising the collection of data, capturing of information and the collation of data to derive meaningful emission reduction results. In some cases it was reported difficult to quantify the emission reduction effects of individual interventions since the programmes were part of a sequential and cumulative process of continuous improvement. Further challenges experienced include difficulties in quantifying energy savings using the electricity sub-meter data as there was no systematic way to analyse the data to compare actual to expected consumption.

The analysis of private sector responses on emission reduction activities indicate that industries are in a continuous process of improvement to report on their mitigation activities. Industries that have implemented energy management systems that monitor and track energy use are few. Emission reductions are most often estimated for mitigation actions and monitoring and evaluation of the emission reductions are not undertaken. The private sector in their submissions to the CDP have highlighted the need for monitoring and evaluation procedures to ensure that estimated emission reductions can be validated against measured emissions. The co-benefits of the mitigation actions also are proposed but no monitoring and evaluation steps were reported to track the developmental benefits. The PPP require significant emitters to implement monitoring and evaluation procedures of mitigation actions which standardizes how emissions activities are monitored and reported. Lesser emitting industries will not be required to implement monitoring and evaluation procedures where there is no requirement for submission of PPPs and in circumstances where emission reductions contributions cumulatively are substantial, the approaches taken to quantify emission reductions and co-benefits will be consistent with National Greenhouse Gas Emission Reporting Regulations. The Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry (DEA, 2017a) prescribe tiered approaches to the quantification of GHG emissions in industry based on IPCC 2006 guidelines and support stakeholder consultations with industries to develop higher tier emission factors.

3.4.6. Challenges to reporting progress and impact of policies and measures

Companies which have implemented voluntary initiatives to curb greenhouse gas emissions have not been required to monitor the performance of individual actions. The present challenge to reporting the progress and impact of policies and measures will be addressed to a certain extent by the implementation of the PPP regulations which will require significant emitters to track and report their mitigation actions. It will not be mandatory for other companies and institutions which emit less than 0.1 Mt CO_2e annually to submit PPPs. As such it will not be possible to report on the progress of all individual mitigation actions that has been or will be implemented in South Africa.

It is required that the emission reductions of programmes earning certified emission reduction credits through the CDM be monitored and reported. Monitoring reports of emission reductions are not publicly available for all registered CDM projects. Emission reductions must also be quantified ex-ante as part of the initial project design and then compared to monitored emission reductions after the implementation of the mitigation intervention. This requirement is unique to the CDM. Companies participating in the Carbon Disclosure Project or NCPC Industrial Energy Efficiency programme do not need to monitor and evaluate the emission reductions of the reported mitigation interventions. As such it is not possible to track the progress of mitigation interventions and the effect on emission reductions contributions of companies participating in the Carbon Disclosure Project and the NCPC Industrial Energy Efficiency programme.

An indication of implementation progress and impact on development of mitigation interventions is not readily available. Companies and institutions have highlighted the co-benefits of mitigation interventions for job creation and improvement in energy efficiency. The financial savings and investment costs of mitigation interventions have been estimated and provided in company reports but the finances are not tracked over the lifetime of the mitigation activity.

The implementation of the National Climate Change Response M&E System will contribute toward addressing these shortfalls of current international systems to centralise information about mitigation interventions in the country. The mainstreaming of the M&E system is expected to be dependent on the compliance and finalisation deadlines for the Atmospheric Emission Licenses, PPPs and Carbon Tax regulation and SETs programme.

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

4.1. Introduction

The chapter captures the financial, capacity and technical support received and further required with regards to climate change between the period 1 Jan 2015 - 31 December 2017*[1]. This includes an analysis of international and domestic climate-related finance flows, as well as non-monetised support received within the reporting period. Financial support needed (or requested) by South Africa to develop its response to climate change is given by sector and the activity, and the description of non-monetised technical and capacity-building needs is also provided. An overview of the country's updated technology needs assessment (TNA) is provided in terms of key sectors and technologies prioritised in the context of the country's development and climate change priorities, and associated barriers to these technologies.

4.2. Climate Finance

According to 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).

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 (ODA) and through bilateral finance institutions.

1 *2017 data was included where available, taking in to consideration the possibility of a lag in release of annual reports or statistics for latest years.

4.3. Progress Since BUR-1 and BUR-2

The reporting period for BUR-1 and BUR-2 was 2000-2010 and 2010-2014, respectively. For BUR-3, reporting period is 1 Jan 2015- 31 Dec 2017* (*2017 data was included where available, taking in to consideration the possibility of a lag in release of annual reports or statistics for latest years). For those projects included in BUR-2 bilateral, multilateral or domestic finance support tables which were beyond the BUR-2 reporting period (i.e. 2015 and 2016), updated amounts committed were provided in this chapter, where relevant.

4.4. Support Received

The financial support committed and non-monetised capacity building and technology support received from international donor funding sources, as well as domestic funds committed though government grants and loans are reported in the sections that follow.

4.4.1. International financial support received

Detailed information on the breakdown of the international bilateral and multilateral financial support received between 2000 and 2014 was presented in South Africa's BUR-1 (Tables 28 and 29) (DEA, 2014) and BUR-2 (Tables 34 and 35) (DEA, 2017). Support received during the BUR-3 reporting period, 1 Jan 2015- 31 Dec 2017* (*2017 data was included where available, taking in to consideration the possibility of a lag in release of annual reports or statistics for latest years) is provided for bilateral and multilateral donor funding sources in **Tables 4.1 and 4.2** respectively.

Table 4.1: Additional information on bilateral financial support committed between 2015 and 2017

Financial flows/ Support	Donor	Amount in (ZAR)	Amount in USD		Type of funding						Principal focus ODA	Co-financing (USD)	Specific purpose of funding
					Mitigation	Adaptation	Capacity Building	Technical Support	Technology support	General			
Grant	Denmark: Danish International Development Agency	107 000	8 223					x					Technical support on the integration of energy efficiency measures in N2 Gateway project.
Grant	Denmark (Danish Government)	69 509 000	5 341 659		x	x							South African-Danish renewable energy development programme. Development of the Wind atlas of South Africa (phase 2).
Grant	Denmark (Danish Ministry of Environment & Food)	9 740 535	748 545			x	x		x		x		South African – Danish Strategic Sector Cooperation on Water. Project duration 2016-2018. A memorandum of understanding on cooperation in the field of water- water use and water resources, signed in November 2015. The purpose of the program 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 of 2013. Thematic areas include urban water management, ground water management, and water efficiency in industries.
Grant	European Union	238 075 000	18 295 694		x								General budget support for the Smart metering implementation programme. This is in support of the renewable energy independent power producers programme
Grant	European Union	24 941 000	1 916 677				x	x					Sector Budget Support: Science and Technology for Poverty eradication. Support for science and technology policy training and the development of a science and technology climate change framework.
Grant	Finland	17 145 000	1 317 567		x								Biofisa II project. To determine the extent to which water and air pollution might impact on the health of two communities in the Lower Olifants water catchment area
Grant	Germany: German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). Implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)	234 805 952	18 044 472		x	x					x		Climate support programme (CSP) - Phase III. Duration: 02/2017 to 03/2020. The Project supports the South-African Department of Environmental Affairs (DEA) in implementing the national climate change response policy in (the areas of) mitigation, adaptation, and MRV. The DEA will be strengthened in its catalytic role to induce other departments and the private sector in implementing concrete climate-relevant projects (so-called 'Flagship Programmes').
Grant	German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). Implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)	51 363 802	3 947 228		x		x	x					Cities for Climate Change project. To support cities in tackling the challenges presented by climate change. Advising cities on how to adapt development plans, urban development strategies and urban design ideas and put them into practice in a way that creates cities fit for climate change. Project supports Chile, India and South Africa. The city of Durban was chosen in South Africa.

Financial flows/ Support	Donor	Amount in (ZAR)	Amount in USD		Type of funding						Principal focus ODA	Co-financing (USD)	Specific purpose of funding
					Mitigation	Adaptation	Capacity Building	Technical Support	Technology support	General			
Grant	Germany: German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). Implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)	51 070 295	3 924 673		x				x		x		Implementation of innovative logistics and supply structures in the refrigerated transport sector in South Africa. Duration: 06/2012 till 05/2017. The project aimed to encourage environmentally-friendly development in the transport sector. This involved undertaking an analysis of the sector and technical needs assessment, and installing and demonstrating suitable technology on a pilot basis. Measures to provide qualifications were implemented and a monitoring system put in place to measure, report and verify emissions reductions.
Grant	Germany: German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). Implemented by KfW Development Bank	733 768 600	56 388 976		x						x		Credit line for the promotion of renewable energies and energy efficiency in southern and eastern Africa. Duration: 11/2008 till 12/2016. The project helped to secure an environmentally-friendly supply of energy in South Africa. It ensured a long-term credit line from KfW Development Bank of EUR 50 m to the Development Bank of South Africa for financing the Jeffrey's Bay Wind Farm (one of largest wind farms in SA) in the Eastern Cape province.
Grant	Germany: German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). Implementing organisation: World Wildlife Fund (WWF)	5 029 602	386 517		x						x		Low-carbon development frameworks in South Africa. Project duration from December 2015 to August 2018. Project aims to provide input to the rollout of South African's National Climate Response Policy to maximise mitigation with concrete targets, deepen understanding and reveal opportunities beyond the current economic trajectory. Six sectors (energy, transport, industry, waste, agriculture forestry and other land use) mitigation regimes will be evaluated.
Grant	Germany	1 396 000	107 280		x								Promethium carbon project - three year project from 2014/2015 to 2016/2017 year.
Grant	Germany	69 919 342	5 373 193		x			x			x		Energy Efficiency in Public Building Infrastructure Programme (EPBIP). Project is from 2017 to 2021. EEPBIP helps scale up the support for implementing the Energy Efficiency and Energy Demand Management flagship programme. Main aim is to ensure all spheres of South African government contribute to the national greenhouse gas mitigation, energy efficiency and energy security targets.
Grant	Belgium- Government of Flanders	366 884 300	28 194 488			x	x				x		CSP 2017-2021 will deal with climate change adaptation and contributing to the creation of employment opportunities in the green economy. It is aligned with the South African main policies relating to green economy and climate change and contributes to the realisation of the 2030 Agenda on Sustainable Development (SDG 13: "Take urgent action to combat climate change and its impacts").

Financial flows/ Support	Donor	Amount in (ZAR)	Amount in USD		Type of funding						Principal focus ODA	Co-financing (USD)	Specific purpose of funding
					Mitigation	Adaptation	Capacity Building	Technical Support	Technology support	General			
Grant	Norway	18 465 000	1 419 007				x				x		Capacity development within the National Greenhouse Gas Inventory Unit. To strengthen the unit's ability to produce greenhouse gas inventories in a sustainable manner in line with accepted international reporting requirement and provision of the national climate change response policy.
Grant	Switzerland	2 865 000	220 171		x						x		Support to the energy efficiency monitoring and implementation project.
Grant	United States of America	815 000	62 631				x				x		SADC capacity building in relation to the risk and vulnerability atlas. Building capacity in the SADC member states in understanding information on climate change impact and risk in the context of the SADC early warning mechanism.
Grant	United States of America	1 152 729	15 000 000		x		x				x		The USAID South Africa Low Emissions Development (SA-LED) Program will help South Africa to reduce greenhouse gas emissions while promoting economic development and wellbeing for citizens. Key opportunities lie in areas of waste management, transportation, renewable energy and energy efficiency. The five year programme is in partnership with the Department of Environmental Affairs and the Department of Science and Technology working with local government to build capacity and develop projects to respond to climate change and support South Africa to transition to a green economy.
Grant	World Wide Fund for Nature South Africa	486 000	37 348		x				x				Energy access to rural communities. A socioeconomic innovation partnership. To develop a social infrastructure lead approach to address the lack of access to energy through renewable or clean technologies.

Table 4.2: Additional information on multilateral financial support committed between 2015 and 2017

Financial flows/ Support	Donor	Year	Implementing organisation	Amount (USD)	Amount (ZAR)		Type of funding						Principal focus		Co-financing (USD)	Specific purpose of funding
							Mitigation	Adaptation	Capacity Building	Technical Support	Technology support	General	ODA	Non-ODA		
Grant	Adaptation Fund	2016	South African National Biodiversity Institute	20 000	260 253							X		X		Technical Assistance Grant for Environmental and Social Policy (ESP). Approval date: 16/02/2016. Status: Readiness Grants. SANBI is the implementing agent.
Grant	Global Environment Facility	2015	Development Bank of Southern Africa	8 093 171	105 313 399		X	X				X		X	124 439 330	Cities-IAP: Building a Resilient and Resource-efficient Johannesburg: Increased Access to Urban Services and Improved Quality of Life. The project will foster city level resilience, resource efficiency, emission reductions and other co-benefits through area-based pilot demonstrations, systems analysis (food), and improved integrated planning.
Grant	Global Environment Facility	2015	Development Bank of Southern Africa	15 000 000	195 189 375		X							X	147 006 333	Equity Fund for the Small Projects Independent Power Producer Procurement Programme (SP-IPPPP) (Year: 2015). Removing Financial Barriers in the Small Scale Renewable Energy Projects: Establishment of an Equity Fund
Grant	Global Environment Facility	2014	United Nations Environment Programme	3 694 873	48 080 000							X		X		Project: South Africa- Enabling activities for the preparation of the third national communications and biennial update report (5 year period between 2014/15 - 2018/19). Undertake consultations with national stakeholders to: review previous climate change activities, identify gaps, and propose activities to be undertaken in line with the UNFCCC third national communication and biennial update report. *Not included in previous BUR-2 report.
Grant	Global Environment Facility	2015	United Nations Environment Programme	219 000	2 400 000							X		X		Preparation of Intended Nationally Determined Contribution (INDC) to the 2015 Agreement under the United Nations Framework Convention on Climate Change (UNFCCC)
Grant	Global Environment Facility	2016	United Nations Development Programme	2 460 000	32 011 058		X							X		Project: South African Wind Energy Project Phase II. Support government to promote the creation of green jobs, increased energy production from renewable sources, greater energy efficiency and increased reliance on low carbon development.
Grant	Global Environment Facility	2017	United Nations Development Programme	200 000	2 602 525		X							X		Project: Leapfrogging South Africa's markets to high efficiency LED Lighting and high efficiency distribution transformers.
Grant	Global Environment Facility	2017	United Nations Environment Programme	1 100 000	14 313 888				X					X	2 289 065	Capacity Building Programme to Implement South Africa's Climate National System. Project objective is to enhance human and institutional capacity related to transparency in South Africa

Financial flows/ Support	Donor	Year	Implementing organisation	Amount (USD)	Amount (ZAR)		Type of funding						Principal focus		Co-financing (USD)	Specific purpose of funding
							Mitigation	Adaptation	Capacity Building	Technical Support	Technology support	General	ODA	Non-ODA		
Grant	Global Environment Facility	2015	United Nations Industrial Development Organisation	5 776 484	75 167 220		X							X	38 439 000	Project Title: Industrial Energy Efficiency Improvement in South Africa through Mainstreaming the Introduction of Energy Management Systems and Energy Systems Optimization (4 year duration) (Year 2015). Project aim is to accelerate and expand the introduction of Energy Management Systems (EnMS), Industrial Energy Systems Optimization (ESO), and the Energy Management Standard ISO 50001 Series within the South African industrial (and selected commercial) context.
Grant	Global Environment Facility	2015	United Nations Industrial Development Organisation	1 300 000	16 916 413		X							X	7 115 000	Project title: Energy Efficient and Low-Carbon Transport in South Africa (Year 2015, 3 years). Promotion of the widespread use of electric vehicles (EVs) and non-motorized transport (NMT), and the development of the necessary infrastructure, as part of the Green Transport and Green Cities initiatives of South Africa.
Grant	Global Environment Facility	2015	United Nations Industrial Development Organisation	4 222 110	54 940 734		X							X	41 884 888	Project: Promoting organic waste-to-energy and other low carbon technologies. The project addresses both the energy needs and challenges related to waste management in South Africa municipalities. The project aims to transform the market of renewables by using organic waste from agriculture and agro-processing industries for energy production in SMMEs.
Grant	Green Climate Fund	2017	South African National Biodiversity Institute	380 000	4 944 798				X					X		Building SANBI's capacity to develop GCF funding proposals and manage and monitor GCF projects in South Africa. Anticipated duration 1/06/2017 –30/05/2019 (24 months)
Grant	European Commission	2015	United Nations Industrial Development Organisation	1 963 619	25 551 833		X	X						X		Project: Climate change, clean energy, and urban water in Africa - promoting market-based deployment of clean energy technology solutions in municipal waterworks (Year 2015, 3 years). The objective of this project is to create model pathways of market-based approaches for cost effective deployment of clean energy technologies, services and systems in municipal waterworks initially piloted in South Africa.
Loan	World Bank - International Finance Corporation	2017	City of Ekurhuleni	50 000	650 631							X		X		The project is to support the City of Ekurheleni's capital investment program. Roads, electrical, water and sanitation infrastructure will be upgraded, and the infrastructure will support the development of a bus system aimed at connecting various areas that make up the municipality and encourage motorists to switch to more climate-friendly modes of transport.
Loan	World Bank - International Finance Corporation	2015	Karsten Group Holdings (Pty) Limited	900 000	11 711 363		X							X		The project entails providing a corporate loan to Karsten Farms (Pty) Limited to introduce energy efficiency measures and use of renewable energy in its farming operations. As a Cleaner Production Lending Facility (CPLF), this IFC investment will result in positive environmental impacts from implementing energy efficient measures.

Table 4.3: Additional information on multilateral support approved/ concept notes submitted between 2015 and 2017

Donor	Project title	Project detail
Green Climate Fund	GEEREF NeXt (Project FP038)	Approved in April 2017 with an estimated 5-year implementation period. Global emerging markets programme (focussed on Green Climate Fund countries). European Investment Bank is the accredited entity. GEEREF NeXt is structured as a fund of funds, with the aim of being a first investor (anchor investor) in renewable energy/ energy efficiency (RE / EE) investment funds, and encouraging other investors to co-invest. The total project investment is $ 765 million, of which Green Climate Fund Financing is comprised of Equity = $ 250 million and Grant = $ 15 million. Co-financing will be from the European Investment Bank (Equity = $ 30 million) and other investors (Equity = $ 470 Million). Multiple countries are involves, of which South Africa is included. Country specific fund allocation was not available/ disbursed at the time of compiling this chapter.
Green Climate Fund	SCF Capital Solutions Project FP029)	This programme was created as a direct result of the needs of MSME start-ups in South Africa's Green Fund incubation program. The facility aimed to supply chain financing techniques to provide working capital to MSMEs involved in Renewable Energy and energy efficiency projects. Green Climate Fund financing (Equity = $12.2 million). The Board's approval of FP029 SCF Capital Solutions by DBSA, submitted to the Board at B.15 under the first tranche of the MSME pilot programme, expired on 23 October 2017. The project will need to be revised and resubmitted for Green Climate Fund Board approval.
Green Climate Fund	Concept note: Commercialisation of Passenger Rail Agency of South Africa (PRASA) Energy Assets	Concept note submitted in November 2016 for Project entitled "Commercialisation of Passenger Rail Agency of South Africa (PRASA) Energy Assets" with a mitigation focus. PRASA highlighted an urgent need to consider all energy options including improved energy efficiency and sustainable resources (such as renewables) to carry out its primary mandate of providing rail commuter services in South Africa. The concept note submitted to the GCF discussed the above options with the specific objective of developing and commercializing PRASA's energy- related assets such as rooftops and ground-mounted solar PV which have the potential to alleviate PRASA's huge energy costs while promoting climate mitigation. Project preparation for Phases 1 and II estimated the total costs ~45 000 000 ZAR (Accredited Entity: DBSA).
Green Climate Fund	Concept Note: South African Green Fund	Concept note submitted in August 2016 entitled "South African Green Fund" with a cross-cutting focus. Total project amount $20 million requested for additional funding to augment existing programme to continue support to early stage green initiatives ((Accredited Entity: DBSA).
Green Climate Fund	Concept note: Credit enhancement mechanism for non-sovereign backed power purchase agreements	Concept note submitted in November 2017 entitled "Credit enhancement mechanism for non-sovereign backed power purchase agreements ("PPAs") (cross-cutting focus). The objective of the concept note submission is to source a first loss/ guarantee facility, to be used as a credit support mechanism to support non-sovereign guarantee backed PPAs for renewable energy projects in South Africa. Total project amount $ 1 381,8 million requested in total, with $253.8 million requested from GCF in the form of guarantees, and co-funding in the form of loans and equity = $ 1 128 million (Accredited Entity: DBSA).

An analysis of bilateral and multilateral support received per donor country is presented graphically in **Figure 4.1** and **Figure 4.2** respectively. The largest proportion of bilateral grants was received from Germany at 54.9%, followed by Belgium 17.5% and European Union funding 12.6%. The remaining 15% was received from various other donor countries/parties as shown in **Figure 4.1** below.

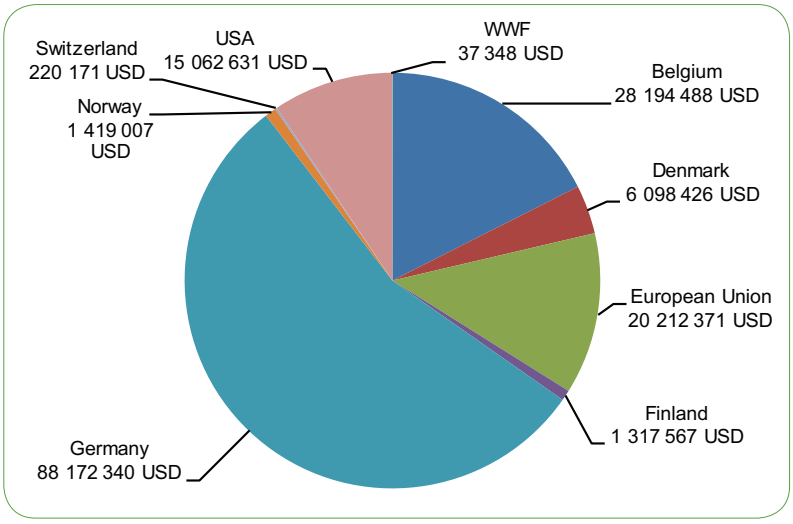

Figure 4.1: Analysis of bilateral support committed/received (2015-2017)

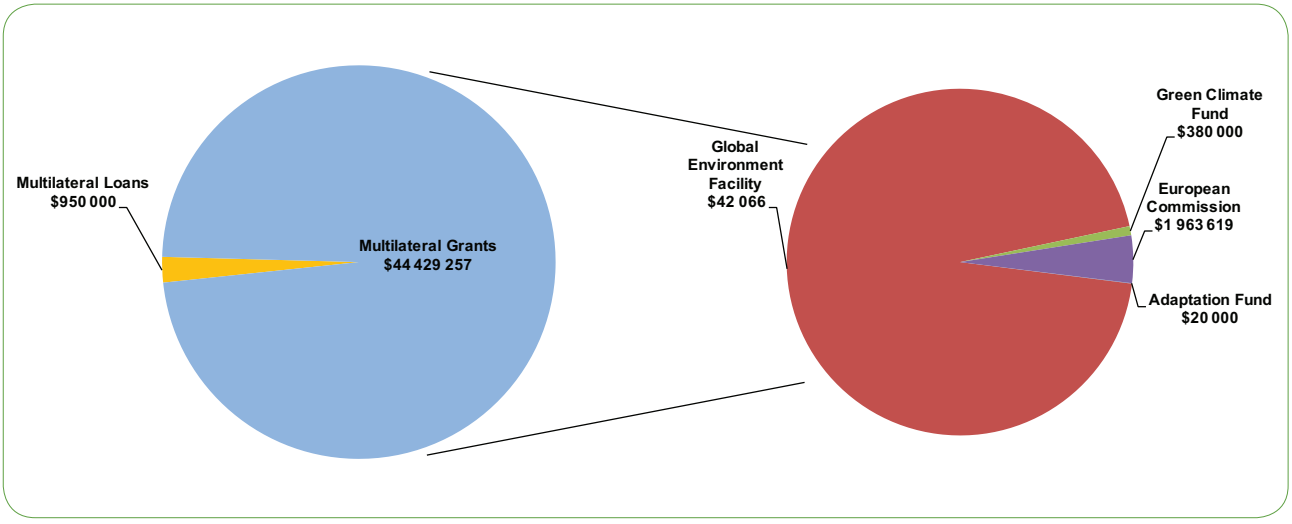

Figure 4.2: Analysis of multilateral support committed/received (2015-2017)

An analysis of multilateral support to South Africa is shown in Figure 4.2. Loans received during the reporting period were from the World Bank International Finance Corporation ($ 950 000). The contribution committed as grants (Figure 4.2, pie chart on the left) made up 98% of the multilateral funds received. The majority of the grants were received though the Global Environment Facility (GEF) (95%, $44 million) which were channelled through the Development Bank of South Africa (DBSA) (55%), United Nations Industrial Development Organisation (UNIDO) (27%), United Nations Environment Programme (UNEP) (12%), and United Nations Development Programme (UNDP) (6%), funding shown USD in **Figure 4.3**.

4.4.2. 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. A number of domestic funding sources are available in South Africa for climate change projects. Examples include the Green Fund managed by the Department of Environmental Affairs (DEA) and the Development Bank of Southern Africa (DBSA) and the Energy Efficiency and Demand-side Management Fund managed by the DoE. The domestic finance flow is reported for the financial period of 2015 to 2017 and is summarised in Table 4.4. Funding is reported in South Africa Rand (ZAR) and in US dollar (USD). The average annual exchange rates as released by National Treasury for 2014/15 to 2017/18 were used. An average rate over this period was applied.

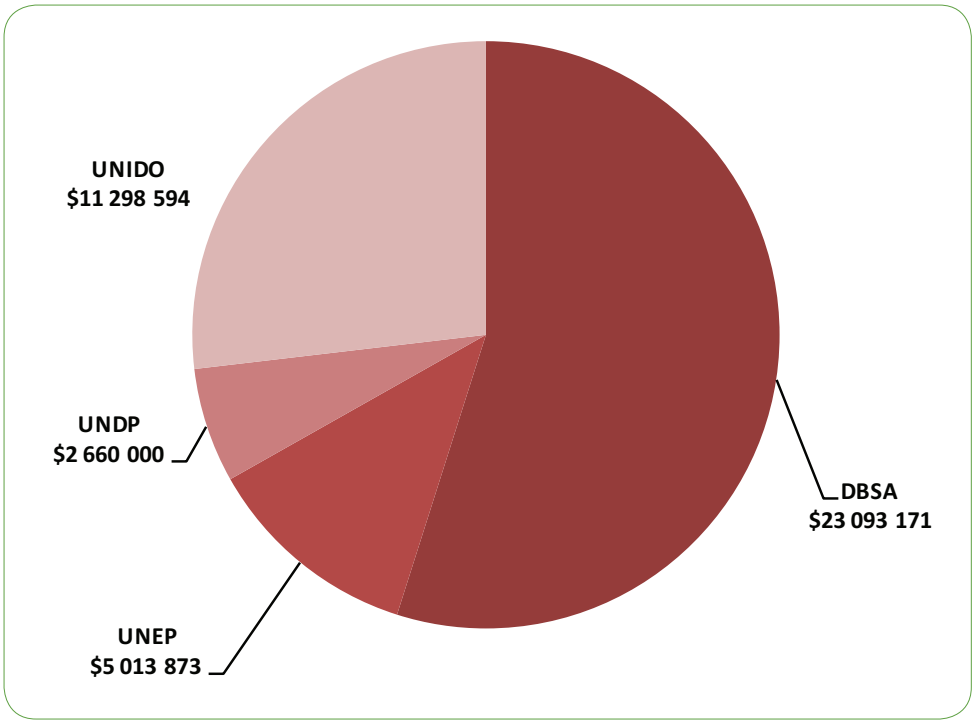

Figure 4.3: Analysis of Global Environment Facility funding received (2015-2017)

Table 4.4: Domestic financial flows between 2015 and 2017

Financial flows/ Support	Institution facilitating transfer of support	Scheme	Amount USD	Amount ZAR		Type of funding						Specific purpose of funding	Outcome (where available)
						Mitigation	Adaptation	Capacity building	Technical support	Technology support	General		
Grant	Department of Energy and Eskom	Integrated National Electrification Programme (INEP)	462 138	6 013 634		x		x		x		To ensure the universal access, efficient delivery and affordable electricity by expanding infrastructure particularly into rural areas. Access to grid and off-grid electrification is included (e.g. solar systems).	
Loan	Department of Environmental Affairs (Managed and implemented by Development Bank of Southern Africa (DBSA)	Green Fund Investment Projects	45 375 549	590 455 000		x	x	x	x	x		The largest focus of the Green fund has been on investment projects. Projects demonstrating and contributing to practical ways in which to transition to a low-carbon, resource-efficient and climate-resilient development path. These projects are also supported by other partners.	There were 19 active investment projects at the end of 2016. These projects addressed a wide range of localised and industry development needs. The largest proportion of funds went to waste management and renewable energy projects, followed by energy efficiency and payment for ecosystem services projects.
Grant	Department of Science and Technology	Sector Innovation and Green Economy	214 400 323	2 789 911 000		x	x	x		x		Provides policy, strategy and direction for research and the development-led growth of strategic sectors of the economy; and supports the transition to a green economy.	
Grant	Department of Trade and Industry (MCEP administered by the Industrial Development Corporation)	Manufacturing Competitiveness Enhancement programme (MCEP)	19 212 111	250 000 000		x						The MCEP provides financial incentives for the manufacturing industry to upgrade production facilities by using green technologies and improving resource efficiency.	During 2016/2017 377 applications were approved for funding.
Conditional Grant	National Disaster Management Centre (NDMC) in the Department of Cooperative Governance	Municipal Disaster Grant	32 150 008	418 356 000			x	x				This emergency funding grant is administered by the NDMC in consultation with National Treasury. The objective is to proactively respond to the immediate needs after a disaster has occurred in order to deal with the consequences from such a disaster.	Grants are allocated to local municipalities for relief from the immediate effects of disasters such as wild fires, storms, floods and droughts.
Conditional Grant	National Disaster Management Centre (NDMC) in the Department of Cooperative Governance	Municipal Disaster Recovery Grant	27 071 248	352 268 000			x	x				Grants may be utilised for the rehabilitation and reconstruction of municipal infrastructure following disaster damage	Grants are allocated based on approved post-disaster reconstruction and rehabilitation assessment reports to the NDMC.
Grant	National Treasury (managed by Department of Environmental Affairs)	National Expanded Public Works Programme: Environmental protection and infrastructure programme	57 519 294	748 477 000				x			x	The Environmental Protection and Infrastructure Programme (EPIP) supports local municipalities to improve the quality of the lives of their communities. Work is done cooperatively with local government to implement environmental projects using labour intensive methods.	Key projects under the EPIP are within the following focus areas: Working for Waste, Working for Coast, Working for Land, People and Parks, Wildlife economy, Youth environmental Services and Green and Open Space Management.

Financial flows/ Support	Institution facilitating transfer of support	Scheme	Amount USD	Amount ZAR		Type of funding						Specific purpose of funding	Outcome (where available)
						Mitigation	Adaptation	Capacity building	Technical support	Technology support	General		
Grant	National Treasury (managed by Department of Environmental Affairs)	National Expanded Public Works Programme: Environment and Culture programmes	249 543 347	3 247 214 000				x			x	The department has launched 14 Working For programmes through the expanded public works programme and this contributes to land and ecosystem restoration and water resource management. Working for Water programme and Working for Fire programme receiving much of the funding in the period of 2015 to 2017.	
Grant	National Treasury (Managed by Department of Energy)	Energy Efficiency and Demand-side Management funding program (EEDSM)	43 554 625	566 760 000		x		x	x	x		Build capacity and support of energy efficient demand-side management in South African municipalities. Through EEDSM interventions, municipalities reduce electricity bills through optimising energy use, improving delivery service and reducing GHG emissions.	The EEDSM programme targets an annual saving of 0.5 TWh. Electricity savings obtained primarily through deployment of energy efficient technologies in buildings (e.g. lighting, heating, ventilation and cooling systems), LED street lighting and smart technologies for managing energy.
Grant	Department of Trade and Industry (South Africa's National Cleaner Production Centre (NCPC-SA) hosted by the Council for Scientific and Industrial Research (CSIR) and implementing Agent by United Nations Industrial Development Organisation (UNIDO)	Industrial Energy Efficiency (IEE) Project	13 588 419	176 821 000		x		x	x	x		The project has a holistic approach to saving energy through promotion and implementation of Energy Management Systems and Energy Systems Optimisation and strengthening the industry capacity in the energy efficiency field.	IEE Project is currently in the second phase (2016- 2019)

The South African government has invested approximately $ 643.9 million in the form of grants and $ 45.4 million in the form of loans to support climate change related programmes and research from 2015 to 2017 as depicted in **Figure 4.4** below.

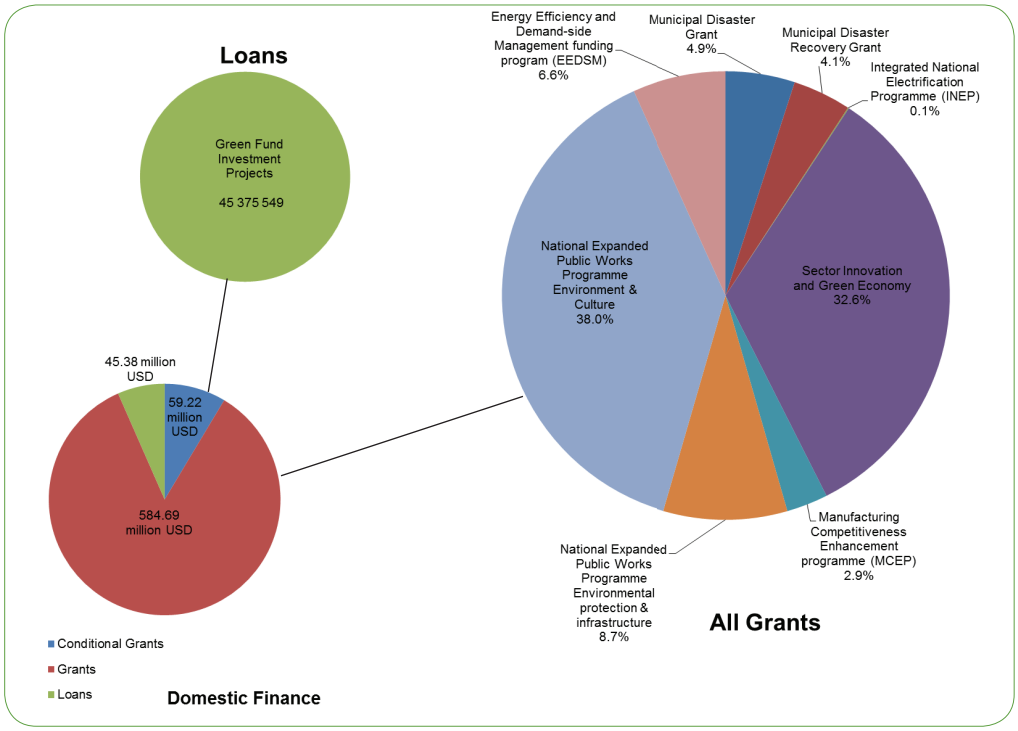

Figure 4.4: Summary of domestic funds that impact climate change responses

4.4.3. Non-monetised support received

The BUR-2 outlined the technical and capacity building needs for South Africa in **Table 39** (DEA, 2017) which were mainly related to initiation, implementation and scaling-up of mitigation actions, including the lack of MRV methodologies to validate and verify the emission reduction potential of projects and institutional arrangements to effectively implement projects under Flagship programmes. Since the BUR-2, South Africa has received non-monetised support for capacity building which addressed some of the support needs which were highlighted in BUR-2. This support received included support for activities related to mitigation methodology, GHG expert reviewer training, and training on an energy and emissions model (the 2050 Pathways Calculator), as well as courses on energy efficiency and green industrial development. Technical support and capacity building support received from developed countries is summarised in Table 4.5 for the period 2015- 2018 (up to March 2018) and is additional to the support reported in Table 37 of BUR-2 (DEA, 2017), and includes some support received within the BUR-2 reporting period (i.e. includes the period 2015-2016).

Table 4.5. Technical support and capacity building support received from developed countries for the period 2015-2018 (up to March 2018)

Type of support	Activity	Focus	Time frame	Donor
Capacity building	African Mobility Week in Kenya. This provided the platform for discussions on cleaner mobility and its impacts on health, environment and economic growth in Africa. The week built on the outcomes of 2014 Africa Sustainable Transport Forum where 13 action points to promote sustainable transport were agreed upon. Participants included governments, private sector, civil society and development partners in fields of environment and transportation. Measures were developed to move to cleaner mobility leveraging on good experiences and case studies from within and outside of the region.	Mitigation	12-17 March 2018 in Kenya	United Nations Environmental Programme (UNEP)
Capacity building	Plenary of the Global Forest Observations Initiative (GFOI). The plenary content included for a global coordination on forest monitoring for emissions measurement, reporting and verification (MRV) issues for REDD+, transparency under the Paris agreement and related fora.	Mitigation and adaptation	13 – 15 March 2018 in Bogota Colombia.	Sponsored by the Australian Government
Capacity building	UNIDO five-day course on Green industrial development – Pathways towards a circular economy at the University of Bahrain.		3 to 7 December 2017 in Bahrain	United Nations Industrial Development Organization (UNIDO)
Capacity building	Cleaner and Efficient Vehicle strategies workshop. Mauritius shared its experience with the Southern Africa Community Development (SADC) countries on implementing vehicle and fuel policies and on developing additional policies for further encouragement of import and use of cleaner vehicles.	Mitigation	12-13 October 2017 in Mauritius	United Nations Environmental Programme (UNEP)
Technical support	Environment Protection Agency working session on mitigation methodology	Mitigation	14-15 September 2017 in Washington DC	World Resources Institute (WRI)
Capacity building	World Resource Institute training	Mitigation	11 to 13 September 2017 in Washington DC	World Resources Institute (WRI)

Type of support	Activity	Focus	Time frame	Donor
Capacity building	13th Conference on Cooperative Green Growth Modelling Forum in Republic of Korea.	Mitigation	10 to 13 July 2017 in Republic of Korea	Sponsored by Greenhouse Gas Inventory & Research Centre of Korea (GIR)
Capacity building	International Energy Association (IEA) Energy Efficiency in Emerging Economies training. The training included parallel courses on energy efficiency in buildings; lighting, appliances and equipment; industry and transport.	Mitigation	12 – 16 June 2017 in Paris France	International Energy Association (IEA)
Technical support	Use of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories - IPCC Expert Meeting to collect EFDB and Software users' feedback	Mitigation	14 – 17 March 2017 in Kitakyushu, Japan	IPCC Trust Fund
Capacity building	Study tour to Australia and New Zealand	Mitigation and adaptation	18 – 26 February 2017	Sponsored by Australian government
Capacity building	National GHG Inventory Expert Reviewer Training and exam	Mitigation	19 to 21 April 2016 in Bonn, Germany	UNFCCC
Capacity building	2050 Pathways Calculator Conference. The Calculator is an open source energy and emissions model allowing users to explore all high-level energy and emission pathway options that the country, territory or region faces.	Mitigation	10 to 12 February 2015 in Taiwan	UK Government (Department for Business, Energy and Industry Strategy, previously Department of Energy and Climate Change
Capacity building	2050 Pathways Calculator Conference.	Mitigation	14 to 16 March 2016 in Mexico	UK Government (Department for Business, Energy and Industry Strategy, previously Department of Energy and Climate Change

4.5. Support Needs

4.5.1. Financial support needed

South Africa' support needed to transition to a low carbon and climate resilient economy and society is detailed in the support component of the NDC (DEA, 2015). Similarly as to what was stated in BUR-2 (DEA, 2017) catalysing the financing and investments required to proceed towards the low carbon and climate resilient economy remains an important challenge for the country. The financial support needed or requested by South Africa to develop its response to climate change is summarised in the table below. Many of the programmes (for adaptation and for mitigation actions) as reported in BUR-2 (DEA, 2017) continue to require financial support for their ongoing existence and expansion or upscaling.

Table 4.6: Financial support required

Sector and activity	Reference to programmes, policies and measures	Type of support needed/ requested			Funding by preferred type		
		General	Technology	Training	Loan	Grant	In-kind
Water conservation and Demand Management	Working for Water and working on Wetlands programmes	x				x	
Integrated fire management	Working on Fire programme	x				x	
Land restoration	Land policy and Working for Water programme	x				x	
Renewable energy	Expansion of Renewable Energy Independent Power Producer Procurement Programme (REI4P)	x				x	
Decarbonisation of electricity sector	National Climate Change Response Policy	x				x	
Carbon Capture and Storage	National Climate Change Response Policy	x				x	
Renewable energy (includes off-grid and mini grid)	Energy Efficiency and Demand Side Management Municipality Programme (EEDSM)	x				x	
Rural energy (includes off-grid and mini grid)	Integrated National Electrification Programme (INEP)	x				x	
Green transport	South African Cities Green Transport Programme				x	x	
Industry in private sector (small, medium and large enterprises)	Funding to assist with decarbonisation of company's activities in a sustainable manner	x				x	
Provincial environmental departments	Support for climate change adaptation planning and development	x				x	
GHG Improvement Programme	Support for inventory team to incorporate new data and for updating the GHG inventory.	x				x	

4.5.2. Technical or capacity-building needs

The technical and capacity building needs for South Africa, highlighted in Chapter 5.4 of SA's TNC, Chapter 5.4 (DEA, 2018) are summarised in **Table 4.7**. The needs focus on strengthening of GHG inventory capacity development, climate change mitigation and adaptation, climate change research and systematic observation and climate change education, training and social learning at a systemic level.

Table 4.7: Summary of non-monetised support needs

Type of Support	Activity	Focus
Capacity Building	Develop training courses covering GHG inventory update process (IPCC guideline methodologies for sectors, QA/QC process and methods, uncertainty analysis, key category analysis, coordination and management of update process)	Mitigation
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. Particular need to improve data in transport and waste sectors	Mitigation
Technical	Support is needed for the production of updated land use change maps in the Agriculture, Forestry and Other Land Use (AFOLU) sector	Mitigation
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)	Mitigation
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	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	Mitigation and adaptation

As part of the technical analysis of the second biennial update report of South Africa, submitted on 28 December 2017, further specific technical and capacity building needs related to the facilitation of the preparation of subsequent BURs and participation in the international consultation and analysis (ICA) were identified as follows (UNFCCC, 2017):

a. Enhancing technical capacity for GHG inventory development on a regular and continuous basis;
b. Enhancing technical capacity for the development of the GHG management system, including for:
    - Operationalizing the system in terms of the personnel capacity to operate and maintain it;
    - Operationalizing QA/QC components, processes and plans;
c. 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);
d. Enhancing technical capacity for the development of country-specific EFs for some key categories in the AFOLU sector, namely direct and indirect N_2O emissions from managed soils and land converted to cropland;
e. Enhancing technical capacity for tracking land-use changes;
f. Enhancing the technical capacity of national sectoral experts to prepare a GHG inventory with the aim of also increasing the number of experts in the GHG inventory team of DEA;
g. 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;
h. 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;
i. Enhancing the technical capacity of DEA to track the progress of mitigation actions;
j. Building the capacity for undertaking comprehensive technical analyses to identify constraints and gaps at the operational level.

4.5.3. Technology needs assessment (TNA)

Technology transfer is a key aspect of achieving the country's developmental goals. In 2007, the Department of Science and Technology (DST) completed a TNA (DST, 2007) which identified and assessed environmentally sound technologies which would reduce the impact of climate change and the rate of GHG emissions. The DST in collaboration with DEA is currently supporting the development of an updated assessment of South Africa's climate technology needs across key sectors to both adapt to and mitigate climate change effects in order to achieve sustainable developmental goals.

The objectives of the updated TNA are:

- To understand developmental priorities in the changing climate of South Africa and to provide a context for which technology needs are determined;
- To understand which sectors and subsectors can support the most effective actions for climate change adaptation and mitigation;
- To determine which climate change technologies are most appropriate to transfer in order to most effectively implement climate change project initiatives and support synergies among adaptation and mitigation responses;
- Identify, analyse and address barriers hindering the acquisition, deployment and diffusion of prioritized technologies; and
- To develop an associated technology action plan for the development and transfer of selected prioritised technologies

The outcomes of the updated TNA study were reported in detail in South Africa's TNC report to the UNFCCC. Several studies have been conducted since the last TNA that have a direct bearing on the contents of the updated TNA. These studies are a direct response to the NCCRP and National

Climate Change Response Strategy. These include the Long Term Adaptation Scenarios (LTAS), Long Term Mitigation Scenarios (LTMS), the latest GHG Inventory, MPA, Climate Change Mitigation Technology Implementation Plan (DEA and DST, 2015), Global Change Research Plan and departmental plans. Analysis of these documents has revealed that the sectors and subsectors that must be characterised in terms of existing technologies and potential impact on sustainable development priorities for mitigation and adaptation.

The TNA presents an opportunity to link climate technology transfer needs for South Africa to development in an integrated manner. The sectors considered in the update in their entirety are:

- **Adaptation:** Agriculture; Biodiversity; Commercial Forestry; Human Settlements; and Water;
- **Mitigation:** AFOLU; Energy; Industry; Transport; and Waste.

These sectors are broader than those considered in the previous TNA and were intended to be more inclusive. On the basis of this sector characterization (Table 4.8), a broader technology prioritization process that will attempt to minimise biases was conducted. While sector prioritisation was conducted on a sector by sector basis, it is important to note that key linkages among sectors were also considered in terms of interactions among adaptation and mitigation priorities, as well as in terms of cross-cutting issues among sectors.

Table 4.8: Results from the sector prioritization

Sectors Priority	Adaptation	Mitigation
1	Water	Energy
2	Agriculture	IPPU
3	Biodiversity	Waste
4	Human Settlements	AFOLU
6	Forestry	
7	Fisheries	

The technology prioritisation was conducted on a sector by sector basis for the sectors shown in Table 4.8, with the exception of the Energy sector, and was informed based on the countries climate change priorities and by the expertise among various sector working groups. Technologies were ranked within each sector through a series of technology prioritisation workshops using the Multi-Criteria Analysis (MCA) approach (described by Dodgson et al. (2009)) which was outlined in a guideline for countries conducting a technology needs assessment (Haselip et al., 2015). The technologies selected are viewed through a climate change lens, with cross-cutting considerations also included to illustrate key linkages among sectors. A mitigation technology prioritization has been conducted by the Climate Change Mitigation Technology Implementation Plan, which, based on the MPA outcomes, resulted in shortlisted short, medium and long term technologies. The technology prioritisation process involved ranking climate change mitigation and adaptation technologies which are most important to transfer in the context of these technologies playing a key role in supporting the effective implementation of climate change project initiatives in the country. The current technology needs assessment is ongoing and will include a comprehensive barrier analysis to categorise and characterise the prioritised technologies towards a technology action plan.

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5. SUPPORT RECEIVED FOR PREPARATION OF THE BUR

South Africa, as a signatory to the UNFCCC, received financial support from the Global Environment Facility (GEF) to compile and publish its BUR-2 and BUR3, as well as the TNC. The United Nations Environment (UN Environment) has been implementing entity responsible for the management of these funds for the GEF.

South Africa has developed its BUR-3 in collaboration with the CSIR as the appointed service provider. The CSIR was responsible for drafting the Mitigation Actions and its Effects Chapter; the Support Received and Needs Chapter as well developing a synthesis of the 2000-2015 NIR report under the leadership as well as strategic and technical guidance of the DEA. Internally within the DEA, the DEA personnel drafted the National Circumstances Chapter, developed the 2000-2015 NIR; Support Received for the preparation of the BUR-3; Domestic MRV Chapter (written in conjunction with the CSIR) as well as the Additional Information Chapter.

South Africa also received additional financial support from the German Federal Ministry for the Environment, Nature Conservation, Buildings and Nuclear Safety (BMUB) through its International Climate Initiative. The Gesellschaft für Internationale Zusammenarbeit (GIZ) is the implementing agency through its Climate Support Programme to South Africa. The financial support provided by the GIZ was to enable South Africa to appoint independent external reviewers to review South Africa's 6th NIR as well as the BUR-3. This process is crucial for quality assurance as well as ensuring that the recommendations from Technical Teams of Experts in South Africa's summary report for BUR-2 were taken into consideration.

5.1. Capacity Building and Technical Support Received

South Africa developed the BUR-2 internally within the DEA. This was a very important exercise in terms of skills transfer for the DEA staff to be able to comply with the enhanced transparency requirements as well as Articles 4 and 12 of the UNFCCCC. This process enabled South Africa to identify its capacity needs especially in terms of developing greenhouse gas inventories as well as tracking mitigation actions and quantifying their impacts. A detailed list of South Africa's capacity-building needs can be found in the summary report for South Africa's BUR-2 as well as in Chapter 4 of this BUR.

South Africa also received some capacity in terms of training in 2017. The personnel attended the workshop organised by the UNFCCC and CGE for the assessment of the mitigation actions, which was held in South Africa in September of 2017. The workshop was very effective in providing hands on training and case studies on how to determine the impact of mitigation actions using the IPCC methodologies. The workshop also trained the participants on how to comply with the BUR guidelines for countries not included in Annex I of the convention as per Decision 2/CP.17.

5.2. Challenges, Constraints and Solutions

The key challenges that South Africa faces in the preparation of BURs relates to the insufficient number of personnel responsible for compiling the NIR as well as the BUR. South Africa's Climate Change Monitoring and Evaluation System has not fully been operationalised so data relating to mitigation actions and support received is still collected on manual basis. In addition, the institutional arrangements for data provision have not yet been fully formalised and data is provided based on informal arrangements between the DEA and the data providers. This affects the quality of data and often results in a delay in data provision, which also affects the finalisation of the BUR. In addition, data providers do not always provide progress updates on the data as well as quantification of the mitigation actions as per the templates provided to them.

South Africa has made remarkable progress with the collection of emissions data for the development of NIRs. South Africa now has mandatory Greenhouse Gas Inventory Reporting Regulations which was promulgated by the Minister in April 2017 (DEA, 2017). In addition, South Africa has also developed the technical greenhouse gas inventory reporting guidelines for industry for reporting their emissions into the NAIES as per the regulations. This has indeed made it easier for the inventory data to be collected and used for developing the NIR.

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6. MEASUREMENT, REPORTING AND VERIFICATION IN SOUTH AFRICA

6.1. An Overview of the South African Climate Change M&E System

Measurement, reporting and verification (MRV) systems will be a significant tool for effectively tracking mitigation goals and improving the implementation of policies as articulated in country Nationally Determined Contributions (NDCs) under the Paris Agreement. Under the Paris Agreement, it was agreed that all countries would provide emissions data and track progress against achievement of their NDCs. The South African National Climate Change Response Policy (NCCRP) (DEA, 2011) called for the establishment of a National Climate Change Response Monitoring and Evaluation (M&E) System, which would 'evolve with international measuring, reporting and verification (MRV) requirements'.

The NCCRP recognises that the effective MRV of emissions and emissions reductions is critical for understanding GHG sources and trends; informing the design of mitigation strategies and effective implementation thereof and; to enhance the credibility of South Africa's climate change policy and actions. South Africa's Climate Change Response M&E framework, published in 2015, explicitly includes evaluation, as basis for the analysis of the impact of mitigation and adaptation measures, while the monitoring component of South Africa's Climate Change Response M&E system encompasses MRV aspects.

The overarching objective of the South African Climate Change Response M&E system is to enable the effective implementation of climate change responses, through the following (DEA, 2011):

a. Provision of timely access to accurate and complete information to reduce climate change risks, projected climate change impacts and to inform effective interventions
b. Monitoring and assessment of success of climate change responses to inform the rapid and widespread replication of those responses that have worked well

Comprehensive climate change M&E system, integrating adaptation, mitigation and climate finance is a practise that is still at its infancy globally and thus, South Africa's approach to climate change M&E is premised upon continuous learning and improvement of the system implemented in phased manner. The fully functional system will monitor and evaluate South Africa's GHG emissions, mitigation responses, adaptation responses as well as tracking climate finance as shown in **Figure 6.1** below.

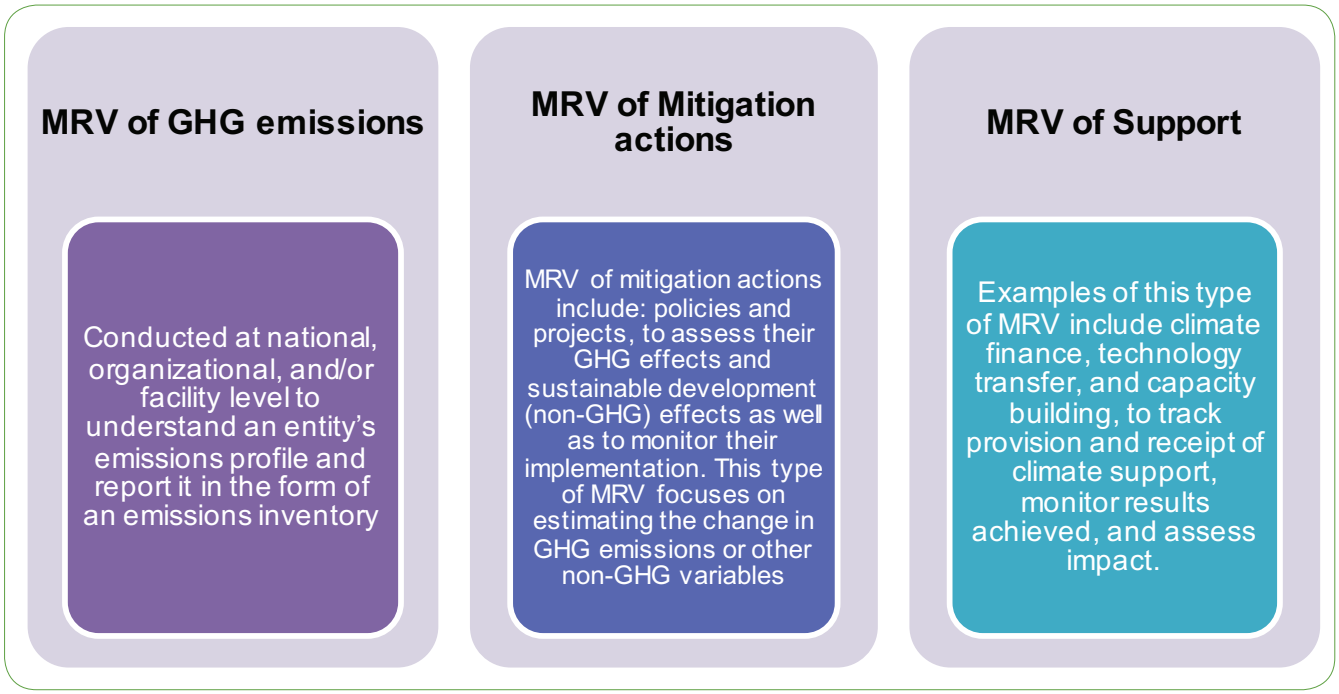

Figure 6.1: Functional aspects of the MRV

South Africa climate change response M&E system seeks to integrate 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 climate change response M&E system the national central depository and portal for climate change information in South Africa. Implementation of the Climate Change Response M&E system is facilitated by a range of legal instruments, regulations including the mandatory GHG reporting regulations and technical guidelines, and supported by a range of tools and processes. These are addressed in more detail below.

6.2. Milestones Reached in Development of Monitoring and Evaluation

The development of an integrated climate change M&E system is a considerable undertaking. As previously indicated, South Africa is taking a phased approach to the rollout of the National Climate Change M&E system with full-implementation of this system envisaged in 2020. **Figure 6.2** provides an overview of the M&E system phasing.

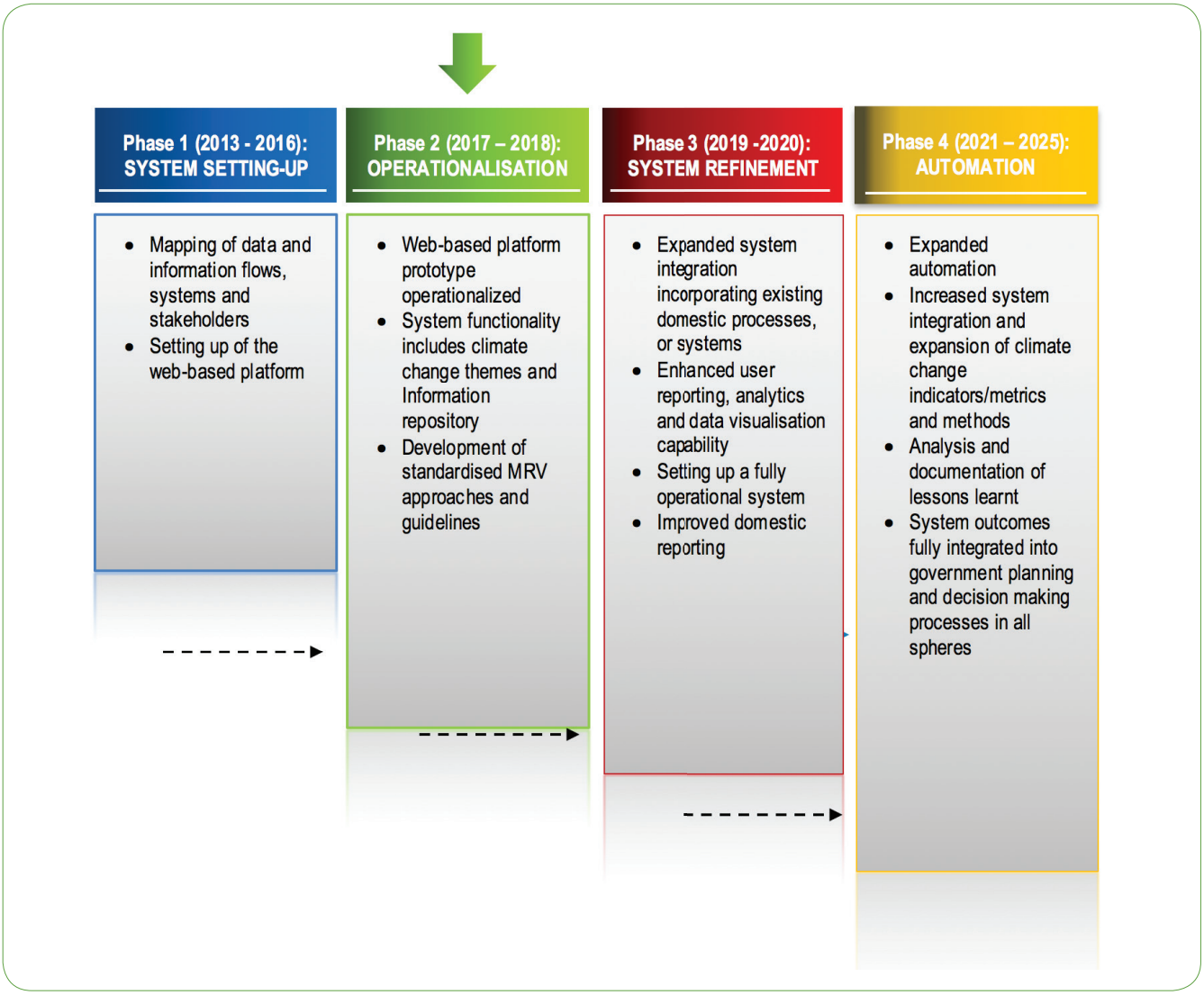

Figure 6.2: Phasing of the South African M&E System Implementation

The chronological update of milestones reached in this development process, which builds on the progress report presented in Table 42 in BUR-2 (DEA, 2017a), is presented in **Table 6.1** which provides a summary of the key milestones in the implementation of the national M&E system since the platform was initiated in 2014 till 2017.

Table 6.1: Development of Climate Change Monitoring and Evaluation in South Africa from 2014

Year	Milestones Reached
2014 - 2015	M&E System Development The development of an M&E platform initiated. BUR-1 and GHG Inventory The DEA publishes draft National Greenhouse Gas Emissions Reporting Regulations for public comment (Gazette No. 38857). The South African government submits to the UNFCCC and publishes South Africa's 1st BUR with a national inventory covering the 2000-2010 time series.
2016	M&E System Development Development of technical M&E for monitoring, reporting and verification of greenhouse gases by Industry for the GHG inventory, The development of six volume series of M&E guidelines for assessment of mitigation policies and actions is initiated, Development of the web-based System Architecture and Design (SAD), detailing the web-based climate change M&E system processes and manages climate change response information on mitigation, adaptation and climate change finance. GHG Inventory DEA published a Declaration of Greenhouse Gases as Priority Air Pollutants for public comment (Gazette No. 39578); draft Regulations on National Pollution Prevention Plans, for public comment (Gazette No. 39578); and draft National Greenhouse Gas Emissions Reporting Regulations for public comment (Gazette No. 40054). National Climate Change Report Publication of South Africa's first Climate Change Report covering different aspects of South Africa's climate change response and progress in South Africa's Climate Change Monitoring and Evaluation capability.
2017 - 2018	M&E System Development The development of M&E guidelines for assessment of mitigation policies and actions is completed, Nine generic Desired Adaptation Outcomes (DAOs) were developed, each of which is of cross-cutting, cross-sectoral relevance, and tested with stakeholders in all spheres government, Approaches for assessing the effectiveness of adaptation responses tested with case studies, The web-based M&E system platform prototype is operationalized, The South African BUR Explorer is launched. BUR-2 and GHG Inventory The South African government submits to the UNFCCC and publishes South Africa's 2nd BUR with a national inventory covering the 2000-2012 time series. Regulations on National Pollution Prevention Plans and mandatory National Greenhouse Gas Emissions Reporting Regulations for public comment (Gazette No. 40054) are promulgated and implemented. National Climate Change Report Publication of South Africa's 2nd Annual Climate Change Report, including a special feature on drought in South Africa.

6.2.1. Summary and update on the M&E System Web-based Portal

The web-based platform of South Africa's Climate Change M&E system has been, developed, in partnership with South African Earth Observation Network (SAEON), an agency of the Department of Science and Technology (DST). The prototype consists of adaptation and mitigation components, but currently focuses primarily on adaptation M&E. It aggregates information from the South African Risk and Vulnerability Atlas (SARVA), National Climate Change Response Database (NCCRD), and a growing list of contributing relevant systems. The National Climate Change Response Database is the primary repository for climate actions and interventions as well as policies and measures, which are further analysed for effectiveness.

South Africa's climate change transparency priorities and key themes have been identified. These priorities and themes inform South Africa's domestic and international reporting obligations and are being integrated into the web-based platform. The development of the Desired Adaptation Outcomes (DAOs) for monitoring and evaluating climate resilience has been updated and now comprises nine DAOs with cross-cutting, cross-sectoral relevance. These DAOs describe, in a general sense, a desired state that will enhance South Africa's transition towards climate resilience and fall into two distinct groups. Six of the nine DAOs (G1–G6) describe the 'inputs' (namely processes, resources and capacities) that need to be in place to enable effective climate change adaptation; and three DAOs (G7–G9) describe the key 'impacts' of adaptation interventions and associated measures (for example, reductions in vulnerability of human and natural systems).

Clearly defined synergies exist between the generic DAOs and the adaptation commitments – goals, targets, impacts and indicators – in a number of key international agreements. A simple approach to monitoring and evaluating the progress being made in achieving individual DAOs has been proposed. this approach should make reporting on climate change adaptation, both through DAOs and corresponding national and international adaptation commitments, more relevant to the ongoing, planned and future adaptation work in 'at risk' sectors and across national, provincial and municipal levels of government. The DAO's are linked to have adaptation goals in the South Africa's NDC and other international agreements that require reporting on adaptation such as the Sustainable Development Goals, United Nations Convention to Combat Desertification. UN Habitat New Urban Agenda and the Sendai Framework for Disaster Risk Reduction.

6.2.2. Summary and update on the data visualisation project (BUR Explorer)

South Africa recently launched the South Africa Biennial Update Report Explorer, which forms part of the Visualisation Platform of the Climate Change Response M&E System. The Biennial Update Report Explorer is a new platform which expands the functionality of the National Climate Change Response M&E System by offering accessible and dynamic data and visualisations of South Africa's climate change responses.

Developed in collaboration with World Resources Institute, the Explorer (accessible at http://www.southafricaclimateexplorer.org/) is an important resource for policymakers, business, researchers and civil society to view and download data on South Africa's climate actions and goals for contributing to the international effort to mitigate GHG emissions under the Paris Agreement. The Explorer Site Architecture is consistent with the Biennial Update Report reporting structure.

The Explorer covers both historical GHG emissions and emission projections to 2050 and; allows for customizable views by sector, sub-sector and gas. It allows users to search for, and compare, the mitigation effects and sustainable development co-benefits of policies, strategies and actions. Users will also able to access information on the implementation and scaling-up South Africa's Climate Change Near-term Priority Flagship Programmes. These large-scale strategic implementation programmes are implemented by national government and other partners to ignite large-scale investment in South Africa's transition to a low carbon and climate resilient future.

The Explorer allows users to track finance flows for climate change related activities in South Africa.

The key project outputs include a dynamic online data visualizations platform that shows key indicators and tells a story of South Africa's climate action and progress made therein, supported by a simple data management system that allows DEA to regularly update visualisation products and formats. As part of this online reporting, new innovative data visualizations key data will also be developed that can be also be used in various media platforms and print reports. DEA staff training and capacitation is a key part of this project, to ensure that technical knowledge and capability is institutionalised.

The South Africa's Biennial Update Report Explorer represents an advance in South Africa's climate change response M&E capability, acting as a visual communication tool to present South Africa's climate change response provided in a simple, structured, dynamic and Interactive way **(Figure 6.3)**.

The South African Government produces a number of publications and outputs for the dissemination of climate change information to a wide ranging domestic and international audiences group. These include, NCs, BURs, as well as a domestic national Climate Change Report, which are, intended to inform and communicate in a clear and simple manner the state of South Africa's climate change responses.

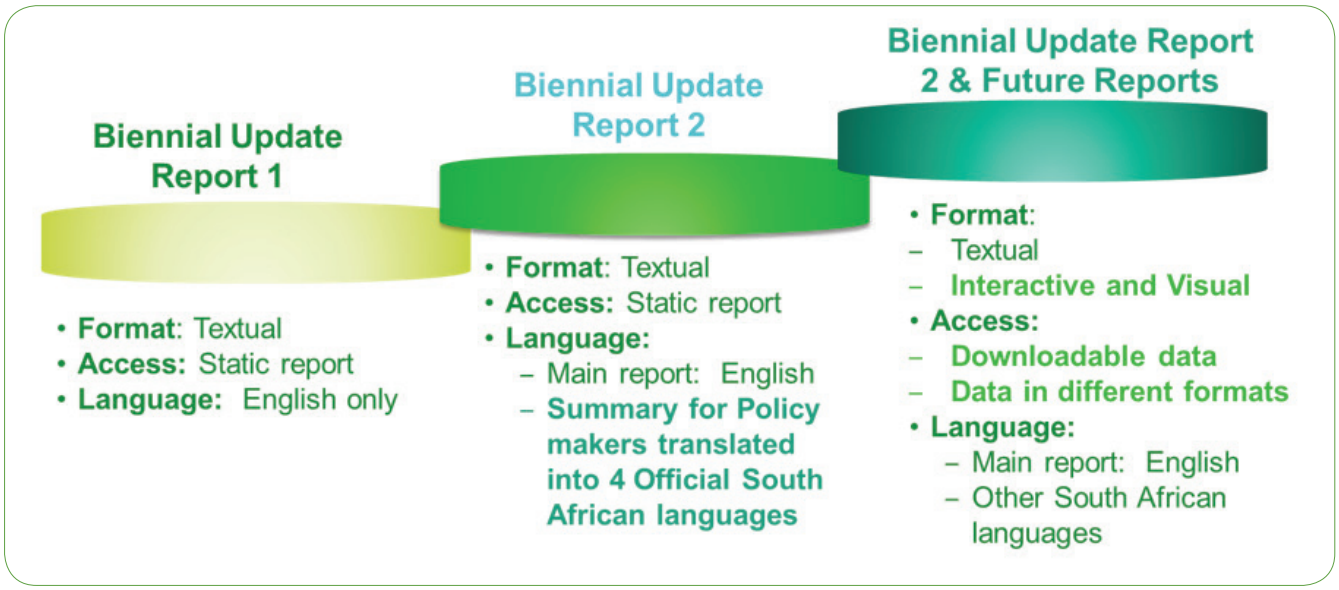

Figure 6.3: South Africa's Biennial Update Report Explorer, which is the Visualisation Platform of the Climate Change Response M&E System

6.2.3. MRV of GHG Emissions

Section 6.7 of the NCCRP (DEA, 2011) states that accurate, complete and up-to-date GHG emissions data is the foundation of an effective national mitigation response. The NCCRP further identifies the national GHG inventory as one of the tools used to compare current emissions profile against the benchmark national GHG emission trajectory range. In addition, the GHG inventory and/or its emission estimation methodologies have proved extremely useful in other climate change mitigation policy response areas such as setting up of carbon budgets, international reporting obligations, carbon tax, and broader climate change monitoring and evaluation. Therefore, an accurate GHG inventory supports various activities and programmes within the country related to natural resource management, climate change planning, and economic development. The MRV of GHG emissions is being implemented through the Greenhouse Gas Improvement Programme (GHGIP), the regulatory framework and through the development of supportive M&E technical tools and guidelines. Figure 6.4 provides an overview of the complimentary components

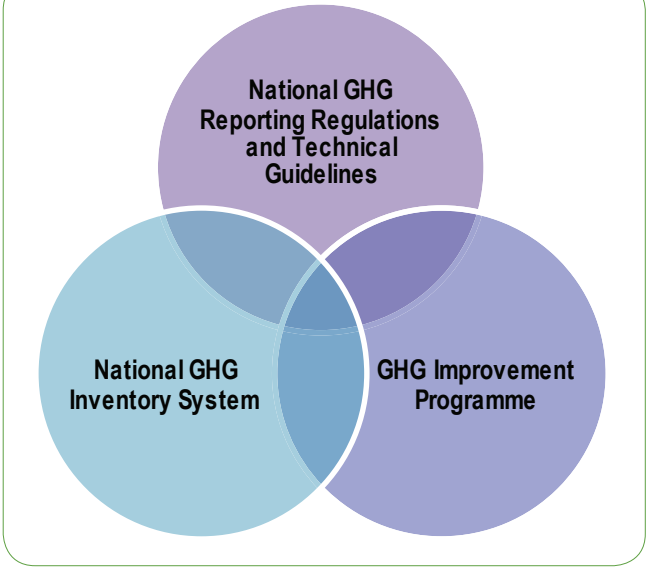

Figure 6.4: Overview of the MRV of GHG emissions

6.2.4. National Green House Gas (GHG) Reporting Regulations of 3rd April 2017

South Africa introduced the National GHG Emission Reporting Regulations that took effect on 3 April 2017. The regulations seek to introduce a single national reporting system for the transparent reporting of GHG emissions and will be used:

- to update and maintain the National GHG Inventory,
- 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
- to inform the formulation and implementation of legislation and policy (DEA, 2017).

In addition the DEA in consultation with the industry has developed the "Technical guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry." The Technical Guidelines provide the "How" with detailed methodological guidance on how emissions to be reported to the DEA should be calculated in line with IPCC 2006 Guidelines.

The National GHG Emission Reporting Regulations fall under the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004). The regulations provide for mandatory reporting of GHG emissions by entities (companies and installations) that emit more than 0.1 Mt of GHGs annually, or that consume electricity which results in more than 0.1 Mt of emissions from the electricity sector. The regulations require emitting entities to register on the National Atmospheric Emissions Information System (NAEIS) and to report emissions by 30 April of each year in respect of GHG emissions and activity data for all their facilities for the preceding calendar year.

The registration of reporting companies was done manually as the NAEIS is not yet able to meet the registration and reporting requirements.

Modifying the NAEIS to meet the requirements of the National GHG Emissions Reporting Regulations is being

undertaken through a project led by National Treasury and involving the DEA and the Department of Energy. The regulations classify entities conducting controlled activities into two categories: category A data providers are private companies that emit GHG emissions and are liable for reporting under the regulations; category B data providers are mainly public institutions which will submit activity data and GHG emissions data upon request by the DEA. A total of 154 category A data providers with over 1,435 facilities have registered with the DEA as of April 2018.

Data providers need to aggregate emissions at company-level, whilst maintaining IPCC activity disaggregation. E.g. using 1A2i as an example, the data provider should sum up all its 1A2i emissions from the different facilities and report this as one aggregated 1A2i emissions from the company. The DEA is also in the process of amending the regulations in order for reporting to be based on declaration at facility level, however still maintaining reporting at company level. This will enhance the transparency of reported emissions by companies and allow for the implementation of verification procedures by the competent authority. In addition, declaration at facility level enhances the administrative activities of verification that the DEA must perform in order to support implementation of the Carbon Tax. The project for the modification of the NAEIS is expected to be completed by December 2019.

6.2.5. Technical Guidelines for Monitoring, Reporting and Verification of GHG emissions by industry

A set of technical guidelines has been developed to provide guidance to reporting companies on methodologies to apply when quantifying GHG emissions from activities listed for reporting under the GHG Reporting Regulations. The guidelines describe the reporting methodology as specified in the National Environmental Management: Air Quality Act, 2004: National GHG Emission Reporting Regulations. These technical guidelines embody the latest methods for estimating emissions and are based on the 2006 IPCC Guidelines for compilation of national GHG inventories, providing additional guidance and commentary to assist data providers in estimating GHG emissions for reporting in the NAEIS. The technical guidelines support the process to update and maintain a National GHG Inventory for South Africa.

The Technical Guidelines support the process to update and maintain a National GHG Inventory for the Republic of South Africa to meet its reporting obligations under the UNFCCC and instrument treaties to which it is bound; and for the formulation and implementation of legislation and policy. A series of consultations were held with the industry to develop these guidelines which have been finalised and will be used by entities to report their emissions.

6.2.6. National GHG Information System (NGHGIS)

South Africa has also established a national GHG inventory system to provide detailed, complete, accurate and up-to-date GHG Inventory which will enhance the management of GHG data reported into the NAEIS.

The national GHG inventory management system is made up of two sub-systems:

a. A web-based reporting system and the mapping of data flows for all the relevant sectors.
b. The process governance which includes the institutional arrangements and the setting up of the National Inventory Unit within the DEA.

The NGHGIS seeks to improve the data management, documentation, governance and institutionalisation of the GHG compilation process thus improving the transparency of the GHG inventory and ensuring the availability of this information for the compilation of subsequent GHG inventories. The main objectives of this national system are; a) strengthening the institutional arrangements around national inventories, including legal matters, and b) sharing of experience on methodological matters, including technical guidelines, data collection and archiving, documentation of methods (including assumptions, emission factors and calculations of results), work with quality assurance and

quality control, uncertainty analysis, reporting (formats and guidelines) and tools for dissemination (including web-based tools).

The next planned activities on the system development will include the review of the National GHG System to improve the GHG inventory taking into account the outcomes of the International Consultation and Analysis (ICA) recommendations as well as the pilot testing of the system in order to move towards full operationalisation of the system.

6.2.7. The National Greenhouse Gas Improvement Programme (GHGIP)

The GHGIP refers to a series of sector-specific projects aimed at improving the quality and accuracy of the National GHG Inventory. The programme entails developing country specific emission factors for different sectors and sub sectors in order to improve calculation of GHG emissions and reduce uncertainty. A majority of projects are donor-funded with clear objectives and targets primarily focusing on the improvement of estimation methodologies, activity data and development of country-specific emission factors. The sectors covered in the GHGIP are the Energy Sector, IPPUIPPU sector, and the AFOLU sector. In addition to the studies reported in BUR-2, South Africa has commissioned two new studies for developing country-specific emission factors in the waste sector and road-transportation sub-sector. The objective of the waste sector improvement programme is to determine the country specific emission factors for solid waste, wastewater treatment organic waste. The main objective of the road-transportation emission factor studies is to determine road transport factors for CO_2, CH_4 and N_2O. This entails detailed measurement of carbon content of CO_2 for petrol and diesel and measurement of CH_4 and N_2O emission factors by vehicle type. The outcomes of these studies will be reported in BUR-4 and will be used in subsequent inventories.

6.2.8. Summary and update on M&E guidelines

Sector guidelines have been completed with support from a number of international partners as shown in **Table 6.2** below.

Table 6.2: Scope and supporting partners for the development of the mitigation M&E sector guidelines

Title	Purpose	Partners
Volume 1: Policies, Strategies And Laws	Provides overall accounting approach for estimating GHG and Non-GHG effects of policies and actions, without providing calculation formulas and data requirements.	WORLD RESOURCES INSTITUTE
Volume 2: Energy & Transport	Provides detailed equations and data requirements for assessing M&E system indicators in the Energy and Transport Sectors, including GHG effects.	USAID FROM THE AMERICAN PEOPLE
Volume 3: Waste	Provides detailed equations and data requirements for assessing M&E system indicators in the Waste Sector, including GHG effects.	Not Applicable
Volume 4: Industrial Processes and Product Use	Provides detailed equations and data requirements for assessing M&E system indicators in the IPPU Sector, including GHG effects.	USAID FROM THE AMERICAN PEOPLE
Volume 5: Agriculture Forestry And Other Land-Use	Provides detailed equations and data requirements for assessing M&E system indicators in the AFOLU Sector, including GHG effects.	Australian Government

The guidelines are comprehensive in their scope and provide worked examples applied to mitigation measures, technologies and processes prioritised in various climate change policy and strategy documents. The transport and waste sector M&E guidelines have already been applied to the Public Transport Policy and National Waste Management Strategy, respectively.

6.2.9. MRV of mitigation actions

The MRV of mitigation actions is co-ordinated within the Department of Environmental Affairs to track progress towards the goals of mitigation actions and to signal emerging challenges and opportunities for improvement using various tools, including the NCCRD. This is part of an ongoing process and various studies have been commissioned to develop sector-specific indicators and to improve on indicators tailored to the country-context. This process is complemented by targeted data collection and analysis for prioritised climate actions which is supported by the different functionalities provided by the M&E system.

Mitigation actions are tracked within the M&E system using a simple framework structure. Information on mitigation project objectives, relevant sectors, progress, timelines, costs and responsible stakeholders is collected and stored in an action registry format. Quantitative information on the impacts and progress of these actions is measured using a set of linked indicators. The structure of these indicators is also defined by a simple framework which applies for three distinct types of indicators:

1. GHG impact;
2. Progress
3. Wider impacts

Key experts can provide data and methodologies on the baseline, ex-anti and ex-post analyses of GHG emissions mitigation using the pre-defined format. These estimations can be updated as new information and calculation methods become available. In this way, a time series of emissions can be built up from a series of ex-post analyses, which contribute towards the achievement of the ex-anti target. GHG emission mitigation targets may apply to an individual action or group of actions.

Stakeholders responsible for an action and project coordinators can also use this format to quantitatively track the progress of mitigation actions. By defining the units of the indicator, baseline, ex-anti and ex-post analyses can be reported for action evolution. For example, the installation of a solar energy system can be tracked through reporting on the installed capacity (in MW) of the project against a target capacity. This quantification relies on the availability of a broad range of datasets and effective referencing of estimates to increase confidence in their legitimacy. Through this functionality, progress of national mitigation action can be reported to a wide audience in a proactive and transparent manner.

Similarly, the impacts of a mitigation action beyond that of its primary objective can be tracked quantitatively. The structure of the M&E system for mitigation action indicators enables key experts to reference literature and project documents that highlight the wider impacts of mitigation actions and identify suitable metrics. By selecting an appropriate unit of quantification, for example the number of jobs generated by the solar energy system installation, it is possible to estimate a baseline value, a target ex-anti value aligned with national strategic areas, and ex-post analyses that track the progress towards achievement of the target. The relational nature of the M&E system framework allows a one-to-one or one-to-many linkage between mitigation actions and indicators and ensures data quality and consistency.

Successful implementation of these action indicators relies heavily on the availability and transparency of various data sources. If employed comprehensively, the indicators can provide the data necessary to produce simple visualisations of the narrative surrounding mitigation action in South Africa. This enables effective communication with decision makers and stakeholders across civil and public spheres alike.

6.2.10. MRV of adaptation actions

Desired Adaptation Outcomes (DAOs) for Monitoring and Evaluating climate resilience have been developed to complement the building blocks of the monitoring and evaluation framework and to facilitate and focus the M&E of the country's progress towards resilience. The DAOs provide a framework for the articulation of sectoral adaptation goals in plans, policies and actions for all spheres of government (DEA, 2017b). Nine generic DAOs have been developed, each of which is of cross-cutting, cross-sectoral relevance and describes, in a general sense, a desired state that will enhance South Africa's transition towards climate resilience and fall into two distinct groups. Six of the nine DAOs (G1–G6) describe the 'inputs' (namely processes, resources and capacities) that need to be in place to enable effective climate change adaptation; and three DAOs (G7–G9) describe the key 'impacts' of adaptation interventions and associated measures (for example, reductions in vulnerability of human and natural systems).

Clearly defined synergies exist between the generic DAOs and the adaptation commitments – goals, targets, impacts and indicators – in a number of key international agreements. The DAO's are linked to have adaptation goals in the South Africa's NDC and other international agreements that require reporting on adaptation such as the Sustainable Development Goals, United Nations Convention to Combat Desertification. UN Habitat New Urban Agenda and the Sendai Framework for Disaster Risk Reduction. The DAO framework has been integrated into the M&E system web-based portal (refer to Section 6.2.1).

A simple approach to monitoring and evaluating the progress being made in achieving individual DAOs has been proposed which uses a traffic light approach as the basis of a scoring system to summarise progress and differentiate proportionally between the level at which adaptation priorities have been addressed and the level of progress made in achieving resilience as follows:

- Legal frameworks, plans/strategies, policies, programmes and projects not informed by existing risk and vulnerability profiles that include climate risks and impacts (red).
- Legal frameworks, plans/strategies, policies, programmes and projects informed by risk and vulnerability profiles that include climate risks and impacts (amber).
- Implementation of legal frameworks, plans/strategies, policies, programmes and projects - informed by risk and vulnerability profiles that include climate risks and impacts - to reduce vulnerability in risk and vulnerability profiles and enhance capacity to respond to climate change impacts (green).

This approach should make reporting on climate change adaptation, both through DAOs and corresponding national and international adaptation commitments, more relevant to the ongoing, planned and future adaptation work in 'at risk' sectors and across national, provincial and municipal levels of government.

Responsibility for delivering individual adaptation outcomes will rest with a range of stakeholders operating at different spatial scales (i.e. national and/or provincial and/or municipal). This approach will enable all stakeholders to gather basic data and information, from which a cumulative 'score' of progress can be derived. Stakeholder groups will be informed of specific data/information needs and of the time period for which these are required. The data/information collected from individual groups will be aggregated to provide a total 'indication' of progress. A summary of progress for the specified time period will then be presented graphically. By comparing progress summaries for successive reporting periods, the effectiveness of adaptation interventions in addressing adaptation priorities and, therefore, delivering climate resilience can be determined.

The detailed articulation of this criteria/approach will be published in South Africa's 3rd Annual Climate Change Report.

6.3. References

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7. ADDITIONAL INFORMATION

This chapter captures an overview of additional work that has been undertaken to address climate change in South Africa. The information presented below provides an update of information presented in BUR-2.

7.1. National Climate Change Near-term Priority Flagship Programmes

The section provides a progress of the various near-term flagship programmes that require scaling-up to enable South Africa to reduce its greenhouse gas emissions and the implementation of the following mitigation Flagship Programmes listed below.

7.1.1. Renewable Energy Near-term Priority Flagship Programme

Presently, the work of the Renewable Energy flagship programme seeks to achieve three key objectives for the period to 2020. Firstly, the programme seeks to support institutional strengthening and coordination for scaling-up embedded generation. The role of the DEA and other key stakeholders will be to facilitate the structured involvement of key actors across the embedded generation value chain with clear institutional arrangements.

Secondly, the programme seeks to actively promote and facilitate large scale uptake of the net-consumer approach to embedded generation through advocacy. This involves the DEA and key stakeholders supporting municipal energy and finance system readiness to better respond to and capitalise on the proliferation of rooftop solar photovoltaic systems, without putting municipalities' financial stability at risk. Thirdly, the programme hopes to scale-up embedded generation and realise the mitigation impact of renewable energy. Noticeably in South Africa, there is an increase in the number of households privately installing small-scale, grid-connected rooftop solar panels. Thus, the DEA and key stakeholders need to be ahead in terms of identifying opportunities with interested municipalities and to develop implementation plans for rolling out the renewable energy programme.

7.1.2. Energy Efficiency and Energy Demand Management Near-term Priority Flagship Programme

In terms of Energy Efficiency and Energy Demand Management flagship, the Energy Efficiency in Public Infrastructure and Buildings work package (EEPIBP) is an example of one of the more mature work packages implemented as part of the Climate Change Flagship Programmes. It has the highest level of scaling-up readiness and the EEPIBP work continues to undergo refinement. EEPIBP work also forms part of an overarching sector-wide NAMA which aims to integrate energy efficiency measures in the public-sector buildings portfolio across the three spheres of government. In addition, the EEPIBP is informed by National Energy Efficiency Strategy (DME, 2005).

The DoE is the lead national government authority for responsible for the EEPIBP. Hence, lead departments and implementation partners have actively steered the development and preparation of the EEPIBP over the past four years, building on the extensive national investment and experience in energy efficiency garnered over more than a decade. The EEPIBP focuses explicitly on stimulating the Energy Service Company (ESCo) market by providing access to the vast public sector building portfolio, facilitating access to private sector finance for energy efficiency initiatives and providing risk reduction measures that encourage private sector investment.

7.1.3. Water Conservation and Water Demand Management Flagship Programme

In terms of water conservation and demand management, issues of water security become critical. Between, 2015/16 and 2016/17, South Africa experienced a severe drought which affected many regions in the country. The City of Cape Town remains amongst the most affected in the country to date. Hence, while the water conservation and water demand management (WCWDM) component of the programme has since been well established, the rainwater harvesting component of this Flagship Programme has yet to reach its full potential. Rainwater harvesting is currently implemented by three different departments: the DWS, DAFF and the DRDLR. Efforts towards a national rollout of rainwater harvesting would benefit from a more coherent approach. Unlike the other WCWDM components, rainwater harvesting is not supported by a strong regulatory framework. The DEA has therefore worked with the DWS to develop a national rainwater harvesting strategy to consolidate and support the scaled-up implementation of the WCWDM Flagship Programme. The work on rainwater harvesting led by the DWS in partnership with the DEA and other key implementers, is in its initial stages and will be featured in more depth in the subsequent domestic and international reports.

7.1.4. Transport Near-term Priority Flagship Programme

Transport remains one of the fastest growing sources of GHG emissions in South Africa. As presented in the second BUR, emissions from transport-related fossil fuel combustion accounted for 11% of the emissions generated from the energy sector. Road transport, encompassing private, freight and public transport vehicles, generates the majority of transport-related emissions. To date, the DoT, the DEA and the GIZ, in collaboration with a range of key programme implementers and stakeholders have drawn from local government, research institutions and international partners to actively work towards the development of a sustainable urban mobility (SUM) National Appropriate Mitigation Actions (NAMAs). This is set to accelerate a new phase of climate action within the Transport Flagship Programme. In addition, with regards to the technical aspects of the programme, there has been effort to develop and examine approaches for measuring GHG emission reductions. The SUM NAMA is also used to enhance policy frameworks to better enable the large-scale uptake of low carbon transport technologies and practices.

7.1.5. Waste Management Near-term Priority Flagship Programme

In terms of waste management, the Waste Management Flagship Programme places emphasis on mitigation projects that are at implementation stage or at advanced design stages in local municipalities. Several municipalities have embarked on projects and programmes to divert waste going in to landfills to waste beneficiation. In the period post 2016, climate finance proposals were developed to pilot alternative waste treatment technologies with the aim of reducing an estimated 572 $MtCO_2e$ per annum as a result of fuel switch to renewable energy and waste.

7.1.6. Agriculture, Food Systems and Food Security Flagship Programme

In terms of this flagship programme, agriculture is identified as one of the most important drivers of employment and job creation in South Africa, particularly amongst the rural poor and low income communities. The National Planning Commission (NPC, 2011) reported that the agriculture sector is estimated to provide opportunities to more than 300 000 households in smallholder schemes by 2020; create 145 000 agro-processing jobs; and enhance employment on commercial farms. The location of agriculture primarily

within rural areas implies that this sector can also play a key role in driving rural development, livelihood improvements and infrastructure development. Agriculture is positioned to stimulate sustainable rural enterprises, investment in agro-processing, and opportunities for broader economic participation for the disadvantaged living in poor rural and low income communities.

The Agriculture, Food Systems and Food Security Flagship Programme, implemented by DAFF, recognises these challenges. It aims to enhance agricultural productivity and climate resilience in agriculture at all scales of production, thus decoupling agricultural growth from GHG emissions growth, and driving enhanced growth and competitiveness of the sector. The primary objective of the programme is to implementation a comprehensive, cohesive and integrated set of climate change mitigation and adaptation measures to build climate-smart agricultural and food production systems.

7.1.7. Carbon Capture and Storage (CCS) Flagship Programme

Carbon capture and storage (CCS) is an internationally tried and tested technology to decrease carbon dioxide (CO_2) emissions into the atmosphere while allowing the continued use of fossil fuels, thus being one of the options in the UNFCCC's tool-kit to address global warming and ocean acidification.

The technology involves four stages:

1. Capture of carbon dioxide from the emissions of inter alia industry, synthetic fuel production and electricity generating stations.
2. Transport to a suitable storage site, usually by pipeline,
3. Injection into an appropriate geological storage site, usually 1–2 km deep.
4. Monitoring and verification to ensure safety and permanent storage.

South Africa relies on fossil fuels for most of its primary energy supply. Approximately 90% of primary energy is derived from fossil fuels – 72% of which is coal. Furthermore, coal provides 85% of electricity generation capacity and 92% of electricity production. Coal is also used for the production of liquid fuels including approximately 30% of the petroleum used in South Africa. This reliance on fossil fuels has led to an approximate 400 $MtCO_2$ emissions per year. South Africa's coal industry contributes significantly to employment opportunities and income generation, as well as accounting for 6% of the country's total merchandised exports.

Notwithstanding the recent advances made in renewable energies and energy efficiency measures, it is evident that fossil fuels will remain the main contributor to South Africa's energy economy for some decades to come.

The International Energy Agency (IEA) has stated that the least cost approach to limiting global temperature must include CCS. Moreover, the Paris target of holding the global temperature increase to significantly below 2˚C may require additional benefits of CCS. CCS in South Africa is viewed as a critical transition measure until nuclear and renewables become more dominant in the national energy supply.

South Africa's CCS implementation roadmap is shown in **Figure 7.1**.

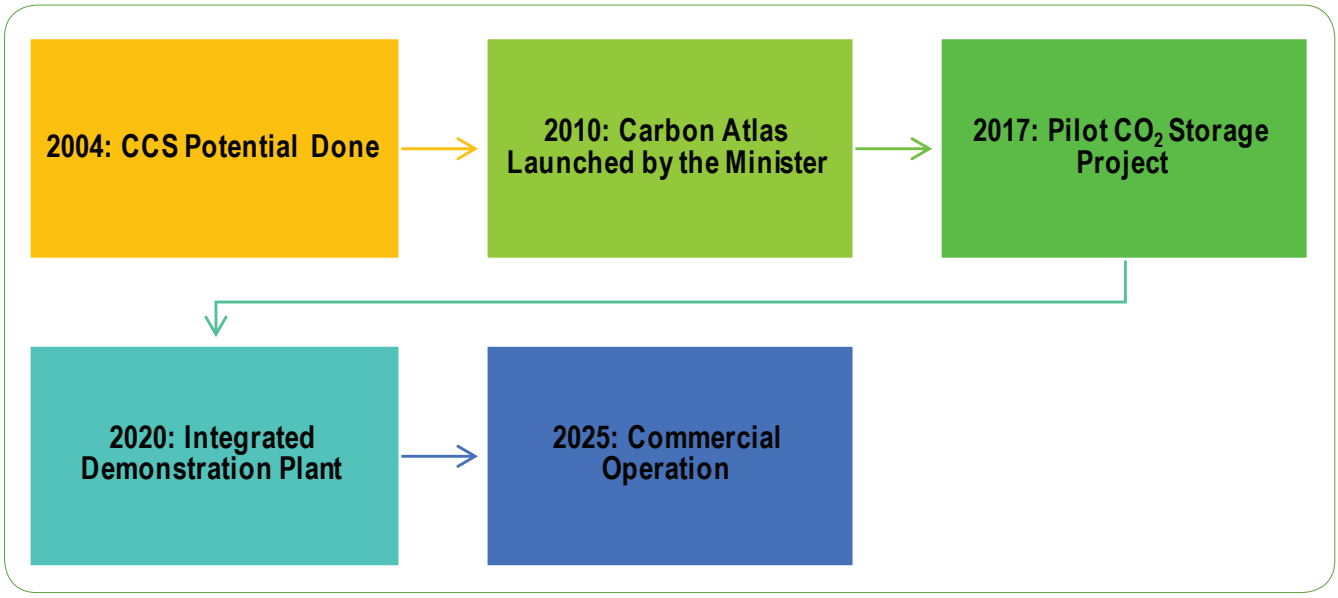

Figure 7.1: South Africa's CCS Roadmap

The Pilot Carbon Storage Project (PCSP) involves the injection, storage and monitoring of 10,000–50,000 t/CO_2 in South African conditions with the primary aim of:

- Demonstrating safe and secure CO2 handling, injection, storage and monitoring in South African conditions, in particular South African geology.
- Increasing the South African human and technical capacity for the development and operation of CO_2 handling, injection, storage and monitoring.
- Raising awareness among the South African public of the potential importance of CCS.
- Working with government to ensure that the development and operation of the PCSP can occur within the South African legal and regulatory environment.

The Programme implementation partners are shown below in **Table 7.1**.

Table 7.1: South Africa's CCS Climate Change Flagship Programme Implementing Partners

Organisation	Role and Responsibility
Department of Energy (DoE) -	The primary project sponsor within South Africa, and provides high level direction and authority for SANEDI.
South African National Energy Development Institute (SANEDI)	A state-owned entity that has been mandated by the DoE to investigate the technical potential for CCS in South Africa and ultimately be responsible for the successful execution of the project. In addition, SANEDI is responsible for conducting procurement for the project, as well as tracking the project budget.
Council for Geosciences (CGS)	Carries a mandate for basic geoscience research as established by the Geoscience Act, 1993 (Act No. 100 of 1993), and thus is an integral member of the project team. CGS resources are used extensively to review legacy data, and to acquire and interpret new data. CGS is expected to be the project operator, at least for the exploration and site characterisation stages of the PCSP to allow the project to be undertaken under the Geoscience Act.
Petroleum Agency of South Africa (PASA)	The oil and gas regulatory body of South Africa, works with the PCSP team to provide support and expertise related to geology, geophysics, and modelling. PASA maintains a database for all oil and gas exploration wells in South Africa.
World Bank	Partly funding the PCSP through its Carbon Capture and Storage Trust Fund. The World Bank overseas procurement using its funds, and has appointed the Project Technical Advisory Services (PTAS) consultant.
Project Technical Advisory Services (PTAS) Consultant	The PTAS consultant has been hired by SANEDI and the World Bank to provide technical and management consultancy services throughout the various phases of the PCSP. The PTAS project manager is located on site with SANEDI, and works as an integral member of the team to build local capacity and to coordinate technical and management inputs for the execution of the PCSP.

The PCSP will involve the investigation and characterisation of a suitable geological CO_2 storage site and the subsequent injection, storage, and monitoring of CO_2 in the identified storage site. Before, during, and after the geological storage, the CO_2 will be monitored to ensure that it is behaving as modelled and projected. The volume of CO_2 to be stored as part of the PCSP is between 10,000 and 50,000 metric tons of CO_2. The location considered for storage investigation will be in the Zululand geological basin in the uMkhanyakude District Municipality in the KwaZulu-Natal Province of South Africa. The project is divided into seven distinct stages (Figure 7.2).

Planning for the PCSP has commenced to the extent that a plan for the project has now been developed and pre-existing data has been analysed. The next stage is field exploration, leading to an injection site selection and characterisation. It is envisaged that the actual undertaking of the injection, monitoring, analyses and determination of CCS potential within the particular basin will take place during the 2019 – 2022 period, focusing on the design, procurement, construction, operation, closure and post closure activities.

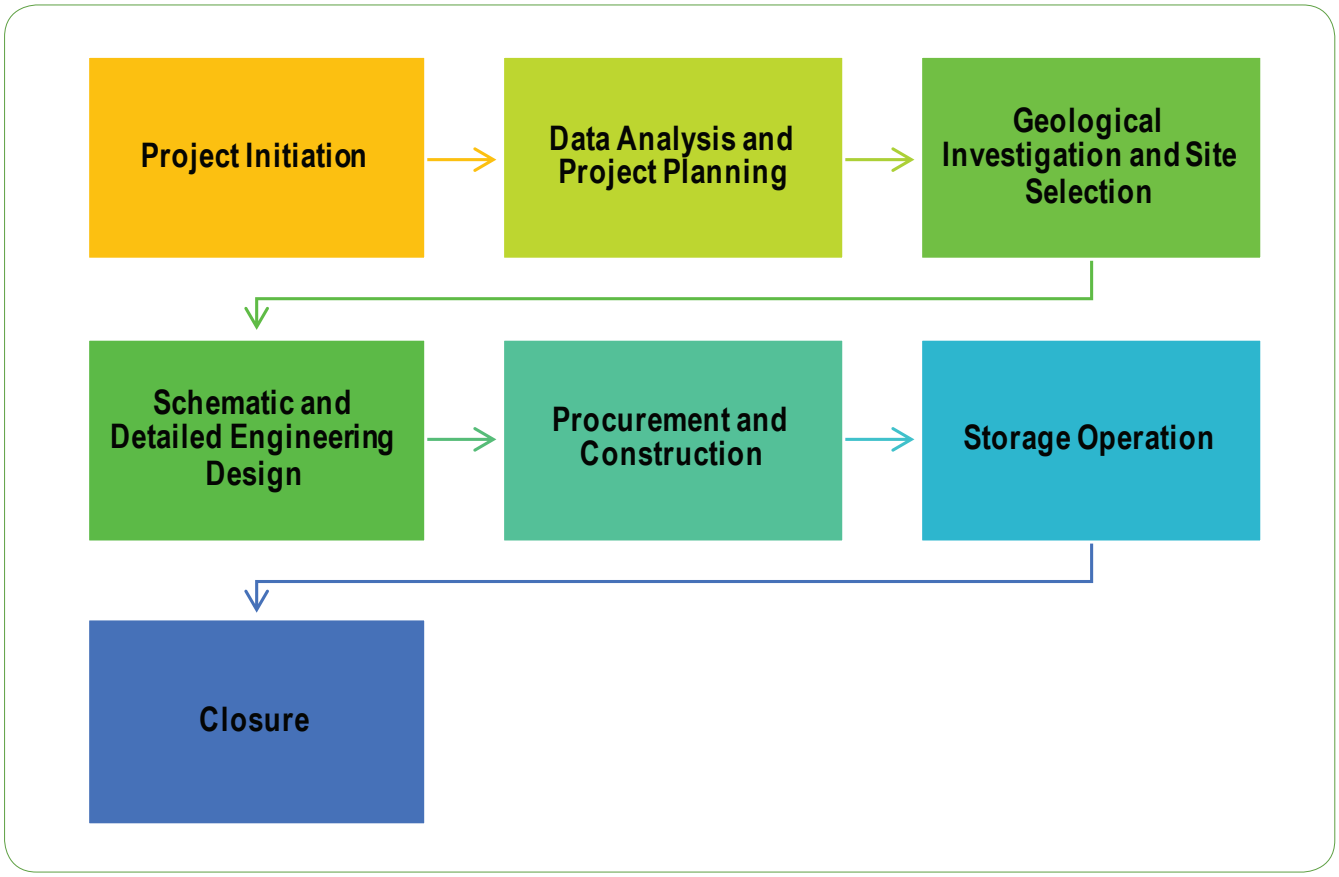

Figure 7.2. CCS Programme Phases

7.1.8. Adaptation Research Flagship Programme- Defining South Africa's Climate Change Adaptation Research Agenda

South Africa has vast climate change research networks and an adaptation research landscape that is as immeasurable. In order for the Department of Environmental Affairs to better understand them, guidance was obtained from the National Climate Change Response Policy 2011 to develop the Long Term Adaptation Scenarios (LTAS) Flagship Research Programme.

The first phase of the LTAS established a collective understanding of South Africa's climate change trends and projections. It summarised key climate change impacts and identified potential response options for primary sectors, namely: water, agriculture and forestry, human health, marine fisheries, and biodiversity.

The LTAS analysed climate trends over the last five decades and climate projections for 2030, 2050 and 2100. Climate projections derived from a range of modelling approaches and scenarios were simplified into four fundamental climate future scenarios to describe South Africa's climate to the end of this century, namely warmer/wetter, warmer/drier, hotter/wetter and hotter/drier. These broad and consensus climate

futures provide a framework within which users of climate information can position a wide range of specific climate change and impact projections with results depending on a range of emissions scenarios, global climate models and downscaling techniques.

The climate projections/adaptation scenarios were then used to analyse i) possible impacts on each of the above-mentioned sectors, ii) determine or propose possible adaptation options/responses, iii) indicate gaps that the study could not provide which are possible future research areas. Phase 2 also looked into modelling additional aspects such as food security and looking into the viability of the staple food crops in South Africa, disaster risk reduction and management focusing on the risks for flooding, drought, sedimentation and sea level rise as well as the economics of adaptation. The adaptation scenarios were further given narratives that describe the type of adaptation and development pathway that South Africa, and in particular certain areas of the country, will need to achieve under a particular climate future. Priority highly vulnerable sub-national areas in need of specific adaptation responses are identified, as well as win-win adaptation responses suitable to all possible climate futures.

Looking at the climate change adaptation research landscape generally, it is acknowledged that an immeasurable amount of research has been ongoing before, during and after the LTAS process. LTAS outputs also identified future research needs for key sectors which also supported or formed part of the sectoral research agendas. Given this, the DEA commissioned work that aims to define South Africa's climate change adaptation research agenda in order to inform the scope of the subsequent Research Programme. The work should involve reviewing the body of climate change adaptation research and research recommendations which have shaped the adaptation policy landscape, including but not limited to LTAS I & II, as well as summarising findings into a timeline and noting gaps and areas of further research.

This work will take the form of two phases with phase one focusing on the review of the climate change adaptation research landscape and developing a timeline which will be an infographic depicting the research plotted on a timeline to date, coupled with a reference list of the reviewed research; and phase two seeking to define the scope of work for LTAS III which will be highly detailed, well researched, strategically focused on advancing the implementation and integration of climate change adaptation into South Africa's development agenda and presented in a well organised, concise manner.

7.1.9. Capacity Building: Let's Respond Toolkit

In terms of capacity building, municipalities in five provinces (Mpumalanga, KwaZulu-Natal, Gauteng, Western Cape and Eastern Cape) were trained on climate change mitigation. The training programme aimed at building capacity for municipalities to be able to integrate climate change mitigation into their Integrated Development Plans. This is intended to allow municipalities to be able to provide a more accurate account of their emissions data for reporting in the GHG Inventory system.

The DEA in partnership with GIZ, SALGA and Sustainable Energy Africa facilitated a series of provincial-based two-day training workshops, based on the mitigation elements of the Let's Respond Toolkit with the aim to build capacity and provide guidance to municipalities to develop their own Climate Change Response Mitigation Implementation Plans. The Municipalities in six provinces (Mpumalanga, KwaZulu-Natal, Gauteng, Western Cape, Eastern Cape and Northern Cape) were trained on climate change mitigation. Practitioners that attended covered a broad range of service functions including environment, energy & electricity, town and spatial planning, infrastructure, finance, transport and even, in the case of Gauteng Workshop, a councillor. While not all local municipalities in a region were reached, this spread had the advantage of opening the door to vertical and horizontal integration of the efforts of the spheres of government towards climate action planning. The workshops combined technical and methodological presentation content with practical group exercises that aimed to bed down concepts but also open space for discussion that could enable peer to peer learning around practical approaches for moving forward.

The workshops involved training on climate change mitigation planning and implementation at the municipal level using the tools from the Let's Respond toolkit and the SALGA Energy Efficiency and Renewable Strategy Framework Guide for Local Government. Its particular focus was on mainstreaming climate change mitigation into municipal planning processes, such as the IDP (Integrated Development Plan), and integrating it into the service functions of the relevant sectors, namely energy, waste and transport. The workshop approach involved a combination of context-specific technical inputs, case studies and intensive interactive group work exercises tailored to the needs and circumstances of the municipalities attending the workshop.

The workshops covered the following broad elements:

- An overview of climate change and understanding the roles and mandates of local government.
- An overview of the Let's Respond toolkit with a focus on the mitigation components of the Toolkit and Guide.
- Evidence based analysis of energy consumption and carbon emissions within municipal areas of jurisdiction to identify the key energy and emission issues facing a municipality, establish the evidence base for the area (as far as data allows), and will also include a harvesting of what projects are underway, whose is undertaking them and how they are being financed.
- Detailed sector level planning embraced the three key mitigation sectors, notably energy, transport and waste and identifying the feasible interventions to be implemented within each sector.
- Climate Mitigation Action Planning: Prioritising and planning new climate responsive projects within the different sectors. Participants were taken through a detailed session on the process of Developing Climate Change Mitigation Action Plans – which including the leys steps in translating the plans into action – integrating into Integrated Development Plans (IDPs), Service Delivery Business Implement Plans (SDBIPs) and Key Performance Indicators (KPIs).
- DEA's introduction into the newly developed Climate Change Transparency and Information System for utilisation by national, provincial and local government, as well as the broader public, as a mechanism for monitoring climate-responsive interventions into the future.
- Harvesting ideas from participants on their requirements relating to the development of a peer-to-peer learning platform for local government.

7.2. References

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National Treasury. (2017). Draft Carbon Tax Bill (published for Public Comment). Pretoria.

ANNEX A: SECTORAL TABLES

Table A.1: Energy sectoral table

Inventory Year: 2015

	Emissions (Gg)						Emissions
Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2	(Gg CO_2e)
1 - Energy	423 181.56	195.75	8.44	NE	NE	NE	NE	429 907.45
1.A - Fuel Combustion Activities	397 861.48	22.47	8.44	NE	NE	NE	NE	400 948.32
1.A.1 - Energy Industries	258 696.23	2.95	3.95	NE	NE	NE	NE	259 981.19
1.A.1.a- Main Activity Electricity and Heat Production	224 009.25	2.49	3.45	NE	NE	NE	NE	225 130.88
1.A.1.a.i- Electricity Generation	224 009.25	2.49	3.45	NE	NE	NE	NE	225 130.88
1.A.1.a.ii- Combined Heat and Power Generation (CHP)				NE	NE	NE	NE	NE
1.A.1.a.iii- Heat Plants				NE	NE	NE	NE	NE
1.A.1.b- Petroleum Refining	3 387.79	0.08	0.01	NE	NE	NE	NE	3 392.93
1.A.1.c- Manufacture of Solid Fuels and Other Energy Industries	31 299.19	0.38	0.48	NE	NE	NE	NE	31 457.38
1.A.1.c.i- Manufacture of Solid Fuels	31 299.19	0.38	0.48	NE	NE	NE	NE	31 457.38
1.A.1.c.ii- Other Energy Industries	NE	NE	NE	NE	NE	NE	NE	NE
1.A.2 - Manufacturing Industries and Construction	36 704.14	0.47	0.50	NE	NE	NE	NE	36 870.32
1.A.2.a- Iron and Steel				NE	NE	NE	NE	NE
1.A.2.b- Non-Ferrous Metals				NE	NE	NE	NE	NE
1.A.2.c- Chemicals				NE	NE	NE	NE	NE
1.A.2.d- Pulp, Paper and Print				NE	NE	NE	NE	NE
1.A.2.e- Food Processing, Beverages and Tobacco				NE	NE	NE	NE	NE
1.A.2.f- Non-Metallic Minerals				NE	NE	NE	NE	NE
1.A.2.g- Transport Equipment				NE	NE	NE	NE	NE
1.A.2.h- Machinery				NE	NE	NE	NE	NE
1.A.2.i- Mining (excluding fuels) and Quarrying				NE	NE	NE	NE	NE
1.A.2.j- Wood and wood products				NE	NE	NE	NE	NE
1.A.2.k- Construction				NE	NE	NE	NE	NE
1.A.2.l- Textile and Leather				NE	NE	NE	NE	NE
1.A.2.m- Non-specified Industry				NE	NE	NE	NE	NE
1.A.3 - Transport	53 034.12	14.61	2.53	NE	NE	NE	NE	54 125.98
1.A.3.a- Civil Aviation	4 258.05	0.18	0.04	NE	NE	NE	NE	4 272.88
1.A.3.a.i- International Aviation (International Bunkers) (1)								NE
1.A.3.a.ii- Domestic Aviation	4 258.05	0.18	0.04	NE	NE	NE	NE	4 272.88
1.A.3.b- Road Transportation	46 676.43	14.26	2.28	NE	NE	NE	NE	47 681.37
1.A.3.b.i- Cars				NE	NE	NE	NE	NE

	Emissions (Gg)						Emissions
Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2	(Gg CO_2e)
1.A.3.b.i.1- Passenger cars with 3-way catalysts				NE	NE	NE	NE	NE
1.A.3.b.i.2- Passenger cars without 3-way catalysts				NE	NE	NE	NE	NE
1.A.3.b.ii- Light-duty trucks				NE	NE	NE	NE	NE
1.A.3.b.ii.1- Light-duty trucks with 3-way catalysts				NE	NE	NE	NE	NE
1.A.3.b.ii.2- Light-duty trucks without 3-way catalysts				NE	NE	NE	NE	NE
1.A.3.b.iii- Heavy-duty trucks and buses				NE	NE	NE	NE	NE
1.A.3.b.iv- Motorcycles				NE	NE	NE	NE	NE
1.A.3.b.v- Evaporative emissions from vehicles				NE	NE	NE	NE	NE
1.A.3.b.vi- Urea-based catalysts				NE	NE	NE	NE	NE
1.A.3.c- Railways	551.36	0.03	0.19	NE	NE	NE	NE	611.20
1.A.3.d- Water-borne Navigation	1 548.28	0.14	0.03	NE	NE	NE	NE	1 560.52
1.A.3.d.i- International water-borne navigation (International bunkers) (1)								
1.A.3.d.ii- Domestic Water-borne Navigation	1 548.28	0.14	0.03	NE	NE	NE	NE	1 560.52
1.A.3.e- Other Transportation				NE	NE	NE	NE	NE
1.A.3.e.i- Pipeline Transport	NE	NE	NE	NE	NE	NE	NE	NE
1.A.3.e.ii- Off-road	IE	IE	IE	NE	NE	NE	NE	NE
1.A.4 - Other Sectors	48 253.83	4.39	1.44	NE	NE	NE	NE	48 793.46
1.A.4.a- Commercial/Institutional	18 326.65	0.65	0.22	NE	NE	NE	NE	18 407.54
1.A.4.b- Residential	25 878.05	3.58	1.19	NE	NE	NE	NE	26 322.23
1.A.4.c- Agriculture/Forestry/Fishing/Fish Farms	4 049.12	0.16	0.04	NE	NE	NE	NE	4 063.68
1.A.4.c.i- Stationary	4 049.12	0.16	0.04	NE	NE	NE	NE	4 063.68
1.A.4.c.ii- Off-road Vehicles and Other Machinery	IE	IE	IE	NE	NE	NE	NE	NE
1.A.4.c.iii- Fishing (mobile combustion)	IE	IE	IE	NE	NE	NE	NE	NE
1.A.5 - Non-Specified	1 173.16	0.05	0.01	NE	NE	NE	NE	1 177.38
1.A.5.a- Stationary	1 173.16	0.05	0.01	NE	NE	NE	NE	1 177.38
1.A.5.b- Mobile				NE	NE	NE	NE	NE
1.A.5.b.i- Mobile (aviation component)	NE	NE	NE	NE	NE	NE	NE	NE
1.A.5.b.ii- Mobile (water-borne component)	NE	NE	NE	NE	NE	NE	NE	NE
1.A.5.b.iii- Mobile (Other)	NE	NE	NE	NE	NE	NE	NE	NE
1.A.5.c- Multilateral Operations (1)(2)								0.00
1.B - Fugitive emissions from fuels	25 320.09	173.29	NE	NE	NE	NE	NE	28 959.13
1.B.1 - Solid Fuels	20.79	75.57		NE	NE	NE	NE	1 607.68
1.B.1.a- Coal mining and handling	20.79	75.57		NE	NE	NE	NE	1 607.68
1.B.1.a.i- Underground mines	20.79	75.57		NE	NE	NE	NE	1 607.68
1.B.1.a.i.1- Mining	16.85	61.25		NE	NE	NE	NE	1 303.07
1.B.1.a.i.2- Post-mining seam gas emissions	3.94	14.32		NE	NE	NE	NE	304.61
1.B.1.a.i.3- Abandoned underground mines	NE	NE		NE	NE	NE	NE	NE

	Emissions (Gg)								
Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2	Emissions ($Gg\ CO_2e$)
1.B.1.a.i.4- Flaring of drained methane or conversion of methane to CO_2	NE	NE		NE	NE	NE	NE	NE
1.B.1.a.ii- Surface mines	NE	NE		NE	NE	NE	NE	NE
1.B.1.a.ii.1- Mining	NE	NE		NE	NE	NE	NE	NE
1.B.1.a.ii.2- Post-mining seam gas emissions	NE	NE		NE	NE	NE	NE	NE
1.B.1.b- Uncontrolled combustion and burning coal dumps	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1.c- Solid fuel transformation	NE	NE	NE	NE	NE	NE	NE	NE
1.B.2 - Oil and Natural Gas	641.83	NE	NE	NE	NE	NE	NE	641.83
1.B.2.a- Oil	641.83	NE	NE	NE	NE	NE	NE	641.83
1.B.2.a.i- Venting	NE	NE		NE	NE	NE	NE	NE
1.B.2.a.ii- Flaring	641.83	NE		NE	NE	NE	NE	NE
1.B.2.a.iii- All Other				NE	NE	NE	NE	NE
1.B.2.a.iii.1- Exploration				NE	NE	NE	NE	NE
1.B.2.a.iii.2- Production and Upgrading				NE	NE	NE	NE	NE
1.B.2.a.iii.3- Transport				NE	NE	NE	NE	NE
1.B.2.a.iii.4- Refining				NE	NE	NE	NE	NE
1.B.2.a.iii.5- Distribution of oil products				NE	NE	NE	NE	NE
1.B.2.a.iii.6- Other				NE	NE	NE	NE	NE
1.B.2.b- Natural Gas				NE	NE	NE	NE	NE
1.B.2.b.i- Venting				NE	NE	NE	NE	NE
1.B.2.b.ii- Flaring				NE	NE	NE	NE	NE
1.B.2.b.iii- All Other				NE	NE	NE	NE	NE
1.B.2.b.iii.1- Exploration				NE	NE	NE	NE	NE
1.B.2.b.iii.2- Production				NE	NE	NE	NE	NE
1.B.2.b.iii.3- Processing				NE	NE	NE	NE	NE
1.B.2.b.iii.4- Transmission and Storage				NE	NE	NE	NE	NE
1.B.2.b.iii.5- Distribution				NE	NE	NE	NE	NE
1.B.2.b.iii.6- Other				NE	NE	NE	NE	NE
1.B.3 - Other emissions from Energy Production	24 657.47	97.72	NE	NE	NE	NE	NE	NE
1.C - Carbon dioxide Transport and Storage	NE			NE	NE	NE	NE	NE
1.C.1 - Transport of CO_2	NE			NE	NE	NE	NE	NE
1.C.1.a- Pipelines	NE			NE	NE	NE	NE	NE
1.C.1.b- Ships	NE			NE	NE	NE	NE	NE
1.C.1.c- Other (please specify)	NE			NE	NE	NE	NE	NE
1.C.2 - Injection and Storage	NE			NE	NE	NE	NE	NE
1.C.2.a- Injection	NE			NE	NE	NE	NE	NE
1.C.2.b- Storage	NE			NE	NE	NE	NE	NE
1.C.3 - Other	NE			NE	NE	NE	NE	NE

Table A.2: IPPU sectoral table

Inventory Year: 2015

Categories	(Gg)			CO_2 Equivalents(Gg)							Emissions
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NO_x	CO	NMVOCs	SO_2	(Gg CO_2e)
2 - Industrial Processes and Product Use	35 777.59	4.34	1.11	3 482.12	2 186.11	0.00	0.00	0.00	0.00	0.00	41 882.30
2.A - Mineral Industry	6 178.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6 178.52
2.A.1- Cement production	5 204.83						NE	NE	NE	NE	5 204.83
2.A.2- Lime production	859.79						NE	NE	NE	NE	859.79
2.A.3- Glass Production	113.91						NE	NE	NE	NE	113.91
2.A.4- Other Process Uses of Carbonates	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.A.4.a- Ceramics	NE						NE	NE	NE	NE	NE
2.A.4.b- Other Uses of Soda Ash	*NE*						NE	NE	NE	NE	NE
2.A.4.c- Non Metallurgical Magnesia Production	*NE*						NE	NE	NE	NE	NE
2.A.4.d- Other (please specify) (3)	*NE*						NE	NE	NE	NE	NE
2.A.5- Other (please specify) (3)							NE	NE	NE	NE	NE
2.B - Chemical Industry	569.00	4.15	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1 001.51
2.B.1- Ammonia Production	C	C					NE	NE	NE	NE	C
2.B.2- Nitric Acid Production			C				NE	NE	NE	NE	C
2.B.3- Adipic Acid Production			NO				NE	NE	NE	NE	NE
2.B.4- Caprolactam, Glyoxal and Glyoxylic Acid Production			NO				NE	NE	NE	NE	NE
2.B.5- Carbide Production	C	NE					NE	NE	NE	NE	C
2.B.6- Titanium Dioxide Production	C						NE	NE	NE	NE	C
2.B.7- Soda Ash Production	NO						NE	NE	NE	NE	NE
2.B.8- Petrochemical and Carbon Black Production	C	C	NE	NE	NE	NE	NE	NE	NE	NE	C
2.B.8.a- Methanol	*NO*	*NO*					NO	NO	NO	NO	NO
2.B.8.b- Ethylene	NO	NO					NO	NO	NO	NO	NO
2.B.8.c- Ethylene Dichloride and Vinyl Chloride Monomer	*NO*	*NO*					NO	NO	NO	NO	NO
2.B.8.d- Ethylene Oxide	*NO*	*NO*					NO	NO	NO	NO	NO
2.B.8.e- Acrylonitrile	*NO*	*NO*					NO	NO	NO	NO	NO
2.B.8.f- Carbon Black	*C*	*C*					NE	NE	NE	NE	*C*
2.B.9- Fluorochemical Production	NA	NA	NA	NO	NO	NO	NE	NE	NE	NE	NE
2.B.9.a- By-product emissions (4)				*NO*			NE	NE	NE	NE	*NE*
2.B.9.b- Fugitive Emissions (4)							NE	NE	NE	NE	*0.00*
2.B.10- Other (Please specify) (3)							NE	NE	NE	NE	0.00
2.C - Metal Industry	28 756.28	0.19	0.00	0.00	2 186.11	0.00	0.00	0.00	0.00	0.00	30 946.36
2.C.1- Iron and Steel Production	14 093.55	0.00					NE	NE	NE	NE	14 093.55
2.C.2- Ferroalloys Production	13 416.26	0.19					NE	NE	NE	NE	13 420.23
2.C.3- Aluminium production	1 178.40				2 186.11		NE	NE	NE	NE	3 364.51

Categories	(Gg)			CO_2 Equivalents(Gg)							Emissions
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NO_x	CO	NMVOCs	SO_2	($Gg\ CO_2e$)
2.C.4- Magnesium production (5)	NO					NO	NO	NO	NO	NO	NO
2.C.5- Lead Production	18.20						NE	NE	NE	NE	18.20
2.C.6- Zinc Production	49.88						NE	NE	NE	NE	49.88
2.C.7- Other (please specify) (3)	0.00						NE	NE	NE	NE	0.00
2.D - Non-Energy Products from Fuels and Solvent Use (6)	**273.79**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**273.79**
2.D.1- Lubricant Use	270.87						NE	NE	NE	NE	270.87
2.D.2- Paraffin Wax Use	2.91						NE	NE	NE	NE	2.91
2.D.3- Solvent Use (7)							NE	NE	NE	NE	0.00
2.D.4- Other (please specify) (3), (8)							NE	NE	NE	NE	0.00
2.E - Electronics Industry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2.E.1- Integrated Circuit or Semiconductor (9)				NE	NE	NE	NE	NE	NE	NE	NE
2.E.2- TFT Flat Panel Display (9)					NE	NE	NE	NE	NE	NE	NE
2.E.3- Photovoltaics (9)					NE		NE	NE	NE	NE	NE
2.E.4- Heat Transfer Fluid (10)					NE		NE	NE	NE	NE	NE
2.E.5- Other (please specify) (3)							NE	NE	NE	NE	NE
2.F - Product Uses as Substitutes for Ozone Depleting Substances	**0.00**	**0.00**	**0.00**	**3 482.12**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3 482.12**
2.F.1- Refrigeration and Air Conditioning	0.00	0.00	0.00	3 419.72	NE	NE	NE	NE	NE	NE	*3 419.72*
2.F.1.a- Refrigeration and Stationary Air Conditioning				3 419.72			NE	NE	NE	NE	*3 419.72*
2.F.1.b- Mobile Air Conditioning				*IE*			NE	NE	NE	NE	*NE*
2.F.2- Foam Blowing Agents				2.10			NE	NE	NE	NE	2.10
2.F.3- Fire Protection				42.10	NE		NE	NE	NE	NE	42.10
2.F.4- Aerosols				18.20			NE	NE	NE	NE	18.20
2.F.5- Solvents				NE	NE		NE	NE	NE	NE	NE
2.F.6- Other Applications (please specify) (3)				NO	NO		NO	NO	NO	NO	NO
2.G - Other Product Manufacture and Use	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2.G.1- Electrical Equipment	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.G.1.a- Manufacture of Electrical Equipment					NE	NE	NE	NE	NE	NE	NE
2.G.1.b- Use of Electrical Equipment					NE	NE	NE	NE	NE	NE	NE
2.G.1.c- Disposal of Electrical Equipment					NE	NE	NE	NE	NE	NE	NE
2.G.2- SF6 and PFCs from Other Product Uses	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.G.2.a- Military Applications					NE	NE	NE	NE	NE	NE	NE
2.G.2.b- Accelerators					NE	NE	NE	NE	NE	NE	NE
2.G.2.c- Other (please specify) (3)					NE	NE	NE	NE	NE	NE	NE
2.G.3- N_2O from Product Uses	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.G.3.a- Medical Applications			NE				NE	NE	NE	NE	NE
2.G.3.b- Propellant for pressure and aerosol products			NE				NE	NE	NE	NE	NE
2.G.3.c- Other (Please specify) (3)			NE				NE	NE	NE	NE	NE

2.G.4- Other (Please specify) (3)								
2.H - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.H.1- Pulp and Paper Industry				NE	NE	NE	NE	0.00
2.H.2- Food and Beverages Industry				NE	NE	NE	NE	0.00
2.H.3- Other (please specify) (3)				NE	NE	NE	NE	0.00

Table A.3: AFOLU sectoral table

Inventory Year: 2015

	Net CO_2 emissions / removals	Emissions					Total emissions
		(Gg)					(Gg CO_2e)
		CH_4	N_2O	NO_x	CO	NMVOCs	
3 - Agriculture, Forestry, and Other Land Use	-27 522.43	1 332.59	66.44	50.89	1 076.60	NE	21 059.86
3.A - Livestock	NA	1 264.15	3.68	NA	NA	NA	27 688.40
3.A.1 - Enteric Fermentation	NA	1 232.41	NA	NA	NA	NA	25 880.65
3.A.1.a- Cattle		976.42					20 504.75
3.A.1.a.i- Dairy Cows		108.16					2 271.46
3.A.1.a.ii- Other Cattle		868.25					18 233.29
3.A.1.b- Buffalo		IE					IE
3.A.1.c- Sheep		161.46					3 390.62
3.A.1.d- Goats		35.93					754.45
3.A.1.e- Camels		NO					NO
3.A.1.f- Horses		5.65					118.69
3.A.1.g- Mules and Asses		1.71					35.91
3.A.1.h- Swine		1.92					40.23
3.A.1.j- Other game		49.33					1 036.00
3.A.2 - Manure Management (1)	NA	31.74	3.68	NA	NA	NA	1 807.75
3.A.2.a- Cattle		7.12	3.31				1 176.24
3.A.2.a.i- Dairy cows		6.48	0.12				173.08
3.A.2.a.ii- Other cattle		0.64	3.19				1 003.16
3.A.2.b- Buffalo		IE	NO				IE
3.A.2.c- Sheep		0.04	NO				0.93
3.A.2.d- Goats		0.04	NO				0.85
3.A.2.e- Camels		NO	NO				NO
3.A.2.f- Horses		NO	NO				0.09
3.A.2.g- Mules and Asses		NO	NO				0.02
3.A.2.h- Swine		21.48	0.09				451.13
3.A.2.i- Poultry		3.03	0.28				63.70
3.A.2.j- Other game		0.01	NO				0.25

	Net CO_2 emissions / removals
3.B - Land	-27 811.07
3.B.1 - Forest land	-33 315.04
3.B.1.a- Forest land Remaining Forest land	-8 695.41
3.B.1.b- Land Converted to Forest land	-24 619.63
3.B.1.b.i- Cropland converted to Forest Land	-2 812.64
3.B.1.b.ii- Grassland converted to Forest Land	-20 093.22
3.B.1.b.iii- Wetlands converted to Forest Land	-151.22
3.B.1.b.iv- Settlements converted to Forest Land	-950.31
3.B.1.b.v- Other Land converted to Forest Land	-612.24
3.B.2 - Cropland	3 591.10
3.B.2.a- Cropland Remaining Cropland	-1 662.42
3.B.2.b- Land Converted to Cropland	5 253.52
3.B.2.b.i- Forest Land converted to Cropland	2 484.13
3.B.2.b.ii- Grassland converted to Cropland	2 708.36
3.B.2.b.iii- Wetlands converted to Cropland	34.31
3.B.2.b.iv- Settlements converted to Cropland	29.12
3.B.2.b.v- Other Land converted to Cropland	-2.40
3.B.3 - Grassland	-3 362.86
3.B.3.a- Grassland Remaining Grassland	-4 609.86
3.B.3.b- Land Converted to Grassland	1 247.00
3.B.3.b.i- Forest Land converted to Grassland	9 719.00
3.B.3.b.ii- Cropland converted to Grassland	-2 537.70
3.B.3.b.iii- Wetlands converted to Grassland	-37.12
3.B.3.b.iv- Settlements converted to Grassland	-484.78
3.B.3.b.v- Other Land converted to Grassland	-5 412.41
3.B.4 - Wetlands	0.00
3.B.4.a- Wetlands Remaining Wetlands	0.00
3.B.5 - Settlements	2 904.96
3.B.5.a- Settlements Remaining Settlements	-1 580.82
3.B.5.b- Land Converted to Settlements	4 485.77
3.B.5.b.i- Forest Land converted to Settlements	1 998.59
3.B.5.b.ii- Cropland converted to Settlements	521.41
3.B.5.b.iii- Grassland converted to Settlements	1 931.21
3.B.5.b.iv- Wetlands converted to Settlements	16.36
3.B.5.b.v- Other Land converted to Settlements	18.21

Emissions					Total emissions
(Gg)					(Gg CO_2e)
CH_4	N_2O	NO_x	CO	NMVOCs	
30.24	NE	NA	NA	NA	-27 176.08
NE	NE	NA	NA	NA	-33 315.04
					-8 695.41
					-24 619.63
					-2 812.64
					-20 093.22
					-151.22
					-950.31
					-612.24
NE	NE	NA	NA	NA	3 591.10
					-1 662.42
					5 253.52
					2 484.13
					2 708.36
					34.31
					29.12
					-2.40
NE	NE	NA	NA	NA	-3 362.86
					-4 609.86
					1 247.00
					9 719.00
					-2 537.70
					-37.12
					-484.78
					-5 412.41
30.24	NE	NA	NA	NA	634.99
30.24					634.99
NE	NE	NA	NA	NA	2 904.96
					-1 580.82
					4 485.77
					1 998.59
					521.41
					1 931.21
					16.36
					18.21

	Net CO_2 emissions / removals	Emissions					Total emissions
		(Gg)					(Gg CO_2e)
		CH_4	N_2O	NO_x	CO	NMVOCs	
3.B.6 - Other Land	2 370.78	NE	NE	NA	NA	NA	2 370.78
3.B.6.a- Other land Remaining Other land	0.00						0.00
3.B.6.b- Land Converted to Other land	2 370.78						2 370.78
3.B.6.b.i- Forest Land converted to Other Land	322.31						322.31
3.B.6.b.ii- Cropland converted to Other Land	-15.86						-15.86
3.B.6.b.iii- Grassland converted to Other Land	2 087.73						2 087.73
3.B.6.b.iv- Wetlands converted to Other Land	-9.80						-9.80
3.B.6.b.v- Settlements converted to Other Land	-13.60						-13.60
3.C - Aggregate sources and non-CO_2 emissions sources on land (2)	948.74	38.20	62.76	50.89	1 076.60	NE	21 207.64
3.C.1 - Emissions from biomass burning	IE	38.20	2.49	50.89	1 076.60	NE	1 575.33
3.C.1.a- Biomass burning in forest lands	IE	6.24	0.24	4.74	127.31	NE	205.51
3.C.1.b- Biomass burning in croplands	IE	9.66	0.25	8.94	329.17	NE	280.51
3.C.1.c- Biomass burning in grasslands	IE	21.02	1.89	35.04	584.08	NE	1 026.43
3.C.1.d- Biomass burning in wetlands	IE	0.94	0.09	1.60	26.67	NE	46.52
3.C.1.e- Biomass burning in settlements	IE	0.33	0.03	0.56	9.37	NE	16.36
3.C.1.f- Biomass burning in otherlands	IE	0.00	0.00	0.00	0.00	NE	0.00
3.C.2 - Liming	462.64						462.64
3.C.3 - Urea application	486.10						486.10
3.C.4 - Direct N_2O Emissions from managed soils (3)			51.03				15 820.33
3.C.5 - Indirect N_2O Emissions from managed soils			7.19				2 228.35
3.C.6 - Indirect N_2O Emissions from manure management			2.05				634.90
3.C.7 - Rice cultivations	NO	NO	NO				NO
3.C.8 - Other (please specify)							0.00
3.D - Other	-660.10	NA	NA	NA	NA	NA	-660.10
3.D.1 - Harvested Wood Products	-660.10						-660.10
3.D.2 - Other (please specify)							

Table A.4: Land background table (IPCC Table 4.A)

Inventory Year: 2015

Categories	Activity Data		Net carbon stock change and CO_2 emissions								Net CO_2 emissions (Gg CO_2)
			Biomass				Dead organic matter			Soils		
	Total Area (ha)	Thereof: Area of organic soils (ha)	Increase (Gg C)	Decrease (Gg C)	Carbon emitted as CH_4 and CO from fires (1) (Gg C)	Net carbon stock change (Gg C)	Carbon stock change (Gg C)	Carbon emitted as CH_4 and CO from fires (1) (Gg C)	Net carbon stock change (Gg C)	Net carbon stock change in mineral soils (2) (Gg C)	Carbon loss from drained organic soils (Gg C)	
3.B - Land	122 068 350	NE	23 843.38	-15 514.91	IE	4 941.72	0.00	0.00	477.13	520.45	0.00	-27 811.07
3.B.1 - Forest land	22 334 944	NE	22 359.53	-14 256.37	IE	8 103.17	0.00	0.00	13.13	969.63	0.00	-33 315.04
3.B.1.a- Forest land Remaining Forest land	13 858 015	NE	14 994.19	-12 622.72		2 371.47			0.01	0.00	NE	-8 695.41
3.B.1.b- Land Converted to Forest land	8 476 929	NE	7 365.34	-1 633.65	IE	5 731.70	IE	IE	13.12	969.63	NE	-24 619.63
3.B.1.b.i- Cropland converted to Forest Land	674 950	NE	594.14	-139.34		454.80	IE		0.00	312.28	NE	-2 812.64
3.B.1.b.ii- Grassland converted to Forest Land	7 313 964	NE	6 335.91	-1 417.80		4 918.11	IE		-0.20	562.07	NE	-20 093.22
3.B.1.b.iii- Wetlands converted to Forest Land	39 954	NE	41.15	-4.35		36.80	IE		4.44	0.00	NE	-151.22
3.B.1.b.iv- Settlements converted to Forest Land	150 222	NE	176.80	-21.77		155.03	IE		8.87	95.28	NE	-950.31
3.B.1.b.v- Other Land converted to Forest Land	297 840	NE	217.35	-50.39		166.96	IE		0.02	0.00	NE	-612.24
3.B.2 - Cropland	13 763 982	NE	642.19	-854.69	IE	-212.50	0.00	0.00	29.32	-1 320.09	0.00	3 591.10
3.B.2.a- Cropland Remaining Cropland	11 913 955	NE	520.20	-78.64		441.56			10.52	1.30	NE	-1 662.42
3.B.2.b- Land Converted to Cropland	1 850 027	NE	121.99	-776.05	IE	-654.06	IE	IE	18.80	-1 321.39	NE	5 253.52
3.B.2.b.i- Forest Land converted to Cropland	457 855	NE	70.36	-533.44		-463.08	IE		8.26	-222.67	NE	2 484.13
3.B.2.b.ii- Grassland converted to Cropland	1 324 625	NE	47.93	-225.69		-177.76	IE		7.24	-568.12	NE	2 708.36
3.B.2.b.iii- Wetlands converted to Cropland	5 380	NE	0.53	-7.66		-7.14	IE		0.76	-2.98	NE	34.31
3.B.2.b.iv- Settlements converted to Cropland	53 913	NE	1.28	-9.10		-7.82	IE		0.57	-0.69	NE	29.12
3.B.2.b.v- Other Land converted to Cropland	8 253	NE	1.89	-0.15		1.74	IE		1.97	-3.06	NE	-2.40

Categories	Activity Data	
	Total Area (ha)	Thereof: Area of organic soils (ha)
3.B.3 - Grassland	65 771 936	NE
3.B.3.a- Grassland Remaining Grassland	55 613 763	NE
3.B.3.b- Land Converted to Grassland	10 158 173	NE
3.B.3.b.i- Forest Land converted to Grassland	4 676 029	NE
3.B.3.b.ii- Cropland converted to Grassland	1 385 780	NE
3.B.3.b.iii- Wetlands converted to Grassland	64 266	NE
3.B.3.b.iv- Settlements converted to Grassland	183 381	NE
3.B.3.b.v- Other Land converted to Grassland	3 848 717	NE
3.B.4 - Wetlands (1)	2 306 440	NE
3.B.5 - Settlements	3 190 064	NE
3.B.5.a- Settlements Remaining Settlements	2 590 266	NE
3.B.5.b- Land Converted to Settlements	599 798	NE
3.B.5.b.i- Forest Land converted to Settlements	191 209	NE
3.B.5.b.ii- Cropland converted to Settlements	81 740	NE
3.B.5.b.iii- Grassland converted to Settlements	320 386	NE
3.B.5.b.iv- Wetlands converted to Settlements	1 159	NE
3.B.5.b.v- Other Land converted to Settlements	5 303	NE

Net carbon stock change and CO_2 emissions									Net CO_2 emissions ($Gg\ CO_2$)
Biomass				Dead organic matter			Soils		
Increase (Gg C)	Decrease (Gg C)	Carbon emitted as CH_4 and CO from fires (1) (Gg C)	Net carbon stock change (Gg C)	Carbon stock change (Gg C)	Carbon emitted as CH_4 and CO from fires (1) (Gg C)	Net carbon stock change (Gg C)	Net carbon stock change in mineral soils (2) (Gg C)	Carbon loss from drained organic soils (Gg C)	
325.53	0.00	IE	-2 629.66	0.00	0.00	1 984.35	489.43	0.00	-3 362.86
1 935.17	-862.16		1 073.02			193.91	-9.69	NE	-4 609.86
325.53	-2 955.18	IE	-2 629.66	IE	IE	1 790.45	499.12	NE	1 247.00
97.12	-2 843.68		-2 746.55	IE		418.03	-322.11	NE	9 719.00
24.44	-95.98		-71.54	IE		47.81	715.83	NE	-2 537.70
1.56	-0.10		1.46	IE		12.60	-3.94	NE	-37.12
1.53	-3.03		-1.50	IE		5.31	128.40	NE	-484.78
200.87	-12.40		188.47	IE		1 306.70	-19.06	NE	-5 412.41
0.00	0.00	IE	0.00	IE	0.00	0.00	0.00	NE	0.00
516.13	-212.85	IE	-128.28	0.00	0.00	-796.46	-299.09	0.00	2 904.96
431.57	0.00		431.57			0.00	-0.44	NE	-1 580.82
84.56	-212.85	IE	-128.28	IE	IE	-796.46	-298.65	NE	4 485.77
29.23	-172.86		-143.63	IE		-294.84	-106.59	NE	1 998.59
7.28	-9.03		-1.75	IE		-104.61	-35.85	NE	521.41
46.40	-23.07		23.33	IE		-397.32	-152.71	NE	1 931.21
0.06	-39999.82		-3.76	IE		0.05	-0.75	NE	16.36
1.59	-4.06		-2.47	IE		0.26	-2.75	NE	18.21

Categories	Activity Data	
	Total Area (ha)	Thereof: Area of organic soils (ha)
3.B.6 - Other Land	14 700 984	NE
3.B.6.a- Other land Remaining Other land	11 567 671	NE
3.B.6.b- Land Converted to Other land	3 133 313	NE
3.B.6.b.i- Forest Land converted to Other Land	188 147	NE
3.B.6.b.ii- Cropland converted to Other Land	16 996	NE
3.B.6.b.iii- Grassland converted to Other Land	2 835 264	NE
3.B.6.b.iv- Wetlands converted to Other Land	87 644	NE
3.B.6.b.v- Settlements converted to Other Land	5 263	NE

[4] The signs for estimates of gains in carbon stocks are positive (+) and of losses in carbon stocks are negative (–).

CH_4 emissions	Gg CH_4	Gg CO_2e
3.B.4 - Wetlands (1)	30.24	634.99

Net carbon stock change and CO_2 emissions									Net CO_2 emissions (Gg CO_2)
Biomass				Dead organic matter			Soils		
Increase (Gg C)	Decrease (Gg C)	Carbon emitted as CH_4 and CO from fires (1) (Gg C)	Net carbon stock change (Gg C)	Carbon stock change (Gg C)	Carbon emitted as CH_4 and CO from fires (1) (Gg C)	Net carbon stock change (Gg C)	Net carbon stock change in mineral soils (2) (Gg C)	Carbon loss from drained organic soils (Gg C)	
0.00	-191.01	IE	-191.01	0.00	0.00	-753.22	297.65	0.00	2 370.78
							0.00	NE	0.00
0.00	-191.01	IE	-191.01	0.00	0.00	-753.22	297.65	NE	2 370.78
0.00	-81.77		-81.77			-6.13	0.00	NE	322.31
0.00	-2.69		-2.69			-1.10	8.12	NE	-15.86
0.00	-105.96		-105.96			-748.50	285.07	NE	2 087.73
0.00	0.00		0.00			2.67	0.00	NE	-9.80
0.00	-0.59		-0.59			-0.16	4.46	NE	-13.60

Table A.5: Waste sectoral table

Inventory Year: 2015

Categories	Emissions [Gg]						Total emissions (Gg CO_2e)
	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2	
4 - Waste	36.44	888.97	2.67	NE	NE	NE	NE	19 533.14
4.A - Solid Waste Disposal		750.30		NE	NE	NE	NE	15 756.26
4.A.1- Managed Waste Disposal Sites				NE	NE	NE	NE	NE
4.A.2- Unmanaged Waste Disposal Sites				NE	NE	NE	NE	NE
4.A.3- Uncategorised Waste Disposal Sites				NE	NE	NE	NE	NE
4.B - Biological Treatment of Solid Waste		NE	NE	NE	NE	NE	NE	NE
4.C - Incineration and Open Burning of Waste	36.44	11.15	0.26	NE	NE	NE	NE	350.34
4.C.1- Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE
4.C.2- Open Burning of Waste	36.44	11.15	0.26	NE	NE	NE	NE	350.34
4.D - Wastewater Treatment and Discharge	0.00	127.52	2.41	NE	NE	NE	NE	3 426.54
4.D.1- Domestic Wastewaster Treatment and Discharge		IE	IE	NE	NE	NE	NE	NE
4.D.2- Industrial Wastewater Treatment and Discharge		IE		NE	NE	NE	NE	NE
4.E - Other (please specify)				NE	NE	NE	NE	NE

ANNEXURE B.1: METHODS AND ASSUMPTIONS TO QUANTIFY THE EMISSION REDUCTIONS OF THE NATIONAL WASTE MANAGEMENT STRATEGY

The GHG effects of the National Waste Management Strategy were quantified based on information from the 2nd National Climate Change Report (DEA, 2017d). There were actions that were excluded because these actions were reported elsewhere. The Sasol coal to gas switch was included in the Energy sector. The Landfill gas projects were reported in section 3.4.2 under international market mechanisms. Remaining actions that were included in the waste sector were for biogas projects, composting projects and material recovery facilities. The cumulative emission reductions until 2012 for these actions reported were 0.92 Mt CO_2e. No further information were immediately available to explain how the emission reductions reported in the 2nd National Climate Change Report were calculated. It was assumed that since the National Waste Management Strategy was introduced in 2011, that emission reductions were cumulative for the two years 2011 and 2012 (Table B.1). As such the estimated annual emission reduction was calculated as 0.46 Mt CO_2e.

Table B.1: Information to quantify emission reductions of the National Waste Management Strategy

Name	Information on methodologies	Assumptions
National Waste Management Strategy (NWMS) (DEA, 2011b)	Annual GHG emission reductions: Biogas Projects: 0.2 Mt CO_2e Composting projects: 0.25 Mt CO_2e Material recovery facilities: 0.01 Mt CO_2e (DEA, 2017d).	Post 2011, the GHG emission reductions remain the same.

ANNEXURE B.2: METHODS AND ASSUMPTIONS TO QUANTIFY THE EMISSION REDUCTIONS OF THE WORKING FOR LAND, WORKING FOR ECOSYSTEMS AND GRASSLAND REHABILITATION MITIGATION ACTIONS

The Working for Land emission reductions were calculated from the total number of trees planted per year (Table B.2) due to the rehabilitation of degraded land, the average annual carbon accumulation per tree in urban trees by species class: broad species class: mixed hardwood which was 0.01 tonnes C/year and the ratio of the molecular weight ratio of carbon dioxide to carbon which was 44/12. Data were readily available for three years and it was assumed that for 2016 and 2017 that the total number of trees planted remained the same as 2015. This assumption can be updated once new information is made available.

Table B.2: Total number of trees planted per year

Year	Number of trees
2013	503758
2014	268862
2015	217616
Total	990236

The working for ecosystems emission reductions were calculated from the hectares of trees planted which was 2749 Ha and the ratio of the molecular weight ratio of carbon dioxide to carbon which was 44/12. Data were readily available for 2014 and it was assumed for 2015, 2016 and 2017 that the hectares of trees planted remained the same. Information about hectares of trees planted will be updated for 2015, 2016 and 2017 in BUR-4 once new information can be made available.

The emission reductions for grassland rehabilitation were based on the emissions calculated in the 2015 GHG inventory (DEA, 2018d). The carbon stock estimates for settlement converted to grassland were used as to determine the emission reductions for grassland rehabilitation. Natural land cover and cropland land cover conversion to grassland was excluded from the calculation as there is uncertainty in determining the anthropogenic effect on conversion to grassland for these land cover classes.

Table B.3: Emission reductions for grassland rehabilitation (DEA, 2018d)

Year	Settlement converted to grassland Carbon Stock (Mt CO_2e)	Emission Reduction (CO_2e)
2000	-0.18	0
2001	-0.2	0.02
2002	-0.22	0.02
2003	-0.24	0.02
2004	-0.26	0.02
2005	-0.28	0.02
2006	-0.3	0.02
2007	-0.32	0.02
2008	-0.34	0.02
2009	-0.36	0.02
2010	-0.38	0.02
2011	-0.4	0.02
2012	-0.42	0.02
2013	-0.44	0.02
2014	-0.46	0.02
2015	-0.48	0.02
Total	-5.28	0.30

ANNEXURE B.3: LAND USE-BASED MITIGATION

The Agriculture, Forestry and Other Land Use (AFOLU) sector is strategically important in terms of both adaptation and mitigation relating to climate change analysis and planning in South Africa. However, the broad nature of this sector requires structured input and action from various government departments, parastatals and a very active and diverse private sector. Furthermore, to enhance South Africa's National GHG Inventory, it is vital to translate existing AFOLU data into emissions and climate change related data. A number of policies have been developed to support the reporting of GHG emissions and research studies undertaken to improve the quantification of GHG emissions in the sector and will be discussed in the sections below.

Other Land Uses

Amongst the policies addressing mitigation in the land use sector, National Terrestrial Carbon Sinks Assessment (NTCSA) is foundational. The NCTSA provides quantitative spatial information on carbon stock in South Africa as well as evaluating the mitigation opportunities within the sector (DEA, 2015c). Other studies including 'Unlocking barriers and opportunities for land use for land use based climate change mitigation' (DEA, 2017b) and the Assessment of the potential to produce biochar and its application to South African soils as a mitigation measure (DEA, 2015e) further investigate the mitigation options listed in the NTCSA. Whilst other studies including 'Current carbon stock estimation capability for South African commercial forest plantations' (ICFR, 2014) and 'Development of potential verification standards and methodologies for carbon offset projects in the AFOLU sector in South Africa' (DEA, 2015f) further explore and develop the methodologies required to quantify emission reductions related to land use.

NTCSA is a first of its kind for South Africa and was commissioned following a directive from the NCCRP. Given this, the aim was to assess the national carbon sinks in relation to afforestation, forest restoration, wetlands, agricultural practices and urban greening (DEA, 2015c). Furthermore, to assess all significant land use change and quantify the potential future carbon stocks under varying climate change and land use scenarios. Taken together, these variables will assist in the understanding of emissions generated from land use and in identifying land based mitigation opportunities.

The intention of the study was to provide an understanding of the scope and nature of terrestrial carbon stocks and fluxes across the country and how they may change overtime. The Ecosystem Processes and Dynamics Group within the CSIR developed an innovative continuous variable approach to map the national distribution of carbon stocks at a resolution of 1 km^2 (Figure B.3). This continual surface approach is a significant improvement on previous traditional stratification methods in that it provides a far better understanding and measure of the variability in carbon stocks across landscapes and the entire country.

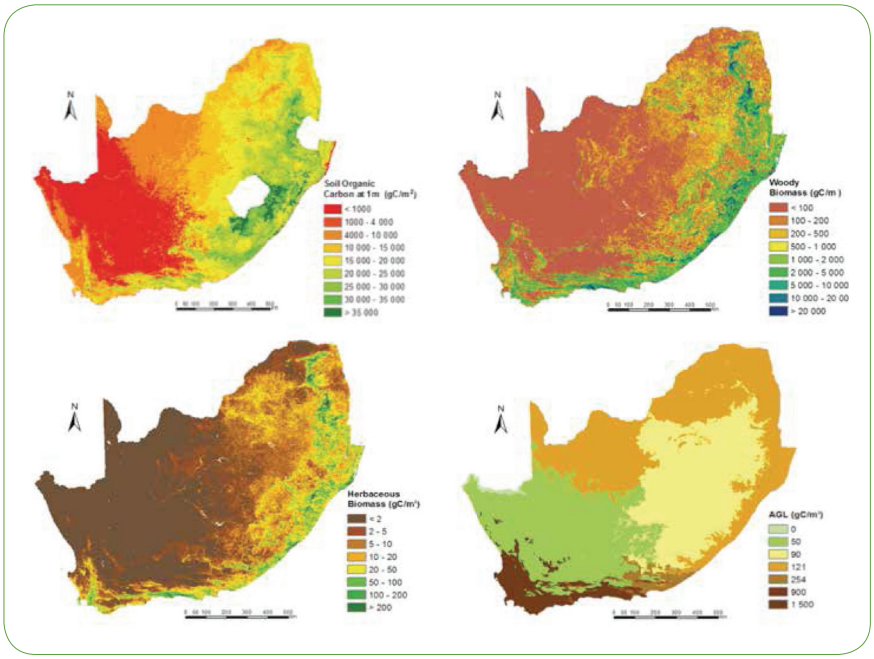

Figure B.1: The components of the terrestrial carbon stock of South Africa. Top left: soil organic carbon to 1 m in depth. Top right: the above- and below-ground woody-plant biomass pool Lower left: above- and below-ground herbaceous biomass pool. Lower right: above-ground litter (DEA, 2015c)

The second part of the study assessed the type and nature of land-use based climate change mitigation opportunities within the country (Figure B.2) A broad range of land use based mitigation activities was adopted as defined in the UNFCCC paper on Agriculture (2008) and in IPCC AR4 (Team et al. 2007). These definitions include biogas and biomass-to energy opportunities in addition to activities that increase or maintain terrestrial carbon stocks (e.g. reforestation, reduced tillage and reducing deforestation). The explicit intention of the analysis was to move from – "the general" to the "specific c", in terms of size and location of activities, potential implementing agencies, and the structure of costs, employment opportunities, required institutional support, incentive mechanisms, and monitoring and reporting requirements.

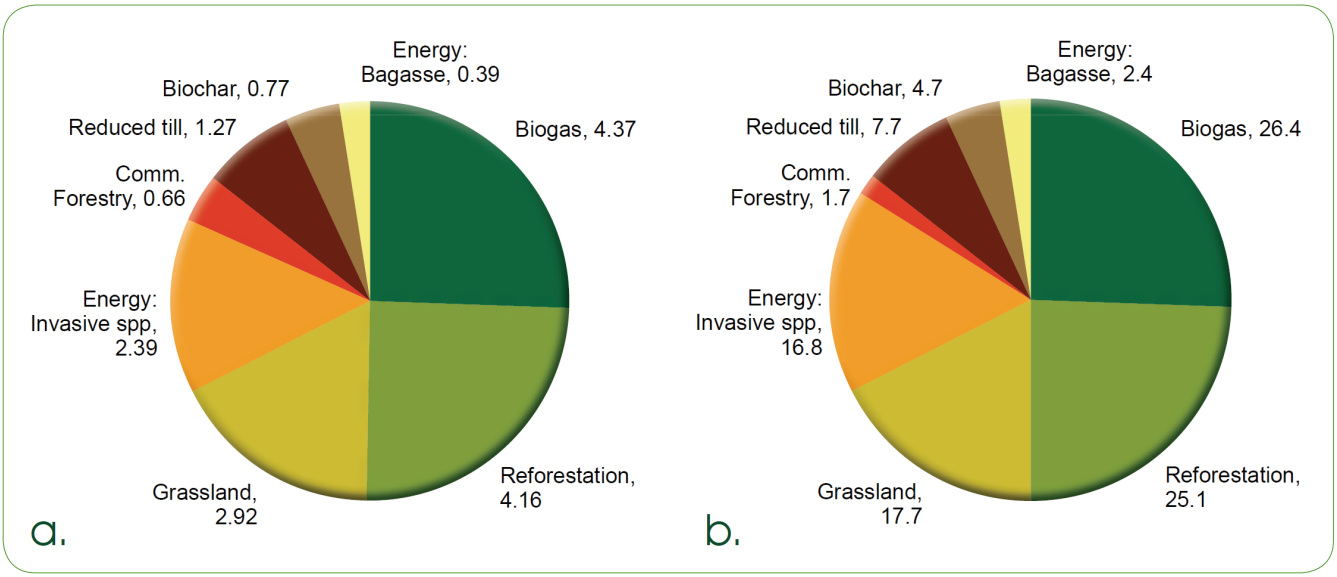

Figure B.2: Individual contribution of the various terrestrial activities towards carbon sequestration and mitigation in (a) million tonnes of CO_2e and (b) in percentage contribution (DEA, 2015c)

Eight prominent land-use based climate change mitigation activities were identified (Table B.4). These include both activities that increase and sustain the size of the national terrestrial carbon stock (reducing tillage, applying biochar, and the restoration and management of grasslands, subtropical thicket, woodlands and forests) as well as activities that lead to a net decrease in GHG emissions (biomass to energy and anaerobic biogas digesters). Biogas has the largest potential (considering farm manure only, i.e. excluding household biogas digesters), followed by sub-tropical thicket and forest restoration, and then the restoration and management of grassland systems. In addition, the generation of energy through the combustion of bagasse and wood sourced from invasive alien species can also form a significant contribution. Implementing these measures presents the opportunity to address degradation and institute sustainable management regimes. The benefits include inter alia enhancement of carbon stocks, the reduction of greenhouse gas emissions, significant reduction of dam siltation downstream, top soil retention. More importantly by rehabilitating these systems the ecological infrastructure is enhanced.

Table B.4: Contribution of terrestrial carbon sequestration and mitigation activities (DEA, 2015c)

Activity	Sub-class	Spatial extent (ha)	Minimum reduction in emissions over 20 yr (Mt CO_2e)
Restoration of sub-tropical thicket, forests and woodlands	Sub-tropical thicket	500 000	44000
	Coastal and scarp forests	8 570	1131
	Broadleaf woodleaf	300 000	24200
Restoration and management of grasslands	Restoration – Erosion Mesic	270 000	13860
	Restoration – Erosion Dry	320 000	11733
	Restoration – Grasslands Mesic	600 000	22000
	Avoided degradation mesic	15 000	1100
Commercial small-grower afforestation	Eastern Cape	60 000	2750
	KwaZulu-Natal	40 000	1833
biomass energy (IAPs & bush encroachment)	Country-wide		39806
Biomass energy (bagasse)	Country-wide		6579
Anaerobic biogas digesters	Country-wide		72848
Biochar	Country-wide	700 000	12833
Reduced tillage	Country-wide	2 878 960	21112
Reducing deforestation and degradation	Through planning Through regulation		
Total			275787

The report on 'Unlocking barriers and opportunities for land use for land use based climate change mitigation' (DEA, 2017b) seeks to expand the implementation of four principle land-use based climate change mitigation options in the country beyond narrow low-cost and risk options, to a larger vision that allows for the realisation of broader national scale social and environmental outcomes. A fundamental change in strategy, implementation, financing and monitoring is required if implementation is to occur in a more inclusive manner at scale.

Agriculture, Forestry and Fisheries

The scope of mitigation relevant studies and policies for the agriculture, forestry and fisheries sector includes policies for climate change planning in the sector namely the draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries (DAFF, 2013), the draft Climate Change Adaptation and Mitigation Plan for The South African Agricultural and Forestry Sectors (DAFF, 2015) and the draft Climate Smart Agriculture Strategic Framework for Agriculture, Forestry and Fisheries (DAFF, 2018).

The draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries (DAFF, 2013) has been developed to address institutional arrangements, vulnerability assessment, mitigation and adaptation in the agricultural, forestry and fisheries sector. The plan was developed by DAFF in line with the National Disaster Management Framework of 2005 and in fulfilment of the requirements of the NCCRP. The basic approach of the sector plan is climate smart agriculture which entails the integration of land suitability, land use planning, agriculture, forestry and fisheries to ensure that synergies are properly captured and that these synergies will enhance resilience, adaptive capacity and mitigation potential.

The draft Climate Change Adaptation and Mitigation Plan for The South African Agricultural and Forestry Sectors (DAFF, 2015) is a component of the Climate Change Sector Plan and outlines a mitigation and adaptation options promoting soil, water and nutrient conservation for agricultural production including soil carbon sequestration (enhanced sinks), soil cover and improved crop and grazing management conducive to sustainable agricultural and soil productivity. The plan specifies the roles and responsibilities of the Department of Agriculture, Forestry and Fisheries for climate change mitigation in the Agriculture and Forestry Sectors including:

- The development and implementation of policies, strategies, action plans and / or regulations to mitigate GHG emissions from changes in land use (i.e. land use changes that convert land from GHG sinks to sources); enteric fermentation (i.e. emissions from livestock); intensive tillage; stubble and trash burning (e.g. sugarcane burning); emissions from fossil-fuel powered agricultural vehicles, equipment and appliances;
- Ensure agricultural policy and strategy alignment with the NCCRP;
- Monitor and report GHG emission reduction interventions in the agricultural sector;
- Forestry- related aspects including fire alerts and REDD+ initiatives; and
- Monitor and report agricultural GHG emissions to the national GHG inventory.

To support the implementation of climate smart agriculture strategies within the agricultural, forestry and fisheries sector, the Draft Climate Smart Agriculture Strategic Framework for Agriculture, Forestry and Fisheries was introduced in 2018 (DAFF, 2018). The framework outlines the role that Climate Smart Agriculture can play in addressing vulnerabilities facing the sector. Various stakeholders, and farmers, have a role to play in promoting resource efficiency, increased productivity and social equity through mitigation and adaptation efforts. Adaptation efforts also need to be complemented by mitigation measures such as carbon capture, securing forests, replanting trees and use of renewable energy. The five core objectives of the Framework are:

- To guide actions at all levels of government, investors and development partners on mainstreaming Climate Smart Agriculture into agriculture, forestry and fisheries plans, programmes and projects.
- Contribute to increasing productivity and growth of agricultural, forestry and fisheries related value chains with nutrition and gender considerations.
- Enhance resilience to climatic and weather shocks on the social, environmental, and economic aspects of agriculture, forestry and fisheries production and food systems.
- Contribute to low carbon development through efficient use of agricultural, agribusiness, forestry and fisheries resources to reduce national emission intensity

Improving the quantification of AFOLU sector emissions

The studies undertaken to improve the quantification of GHG emissions for the AFOLU sector includes:

- Towards the development of a GHG emissions baseline for the Agriculture, Forestry and Other Land Use (AFOLU) sector in South Africa (DEA, 2016f)
- Improvement of the Greenhouse Gas Emissions Inventory for the Agricultural Sector (DEA, 2016g)

The aim of the study "Towards the development of a GHG emissions baseline for the Agriculture, Forestry and Other Land Use (AFOLU) sector in South Africa" was to develop a robust, transparent and accurate projected GHG emissions baseline for the AFOLU sector that will enable South Africa to project its emissions into the future.

Combining the land and the agriculture baseline creates a baseline which shows an 8.2% decline between 2014 and 2020, after which it increases by 37% to 38 938 Gg CO_2e in 2050 (Figure B.3 and Table B.5). The increasing land sink contributes to the slight decline in the early years while the increasing agricultural emissions combined with the stabilizing carbon sink leads to the increase between 2030 and 2050. Land sequesters almost as much as the aggregated non-CO_2 emission and so the baseline is very similar in magnitude to the enteric fermentation value.

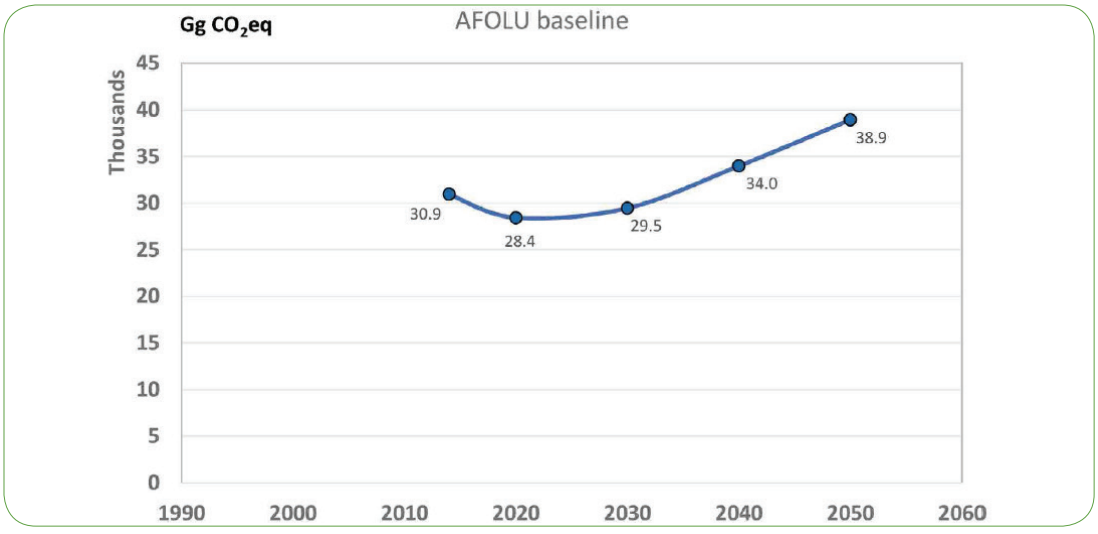

Figure B.3: AFOLU sector baseline trajectory emissions

Table B.5: AFOLU sectoral emissions

Categories	(Gg CO_2eq)				
	2014	2020	2030	2040	2050
Total AFOLU	30 949.40	28 442.40	29 461.90	33 978.70	38 938.20
Livestock	30 727.59	32 256.49	36 353.45	39 516.62	41 177.52
Aggregate sources and non-CO_2 emissions sources on land	21 326.34	22 026.32	24 499.04	26 685.29	28 443.83
Land	-22 920.70	-27 663.20	-33 169.90	33 977.90	-32 407.60
Biomass burning	1 818.47	1 805.02	1 781.55	1 756.86	1 726.61

The study undertaken for the quantification of emissions in the agriculture sector was the Improvement of the Greenhouse Gas Emissions Inventory for the Agricultural Sector (DEA, 2016g). The aim of the project was to estimate the 2012 GHG emissions from the agricultural sector using the Agriculture and Land Use (ALU) National GHG Inventory software. The software utilises the recommended IPCC guidelines on compiling countrywide GHG inventories. The specific objectives were to approximate emissions for activities related to livestock and crop production in response to human needs. Livestock emissions are mostly CH_4 from enteric fermentation, as well as CH_4 and N_2O from manure management. Magnitudes of CH_4 and N_2O emissions depend on the type of manure management system implemented by farmers. Emissions from crop management can be a result of fertilisation, crop residue management and the liming of fields.

The total South African GHG emissions from agriculture in 2012 are estimated at 62,906 Gg CO_2 equivalent (CO_2e), with livestock emissions contributing over 77% of the emissions, while agricultural soils account for 21%, and other emissions like biomass burning and crop residue management account for about 2% (Figure B.4). Enteric fermentation CH_4 proportions for livestock and emissions for the entire agricultural value chain are 74 and 55% respectively, making this subcategory the highest emitting subcategory in the agricultural sector in South Africa. Manure management emissions are 26 and 19% of the total livestock emissions and overall agricultural emissions respectively. This makes manure management the second highest agricultural contributor. The overall contribution value, combined with the application of animal manure on pasture, paddock or rangelands (reported under agricultural soils), is 35%. Other significant agricultural soil emissions emanate from the application of synthetic nitrogen fertilizer and the application of lime on soils, with the percentage contribution on agricultural soils (overall emissions) at 19% (4%) and 14% (3%) respectively. Emissions from crop residue management and the burning of savannas each account for approximately 1% of the total agricultural GHG emissions.

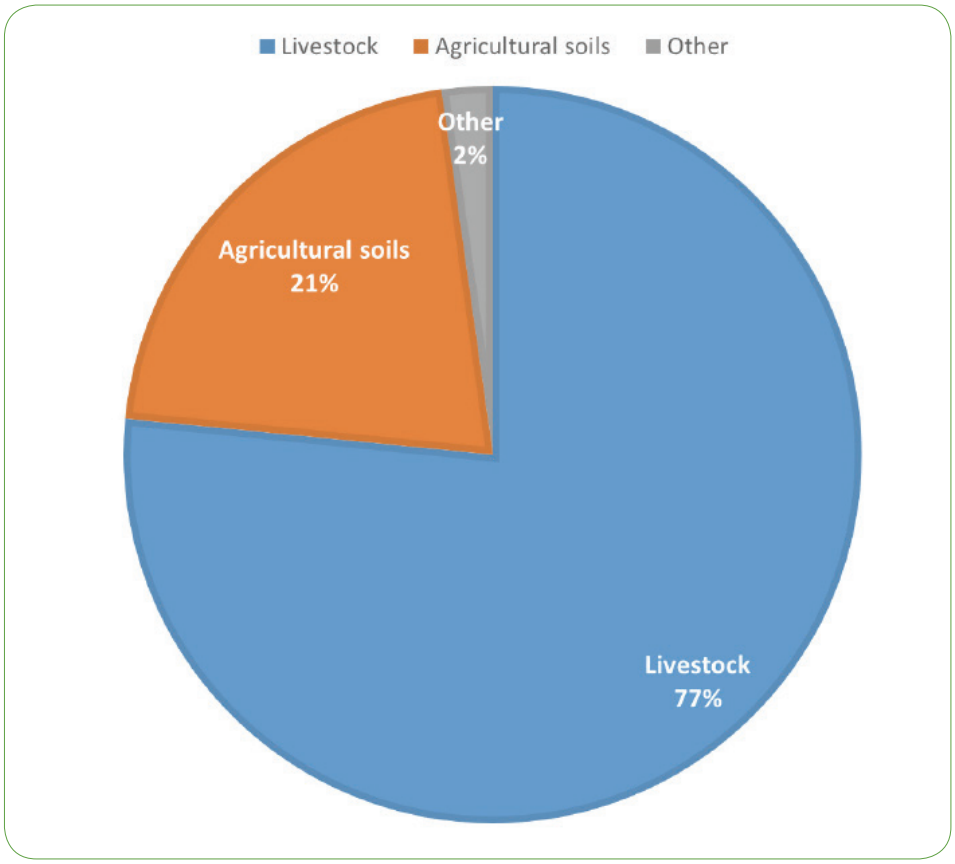

Figure B.4: Composition of AFOLU sector emissions

Finally in terms of monitoring and evaluation, the study "A National Climate Change Monitoring and Evaluation system of the AFOLU Sector" (DEA, 2015b) was undertaken. The study supports the need to improve MRV measures in the AFOLU sector to improve data collection ultimately relates to improving the GHG inventory. This study identifies the various mandates that are currently in place to collect AFOLU data. Existing methods of data collection were assessed across the government and private sectors. This enabled an assessment of the scope of mandates in relation to current data collection practices. This study recognised the strategic importance of aligning the AFOLU MRV system with the National Climate Change Response Monitoring and Evaluation System Framework.

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