SOUTH AFRICA'S LOW-EMISSION DEVELOPMENT STRATEGY 2050

February 2020

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ACRONYMS

ADP	Ad Hoc Working Group on the Durban Platform for Enhanced Action
AFOLU	Agriculture, Forestry and Land Use
BRT	Bus Rapid Transport
CA	Conservation Agriculture
CO_2	Carbon dioxide
CoP	Conference of the Parties
CSIR	Council for Scientific and Industrial Research
CTL	Coal-to-Liquids
DAFF	Department of Agriculture Forestry and Fisheries
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
DoE	Department of Energy
DSI	Department of Science and Innovation
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GJ	Gigajoule
GTL	Gas-to-liquids (GTL)
GTS	Green Transport Strategy
GWh	Gigawatt hour
HySA	Hydrogen South Africa
IDC	Industrial Development Corporation
IEP	Integrated Energy Plan
IGCCC	Intergovernmental Committee on Climate Change

IMCCC	Inter-Ministerial Committee on Climate Change
IPAP	Industrial Policy Action Plan
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRP	Integrated Resource Plan
KfW	German KfW Development Bank
LEDS	Low-Emission Development Strategy
LTAS	Long Term Adaptation Scenarios
LTMS	Long Term Mitigation Scenarios
MACC	Marginal Abatement Cost Curve
M&E	Monitoring and Evaluation
MINMEC	Ministers and Members of Executive Councils
MINTECH	Ministerial Technical Advisory Body
MPA	Mitigation Potential Analysis
MRF	Material Recovery Facility
Mt	Megatonne
Mt CO_2-eq	Megatonne Carbon Dioxide Equivalent
MW	Megawatt
NCCC	National Committee on Climate Change
NCCRP	National Climate Change Response Policy
NDC	Nationally Determined Contribution
NDP	National Development Plan
NEES	National Energy Efficiency Strategy
NEM:WA	National Environmental Management: Waste Act

NERSA	National Energy Regulator of South Africa
NEVA	National Employment Vulnerability Assessment
NIPF	National Industrial Policy Framework
NPC	National Planning Commission
NTCSA	National Terrestrial Carbon Sinks Assessment
NWMS	National Waste Management Strategy
PAMs	Policies and Measures
PCCCC	Presidential Climate Change Coordinating Commission
PJ	Petajoule
PPD	Peak, Plateau and Decline
RE	Renewable Energy
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
REDD	Reducing Emissions from Deforestation and Forest Degradation
SACCS	South African Centre for Capture and Storage
SANS	South African National Standard
SA-LEDS	South Africa Low-Emission Development Strategy
SDG	Sustainable Development Goal
SET	Sectoral Emissions Target
SJRP	Sector Jobs Resilience Plan
STEP	Subtropical Thicket Ecosystem Project
STI	Science, Technology and Innovation
SWH	Solar Water Heater
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization

UNFCCC	United Nations Framework Convention on Climate Change
WtE	Waste-to-Energy
ZAR	South African Rand

EXECUTIVE SUMMARY

INTRODUCTION

South Africa, like the rest of the world, is vulnerable to the impacts of climate change. In unmitigated greenhouse gas (GHG) emissions scenarios, warming of up to 5 to 8°C is projected over the interior of the country by the end of this century. Under a range of warming scenarios, drier conditions will be experienced in the west and south of the country and wetter conditions in the east. Rainfall patterns will become more variable and unpredictable. These changes will impact on water resources and food production, and increase the vulnerability of impoverished communities, amongst others. The South African government thus regards climate change as a considerable threat to the country and its socio-economic development. At the same time, if climate change is to be limited through limiting the growth in global GHG emissions, with South Africa contributing its fair share to emission reductions, there will be other implications for the country. As one of the top 20 global emitters, with a high dependency on fossil fuels, substantial emission cuts will be required. The rapid transition that will be required presents a potential risk to economic growth and sustainable development if not managed properly.

Through the Paris Agreement, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have agreed to limit "the increase in the global average temperature to well below 2°C above pre-industrial levels, and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels". Article 4 of the Agreement sets out Nationally Determined Contributions (NDCs) as the instrument countries must develop to present their part of the global effort to "reach global peaking of greenhouse gas emissions as soon as possible… on the basis of equity and "in the context of sustainable development and efforts to eradicate poverty". To help ensure that the Parties' national contributions can jointly achieve the collective goal, the Article further states that "Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2 taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances".

This document has been prepared in response to that Article, and presents South Africa's first Low Emission Development Strategy (SA-LEDS). Through submitting this document to the UNFCCC our country reiterates its commitment to achieving the Paris goals. Implementation of the Strategy will also contribute directly and indirectly to the meeting of Sustainable Development Goals (SDGs).

SA-LEDS builds upon years of work on climate change in the country, which has contributed to the establishment of an important set of policy documents. Building on existing plans offers numerous benefits, such as optimizing

resources and ensuring buy-in of key stakeholders. Three key climate policy documents provide the foundation on which SA-LEDS has been developed. These are:

- **The National Development Plan (NDP):** With an overarching objective of eliminating poverty and reduce inequality by 2030, the NDP outlines a set of goals and actions to meet the country's environmental sustainability and resilience needs, and dedicates a full chapter to "Environmental Sustainability – An equitable transition to a low-carbon economy".
- **The National Climate Change Response Policy (NCCRP)** represents government's comprehensive policy framework for responding to climate change, including provisions for adaptation and mitigation.
- **The Climate Change Bill** (forthcoming) will form the legislative foundation for the climate change adaptation and mitigation response. With respect to mitigation, the Bill provides for future review and determination of the national greenhouse gas emissions trajectory; determination of sectoral emissions targets for emitting sectors and subsectors; and allocation of carbon budgets. It also makes provision for the development of plans to phase down or phase out the use of synthetic greenhouse gases – in line with the Kigali Amendments to the Montreal Protocol.

Various other strategies, policies and sector plans have been developed for individual sectors of the economy, which will all contribute to driving emission reductions. These are detailed in later sections of this document to outline the set of discrete measures which serve as a starting point for implementation of the LEDS. At the same time, many of these plans were developed prior to the adoption of the Paris Agreement and do not consider the long-term, global goals in a coordinated manner and address a shorter timeframe than mid-century. Keeping SA-LEDS as a dynamic and flexible document is important to ensure it keeps pace with domestic policy developments, research, development and innovation, and declining costs of emissions mitigation technologies. Notable here is a process being undertaken by the National Planning Commission (NPC) to develop a common vision for the country in 2050. This vision will be instrumental in driving harmonisation of government plans and policies and so it is important that the NPC process and vision takes into account the Paris goals.

In addition to policies and measures being implemented by national government, many sub-national (provincial and local) government departments are undertaking activities that contribute to the national mitigation, adaptation and resilience efforts. Sub-national activities have, however, not yet been aligned or coordinated, and different geographical locations see different levels of activity. A diverse range of actions that contribute to GHG emissions mitigation is also being seen across the private sector, with significant gains having been made in certain sectors on both energy efficiency and emissions mitigation.

Although this strategy focuses primarily on greenhouse gas emissions mitigation, the vulnerability to climate change impacts, as well as the need to build resilience to these impacts is noted, and will be further elaborated in future iterations of SA-LEDS. South Africa has developed a National Climate Change Adaptation Strategy that highlights nine key vulnerability areas for the country which acts as a complement to this document.

VISION STATEMENT

The stated vision for SA-LEDS is as follows:

> ***South Africa follows a low-carbon growth trajectory while making a fair contribution to the global effort to limit the average temperature increase, while ensuring a just transition and building of the country's resilience to climate change***

In the absence of an agreed quantitative articulation of the vision, the Peak, Plateau, Decline Emissions Trajectory Range, as reflected in the NCCRP and NDP, is used as the benchmark against which the performance of SA-LEDS will be measured. The Climate Change Bill, described later, makes provision for regular updates of this trajectory, through which it can be better placed within the context of the Paris Agreement. The outcomes of the National Planning Commission process to develop a common vision for the country in 2050 will be used to update SA-LEDS once released. In the development of the vision, South Africa will give due consideration to the IPCC Special Report on 1.5°C, which represents the latest available science regarding this goal.

GHG EMISSIONS MITIGATION MEASURES

The strategy centres on measures currently being implemented by government to address mitigation across the four key sectors of the economy, namely energy, industry, AFOLU and waste. It also presents planned cross-sectoral measures that will contribute to driving mitigation action. As indicated previously, many of the measures address only the short term, and are not considered transformational. South Africa puts these forward as a starting point from which to ratchet up our future ambition towards more integrated, transformational strategy.

Energy supply

Decarbonisation of energy supply will largely be driven through the:

- **Integrated Energy Plan,** which analyses current energy supply and demand trends within the different sectors of the economy, across all energy carriers. It then uses this information along with assumptions

about future demand and technology evolution to project the country's future energy requirements under a variety of different scenarios, including those with emissions limits and carbon prices.

- **Integrated Resource Plan**, which guides the evolution of the South African electricity supply sector, in that it identifies the preferred electricity generation technologies to be built to meet projected electricity demand. It thus provides a mechanism for Government to drive the diversification of the country's electricity generation mix and promote the use of renewable energy and other low-carbon technologies.
- **Biofuels Opportunities**, offered through the Biofuels Industrial Strategy of 2007 (yet to be implemented) and second and third generation biofuels technologies that could potentially increase the volumes of biofuel that could be produced, without competing with food products for feedstocks.

Energy demand

SA-LEDS supports the implementation of a selection of measures to reduce energy demand, or limit growth in energy demand, as the economy and population grows:

- **The National Energy Efficiency Strategy:** In 2005, the Department of Energy launched the first National Energy Efficiency Strategy (NEES). Building on this document, the Department of Minerals and Energy is finalizing the post-2015 NEES, which outlines a set of goals for energy efficiency improvements across the economy to 2030. The NEES also identifies a set of measures to be implemented in each sector to achieve the stated targets. The Post-2015 NEES makes provision for a review every five years.
- **Support for increased uptake of Solar Water Heaters:** Solar Water Heaters (SWH) partially offset use of electricity for water heating in middle- and high-income households, and can service low-income households that did not previously have ready access to hot water or used fuels other than electricity for water heating. Since 2005 a number of goals have been set, and associated support programmes have been established to drive uptake of SWH, with the NDP introducing a goal of five million SWHs by 2030.
- **The National Building Regulations and Buildings Standards Act:** To further efforts to decrease energy consumption and associated GHG emissions of new commercial and residential buildings, the government has implemented energy efficiency and energy consumption standards under the National Building Regulations and Buildings Standards Act. The first of these is South African National Standard (SANS) 204 – Energy Efficiency in Buildings. This standard "specifies the design requirements for energy efficiency in buildings and of services in buildings with natural environmental control and artificial ventilation or air conditioning systems." The second, SANS 10400-XA – Energy Usage in Buildings, includes the provisions of SANS 204 and others, providing a standard for energy efficient buildings.

- **Promotion of cleaner mobility:** Emissions from energy supply in the transport sector are addressed through a number of policy documents. The 2007 Public Transport Strategy sets out an action plan for accelerated modal shifts and for the development of integrated rapid public transport networks. Since then, the successful implementation of the bus rapid transport (BRT) system in Johannesburg has led to it being adapted and implemented in other major South African cities, with further roll-outs being planned. In 2018 the Green Transport Strategy (GTS) to 2050 was launched. The GTS provides the strategic direction for the transport sector regarding the reduction of GHG emissions, the contribution of transport to the green economy and the promotion of sustainable mobility. The Strategy aims to support reductions in the contribution of the transport sector to national greenhouse gas emissions through interventions that include local electric vehicle and battery production and roll out of solar powered charging stations; continued use of fuel economy norms and standards for fuel efficiency and GHG emissions of vehicles; and facilitating a shift of freight from road to rail. In September 2010 a CO_2 tax was introduced on the selling price of new motor vehicles that exceed a certain emissions limit.

Industry

Two sets of policies that directly and indirectly support emissions reductions in the industrial sector are identified, beyond those that target energy efficiency. The **Industrial Policy Action Plan (IPAP)**, the implementation plan for the National Industrial Policy Framework, is revised at various intervals. The most recent revision, which covers the period 2018/19 to 2020/21, provides updates on key focus areas within the industrial sector, one of which is green industry investment. The implementation of technologies with potential for contribution to emissions reductions in the industrial sector is also supported by various **tax incentives**, contained in the Income Tax Act.

Agriculture, Forestry and Land Use (AFOLU)

Mitigation actions identified in the AFOLU sector include Policies and Measures developed by line departments including the Department of Agriculture Forestry and Fisheries (DAFF)[1]. These include the draft Climate Change Adaptation and Mitigation Plan for the South African Agricultural and Forestry sectors, the Conservation Agriculture Policy and the Agroforestry Strategic Framework for South Africa.

[1] Note that with a government restructure Forestry and Fisheries has now been combined with Environmental Affairs, while Agriculture has been combined with agriculture and the department of rural development and land reform. The implications of this restructuring on policy implementation has not yet been considered.

Waste

Waste management activities are legislated through the National Environmental Management: Waste Act, with further policy direction being provided through the National Waste Management Strategy (NWMS). The Strategy adopts the waste management hierarchy of waste avoidance and reduction, re-use, recycling, recovery, treatment and disposal, activities which potentially contribute to a reduction in emissions from material life cycles[2]. Subsequent to the Waste Act and NWMS, twenty national waste management initiatives and annual targets have been established through a process known as the Waste Phakisa. Of the initiatives, five are likely to have direct and indirect impacts on the total national greenhouse gas emissions. The importance of circular economy thinking in guiding the Waste Phakisa initiatives is recognised.

Cross-Cutting Measures

In addition to the measures specific to individual sectors described, four cross-cutting measures that will support low carbon development are in various stages of being implemented.

- **Carbon Tax:** The Carbon Tax Act was brought into effect from 1 June 2019, which gives effect to the "polluter pays principle" and aims to price carbon by internalising the negative costs of emitting GHGs. The tax rate is set at R120 per tonne of CO_2-eq. To allow businesses time for transition, a basic tax-free allowance of 60% will initially apply to all emissions, with further allowances depending on the activities. The tax structure will be revised post-2021 to align with the proposed mandatory carbon budgets.
- **Sectoral Emissions Targets (SETs):** The national emissions trajectory will be translated into Sectoral Emission Targets or SETs, which are quantitative greenhouse gas emission targets allocated to an emitting sector or sub-sector, over a defined time period. Individual national government departments will be tasked with developing and implementing Policies and Measures (PAMs) to ensure emissions from within a sector or sub-sector remain within SET limits.
- **Carbon Budgets:** Carbon Budgets set a maximum volume of emissions from certain activities that individual entities are allowed to emit over three rolling five-year periods. By assigning a Carbon Budget to an entity, a signal is provided as to the degree of GHG mitigation that is required within a specific time period, with a penalty being imposed if the budget allocation is exceeded. Furthermore, by providing entities with an understanding of how budgets are likely to be assigned in future phases to keep overall

[2] Emissions savings achieved through actions in the waste sector will not all be reflected in that sector's inventory, however they may contribute indirectly to national emissions savings.

national emissions within the bounds of the national emissions trajectory, which will continue to be revised downward in keeping with the Paris Agreement, they are sensitised to how mitigation requirements may change in the future. The system thereby provides an opportunity for entities to plan ahead.

- **Phasing out of inefficient fossil fuel subsidies/incentives:** As a member of the G20, where countries have committed to phasing out inefficient fossil fuel subsidies, South Africa has indicated willingness to identify and minimise their harmful impacts, taking cognisance of its developmental state. South Africa should consider participating in a fossil fuel subsidy peer review within the G20 framework to facilitate the sharing of experience and mutual learning among G20 members as the next step in identifying inefficient fossil subsidies within the economy.

GOING FURTHER TO ACHIEVE THE PARIS GOALS

A set of stand-alone, sector-based policies and measures as well as a selection of cross-cutting interventions that government is busy implementing has been presented above. However, a broad range of structural changes will be necessary, in order to ensure the global economy achieves carbon neutrality within the second half of the century. Changes will be required in terms of service demand, technology fleet, infrastructure, operating practice, and energy sources, for all sectors of activity. As South Africa continues to strengthen its response to climate change as part of a global effort, it will increase its focus on a range of strategic elements that will together promote the change to low carbon growth, while continuing to align with the goals of the Paris Agreement. These relate to:

- Enhancing the vision for development, including revising the emissions trajectory to reflect a fair contribution to the global achievement of the Paris Agreement
- Enhancing institutional capabilities and arrangements for the transition
- Creating the right financial environment through aligning fiscal strategy with sustainable growth
- Providing broad access to funds
- Driving innovation, research, and skills for future value capture
- Ensuring a just transition with jobs for all
- Promoting sustainable development through education and culture
- Enhancing information and metrics

Each of these is elaborated upon in the main body of the document.

CONCLUDING REMARKS: PLANNING FOR IMPLEMENTATION

SA-LEDS sets out a direction of travel for South Africa as we refine our low carbon emission development pathway to meet our commitments to the international community and address our developmental agenda/priorities and needs. We know that success will require decades of dedicated effort. Therefore, this Strategy is a living document, the beginning of our journey towards ultimately reaching a net zero carbon economy by 2050.

The first step will thus be to ensure national targets are aligned with the Paris Agreement. Thereafter, planning teams with analytical and sectoral expertise will engage in detailed scenario work to develop transformation pathways towards achieving the national targets. Building a scenario is, however, not enough to plan for its delivery. The work of translating such a plan to policy is a challenge which all Parties will have to grapple with over the coming months and years. South Africa aims to inform rollout plans through the use of a dedicated change framework. SA-LEDS will thus be reviewed at least every five years or earlier, should there be significant changes in sectoral or national plans/programmes that can result in a big structural changes, growth or decay of the economy and major global events that impact on its content or implementation.

Detailed sectoral work to explore transformation pathways

The Paris Agreement sets out the long-term climate change goals for the international community. While countries establish their own goals in a nationally determined manner, sectoral details will have to be analyzed in significant detail, laying out different scenarios to understand trajectories of investment, technology take-up, emissions reduction, and market change. This work has already commenced in South Africa through a number of studies:

- The Mitigation Potential Analysis (MPA), the overall objective of which was to conduct an updated, bottom-up assessment of mitigation potential in key economic sectors to identify a set of viable options for reducing GHGs. Marginal abatement cost curves (MACCs) for key sectors and subsectors were constructed. The MACCs provide estimates of mitigation potential and marginal abatement costs for broad mitigation measures. Estimates of national mitigation potential have been derived from the sectoral MACCs and ranked in terms of level of implementability at national level for each of the technologies.
- The Pathways study to explore the impact of alternative economic growth trajectories on the country's emissions trajectory, looking at the implementation of structural changes rather than the implementation of purely technical interventions. This study, which also used the single national emissions model, had not been released at the time of writing of this document.

- The Policies and Measures (PAMs) analysis, which explored the impact of existing PAMs, many of which were identified previously, on the emissions trajectory.

It is recognized that detailed forecasting is unlikely to accurately predict the evolution of markets. However, "failing to plan is planning to fail", which is why systematic planning is recommended for all sectors. Common characteristics between scenarios that succeed and those that do not will help policymakers identify those conditions which must be met in order for the transition to succeed, aligned with Paris in a manner consistent with the latest science from the IPCC. Based on the sectoral pathways work, which will identify the requirements of the different sectors, a cross-cutting analysis of such pathways will help identify common needs. An aggregate understanding of the evolution over time of such critical factors such as levels of capital investment, consumer prices of different energy options, and requirements for skilled workers in various industries (increasing and decreasing), will set out the parameters for the cross-cutting strategies described previously.

Creation of policy package roadmaps across three phases

The likelihood of policy action leading to long-term transformation results would require the application of new planning techniques. Pathway planning is an analytical tool that can inform national policy development over time towards objectives that sit beyond a typical policy horizon. Pathways visualize the whole timespan between the present and the time for which a target is set, seeking to establish what steps make sense now in the context of reaching the long-term goal. When establishing potential pathways, the desired end-state should be linked to the present, by "backcasting" rather than forecasting. This means that requirements for intermediate steps between today and the long-term goal are deduced not on the basis of how compatible they may be with the current context, but rather in terms of what is required for the end-state to be achieved. This leads policy-makers to consider the question "what would have to be true" regarding short and medium-term checkpoints, deriving the answer from the evolution to the goal.

Once pathways are clearly drawn out, regulatory, institutional, or other structural changes which are required for the transformation can be identified, from which necessary changes can be deduced and used to suggest concrete policy action. In this manner, a rigorous pathway analysis towards a long-term target can produce a number of concrete actions which must be carried out by a certain time, to enable other actions. It can be helpful to structure the time interval into three parts: short, medium and long-term, organising and communicating such actions on a three-stage timeline. These stages are:

- Starting Right (to be completed prior to end of 2021 financial year)
- Turning the Corner (to begin in parallel with the Starting Right stage and continue to 2025)
- Massive Rollout (2025 to 2050)

"Starting Right" will focus on actions relating to the current government administration, or perhaps also address the initial years of the following one. The most important aspect of this stage is to ensure that a true transition is kicked off. On the one hand, rapid implementation must begin in all areas where pathways to achieving the Paris Goals are already clear while on the other, steps taken will need to enable future action at scale, as much as (or perhaps more than) drive immediate emissions reductions. Clearly, "Starting Right" cannot be successfully executed without a long-term pathways analysis to provide confidence on the Paris-compatibility of implemented measures as well as the overall direction of travel. Indeed, the search for immediate emissions reductions in the short-term can often lead to investments in technologies or business models which, while emitting less than traditional options, are not on track to drive the large reductions demanded by the long-term transformation. Avoiding decisions which will lead to emissions lock-in is thus a core priority of the "Starting Right" stage.

"Turning the Corner" would typically take five to seven years. This phase will begin to be implemented in parallel with the "Starting Right" stage, where appropriate, and continue to 2025. This period is decisive, since within it new decision and investment criteria are broadly applied, bringing about changes to the day-to-day operation of many sectors of the economy at the same time. Resistance to change can become challenging if not well handled, and must be anticipated and addressed with social acceptance and just transition actions. It is at this stage that multiple policies will need to work in concert for the new technological options to make economic sense for businesses and consumers. An overall understanding of the sectoral narratives of change and how they collectively feed into the national vision will be core to the success of this stage.

"Massive rollout" is the final phase, in which low-emissions climate resilient options have become the new normal. The constant application of transformative action will drive large volumes of investment towards transformational change. Perseverance on the application of all aspects of change will be required to avoid imbalances or injustices which will compromise the change, and sectors which achieve important milestones must not be allowed to become complacent, but rather contribute to the broader change by supporting areas of natural synergy. Examples of activities that might be taken during the three phases of implementation of the transition are shown in the Table below. All along the way provision needs to be made for regular review of the Strategy and the implementation plan, and M&E of implementation.

Table E1: The three phases of the just transition

Starting Right (start immediately and complete by end of 2020/21 financial year)	• Start the process of developing long term plans for each sector, to avoid lock-in to emissions intensive infrastructure and establish the basis for transformation at scale • Develop approaches for allocation of Sectoral Emissions Targets (SETs) and carbon budgets to high emitting entities • Develop Sector Jobs Resilience Plans (SJRPs) to support the transition to the low carbon economy and climate resilient society in a Just manner • Identify the institutional, legislative, finance and other changes required to achieve the transformation • Develop an understanding of the relevant government decisions which need to be taken to achieve the long-term plans • Develop a monitoring plan
Turning the corner (start immediately, as appropriate, and complete by 2025)	• Develop and begin to implement detailed transformation plans for each sector, which is supported by the implementation of the SETs, carbon budgets and SJRPs • Develop investment pathways to support the transformation • Implement foundational changes to drive down the national trajectory • Implement the institutional changes to accelerate the rate of transformation and remove barriers
Massive roll-out (to 2050)	• Roll-out the implementation plans for each sector along with measures to support changes until they become the new reality • Refine strategies as required, to account for changes in technologies, society and markets

Successful rollout across the three stages will require policy action to be taken in a coordinated manner. It is helpful to present policies not as stand-alone actions but rather as parts of *policy packages*, combinations of measures which may include planning, regulatory, financial, and other instruments to collectively drive towards the desired outcome, providing capabilities and overcoming barriers to change. Complementarity and sequencing are both crucial to building effective policy packages. Proposed components of policy packages could include those that focus on planning; institutional / regulatory considerations; project implementation; financing; acceptance, skills and just transition; and avoiding lock-in. Policy packages should be built up in sequence over time to ensure the full implementation of the pathway, in the form of a *policy pathway* which is required to implement the low-carbon transition.

1 INTRODUCTION

1.1 The global climate crisis

Robust scientific evidence shows that the earth's climate system is changing as a result of anthropogenic greenhouse gas (GHG) emissions. Concentrations of GHGs in the atmosphere have been rising steadily since the industrial revolution (circa 1760), mainly as a result of the burning of fossil fuels, industrial processes, deforestation and agricultural activities. An extensive global body of research from climate scientists has confirmed the relationship between human-induced GHG emissions, higher global average surface temperatures and changes to the earth's climate system (IPCC, 2014; IPCC, 2018).

If current trends continue, global average temperatures are likely to increase by at least 1.5°C above pre-industrial levels between 2030 and 2052. The impacts associated with such temperature increases are significant and far-reaching; threatening people and ecosystems. The impacts, which become more severe the greater the temperature increase, include sea level rise as a result of melting polar ice and glaciers, increases in the frequency and severity of extreme weather events, changing ecosystems and desertification, ocean acidification, and loss of biodiversity. The knock-on effects on human populations include health risks due to increasing temperatures and heatwaves, water shortages, food insecurity, increased spread of diseases and pests as well as damage to infrastructure due to extreme weather events. All of these impacts have economic repercussions (IPCC, 2014).

The severity of impacts is not only a function of the magnitude and rate of warming that is experienced, but also geographic location and levels of development and vulnerability. Along with other developing nations, South Africa is particularly vulnerable to the impacts of climate change. In unmitigated GHG emissions scenarios, warming of up to 5 to 8°C is projected over the interior of the country by the end of this century. Under a range of warming scenarios, drier conditions will be experienced in the west and south of the country and wetter conditions in the east. Rainfall patterns will become more variable and unpredictable. These changes will impact on water resources and food production, and increase the vulnerability of impoverished communities, amongst others (DEA, 2013). For this reason, the South African government regards climate change as a considerable threat to the country and its socio-economic development, having the potential to undermine many of the advances made in recent years. At the same time, if climate change is to be limited through limiting the growth in global GHG emissions, with South Africa contributing its fair share to emission reductions, there will be other implications for the country. As one of the top 20 emitters globally, with a high dependency on fossil fuels, substantial emission

cuts will be required. The rapid transition that will be required presents a potential risk to economic growth and sustainable development if not managed properly.

1.2 The Paris Agreement

The international community has a long history of working to address the climate challenge. The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". All 197 member states of the UN are parties to the Convention, and South Africa ratified the Convention in August 1997.

Annual Conferences of the Parties (or COPs) have achieved different milestones since the first meeting in 1994. The Kyoto Protocol, adopted in 1997, set out the first concrete emissions reductions targets, which were adopted by some Annex I (developed) countries. However, these reductions were insufficient to stop climate change. A global deal, seeking to involve all countries, was pursued at COP15 in 2009 but was not achieved, leaving many Parties concerned about the complexity of agreeing such a deal. At COP 17, held in Durban, South Africa in 2011, the “Ad Hoc Working Group on the Durban Platform for Enhanced Action” (ADP) was established to "develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties". The work of the ADP culminated in the drafting of the text which was negotiated and ultimately adopted in 2015 by the Parties to the Convention, including South Africa, as the Paris Agreement.

In the Paris Agreement, Parties collectively agree to limit “the increase in the global average temperature to well below 2°C above pre-industrial levels, and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels”. Article 4 of the Agreement sets out Nationally Determined Contributions (NDCs) as the instrument countries must develop to present their part of the global effort to “reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity and “in the context of sustainable development and efforts to eradicate poverty” (UNFCCC, 2015).

In order to help ensure that the Parties’ national contributions can jointly achieve the collective goal, the Article further states that “Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2 taking into account their common but differentiated responsibilities

and respective capabilities, in the light of different national circumstances". This document has been prepared in response to that Article.

1.3 The Science of 1.5°C and what it means for the Paris goals

At the time of adoption of the Paris Agreement there was limited scientific literature available regarding the goal of 1.5°C, making it difficult for Parties to gauge the effort required of their NDCs to achieve it. Parties therefore invited the Intergovernmental Panel on Climate Change (IPCC) to provide a special report on the impacts of global warming of 1.5 °C above pre-industrial levels, and the related global greenhouse gas emission pathways. This Special Report, published in 2018, sets out the latest available science for countries to refer to when planning their implementation of the Agreement (IPCC, 2018).

The Special Report makes clear the scale of the challenge facing all Parties in achieving the objectives of the Paris Agreement. With regards to the temperature goal, it shows that every tenth of a degree centigrade in warming makes a significant difference to the impacts on people and ecosystems, making 1.5°C of warming much more closely aligned with the objective of the Convention, than 1.6°C, 1.6°C preferable to 1.7°C, and so on. Furthermore, the Special Report shows that, to be consistent with 1.5°C, global CO_2 emissions by 2030 must be about 45% lower than those of 2010, reaching net zero emissions around 2050. Since global emissions have continued to grow practically every year since the convention was signed, despite climate efforts to date, a number of important in-depth changes will have to take place very quickly around the world for this to be credible. The IPCC describes these as "deep emissions reductions" in energy, industrial, urban, agricultural, and land management systems, which will transform key aspects of the world economy (IPCC, 2018). For this to succeed, the coming decade will be decisive.

The challenge of incorporating this rapid transformation into country plans must be resolved in a nationally determined manner. Developed countries, which have committed to take the lead, must rapidly change the nature of their investments both nationally and internationally to avoid locking in emissions. At the same time, the scale of the reductions required means developing countries must also start to implement transformational changes.

For example, if a developing country were to commit to the target of 45% emissions reduction in double the time recommended by the IPCC (which could be consistent with the IPCC global scenario provided developed countries acted much earlier), and at the same time maintained a dynamic economic growth to reduce poverty, that country's emissions intensity per unit of GDP by the year 2042 would need to be under a quarter of its present value. This has very clear implications: for developing as well as developed countries, before 2050 the core

technologies in operation must be fundamentally different from today's. This is because there is no technological scenario possible which achieves such a reduction while maintaining electric power primarily generated from coal, oil or gas (without carbon capture), or in which passenger transport is provided primarily by petrol/diesel internal combustion engine vehicles. Fossil fuel participation in power generation, where still present, will be only a minor share of the total, and will continue to decline. Urban infrastructure and planning will have reduced the demand for passenger kilometers travelled per person for a broad range of activities, and these will be provided far more through shared platforms than today (be these traditional public transport, or new asset types serving through innovative business models). The majority of these passenger kilometers will be provided by zero-emissions vehicles/platforms, with energy supplied from renewable sources.

The availability of sustainable bioenergy and biomaterials will be limited by global constraints of forest coverage, biodiversity, and food security. These products must be channeled to applications with limited alternatives (such as long-haul aviation), reducing their potential availability as a drop-in substitute for fossil fuels in the bulk of traditional power, energy, or transport applications. Industrial and commercial energy use will incentivise resource efficiency at every turn, with service fulfilment models and product specification, design, and production processes all re-engineered to practically eliminate emissions.

1.4 Methodological elements for developing LEDS

The broad scope of change required to achieve the Paris Agreement presents several important planning challenges and opportunities. The LEDS planning process provides a space for Parties to use to reflect upon how their national plans can achieve emissions pathways consistent with the Paris Agreement, within their common but differentiated responsibilities and respective capabilities. While the timelines, targets and sectorial details of the transformation will vary by country, the expectation is that all targets should follow a downward trajectory. To achieve such a trajectory, transformational rather than incremental change is needed: while most national policies aim to effect limited change within one area of national life over a timeframe of one to five years, the transformation described in the IPCC Special Report on 1.5 degrees will require planning over a 30-year timeframe to ensure broad-based change across all sectors in a coordinated manner.

The decisive change of operating technologies requires a concerted, planned effort if it is to occur in an economically rational manner over such a short timeframe. The timing dimension is crucial. While 2050 may seem a long way off for citizens going about their daily life, or indeed in terms of changing government administrations, the speed of technological change is determined by the lifetime of assets and their rate of replacement. If we

consider power generation plants which consume coal, many of these can operate 30 or 40 years after commissioning, and while an internal combustion engine vehicle lifetime may extend to 15 years in the industrialized world, vehicles of 25 years of age or more can be regularly seen on the streets of Africa. Investments in city and transport infrastructure are also built with the expectation they should last for over 30 years. This means that the investments made today and during the current NDC period will determine much of the activity, and associated emissions, of 2050.

Creating a LEDS which aligns with the Paris Agreement thus requires new planning approaches and tools. Clear, ambitious long-term targets must be set, consistent with the Paris goals. From these, policy makers must establish what are the medium and short-term requirements needed to ensure the achievement of the long-term goals, to inform actions taken on a much shorter timeframe so they can help rather than hinder success and avoid long-term lock-in to emissions intensive options.

Transformation pathways, which show how changes must occur over time, must be developed, linking the desired end-state with the current economic and technological structures. Enough is known about the direction of travel required in all sectors to identify some key components of such trajectories in parallel to the process of agreeing the long-term targets.

Specialist analytical work should feed into the transformation pathways across all sectors of activity, so the credible projections of national emissions can be made, and to allow clear visibility of the trade-offs which will emerge. Once the technology scenario options have been outlined, specific policies must be considered to guide the transformation. Single policies will not be enough to effect such change, however: policy packages including regulatory, financial, planning, project execution, social justice, and lock-in considerations must be built up so their coordinated impact can achieve the transformation. In addition, Parties must identify the enablers of the transition which are required but cannot be provided by the country alone, but rather by the international community through collaboration.

The implementation of the policies and interventions can be thought of three stages. In the first stage, the in-depth plans and changes which will be required in order for the transformation to take place will be identified, and the most pressing lock-in threats avoided. The second is the inflection stage (beginning in parallel with the first stage where appropriate) in which climate policies become an ongoing consideration in an ever-larger number of decisions, changing the character of investments and policy decisions to leave behind development models which imply GHG emissions. The final rollout stage follows during which climate-compatible modalities are fully adopted in all sectors, and implemented continuously to achieve the transformation through ongoing technology

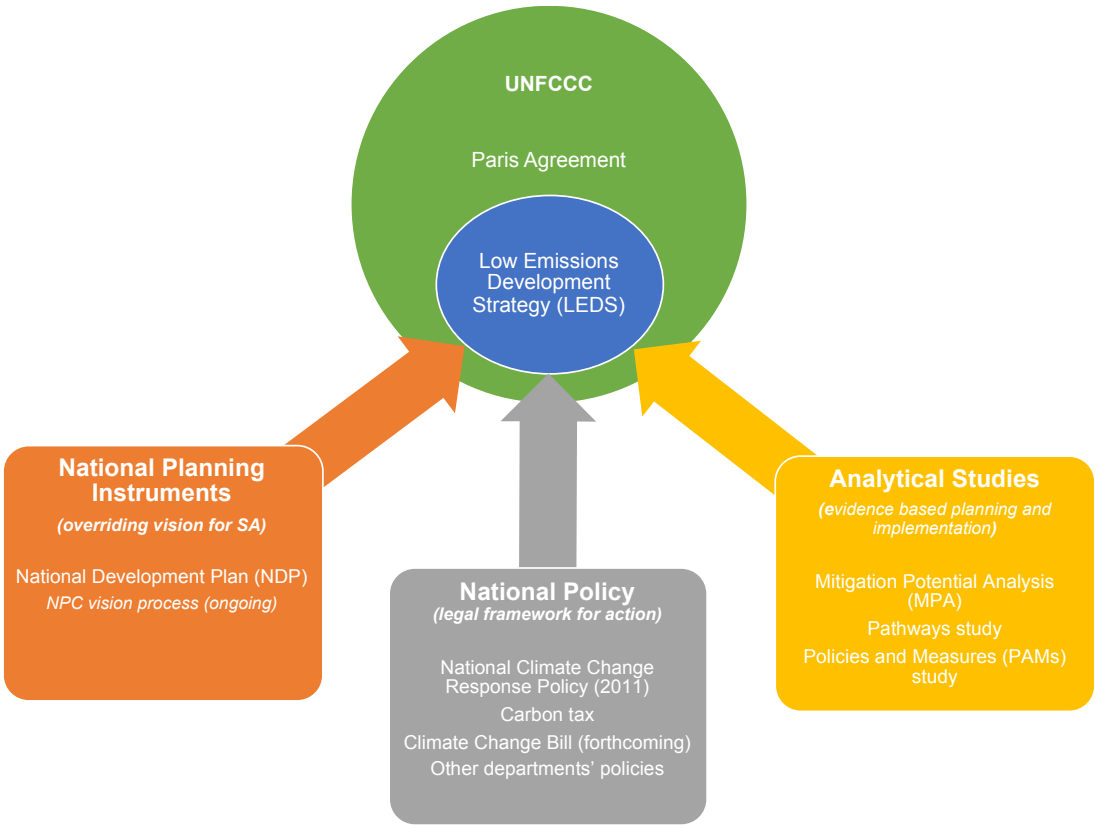
replacement. The benefits of economies of scale and the global transition will provide a positive feedback to the rollout, making Paris-compatible options the most viable throughout this stage.

1.5 South Africa LEDS – a living document

This document presents South Africa's first Low Emission Development Strategy (SA-LEDS) generated after the adoption of the Paris Agreement. Through submitting this document to the UNFCCC our country reiterates its commitment to achieving the Paris goals. It also highlights that implementation of the Strategy will contribute directly and indirectly to the meeting of Sustainable Development Goals (SDGs).

SA-LEDS builds upon years of work on climate change in the country, which has culminated in the establishment of an important set of policy documents (Figure 1). Building on existing plans, policies and aligned research, and particularly the work that is supported by robust analytical and domestic engagement processes, offers numerous benefits, such as optimizing resources and ensuring buy-in of key stakeholders. At the same time, many of these plans were developed prior to the adoption of the Paris Agreement and therefore do not consider the long-term, global goals embedded therein in the coordinated fashion that is required. Furthermore, most of these pre-existing plans and policies address a shorter timeframe than mid-century.

The National Planning Commission (NPC) is currently undertaking a process to develop a common vision for the country in 2050. This vision will be instrumental in driving harmonisation of government plans and policies and so in order to make these more aligned with the methodological elements of developing a LEDS presented in Section 1.4, it is important that the NPC process and the vision it develops takes into account the Paris goals.



UNFCCC: Has an objective to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"
Paris Agreement: Refers to post-2020 climate actions countries intend to take under the Agreement
Low Emissions Development Strategy (LEDS): Communication of mid-century long-term low GHG emissions development strategies, towards the goal of limiting global warming to well below 2°C and to pursuing efforts to limit the increase to 1.5°C
National Development Plan (NDP): Long-term development plan that aims to eliminate poverty and reduce inequality by 2030. Recognises the need for a just low carbon transition
NPC vision process (ongoing): Process to develop a low-carbon vision for the country to guide mitigation and adaptation action
National Climate Change Response Policy (2011): Framework for South Africa's climate mitigation and adaptation response
Carbon Tax: Sets a price on greenhouse gas emissions from certain activities
Climate Change Bill (forthcoming): Establishes the legal framework for implementation instruments to drive mitigation and adaptation
Other departments' policies: Other government policies across many departments either increase or decrease GHGs
Mitigation Potential Analysis (MPA): Projections of National Greenhouse Gas emissions under "technically feasible" mitigation action
Pathways study: National emissions trajectories under alternative economic futures and enhanced/step change mitigation action
Policies and Measures (PAMs) study: Impact of existing PAMs on the national emissions trajectory

Figure 1: SA-LEDS in the context of prior climate-related work in South Africa

Despite being based largely on current knowledge and legislative context, SA-LEDS will be updated as new and critical areas of work are completed by relevant government departments. Keeping SA-LEDS as a dynamic and flexible document is important to ensure that it keeps pace with domestic policy developments, research, development and innovation, and the declining costs of emissions mitigation technologies.

2 THE SOUTH AFRICAN ECONOMY, EMISSIONS PROFILE AND POLICY LANDSCAPE

An overview of the local economy, greenhouse gas emissions profile and relevant policy, legislation and strategies is provided to set the context in which SA-LEDS has been developed.

2.1 South Africa's Economy

South Africa has the second largest economy in Africa, after Nigeria, with a nominal 2019 GDP of US$ 371.298 billion and nominal GDP per capita in that year of US$ 6,331 (IMF, 2019). Figure 2 shows the sectoral contributions to GDP. At the same time, South Africa is amongst the most economically unequal countries in the world, as reflected by the Gini Coefficient of 0.63 in 2014 (World Bank, 2019).

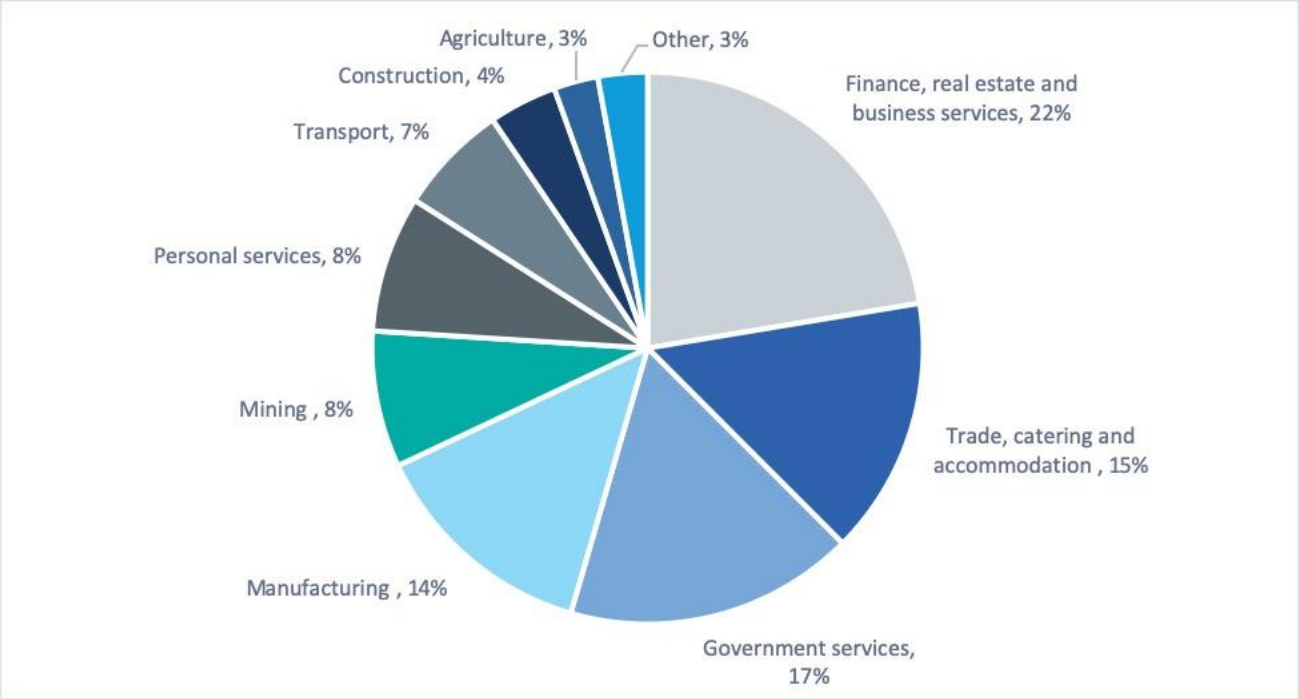


Figure 2: Key contributors to GDP

Source: (Stats-SA, 2017a)

2.1.1 Energy supply

In 2016, the country's total primary energy supply was approximately 5,880 Petajoules (PJ), with fossil-fuels (coal, crude oil petroleum products and natural gas) supplying about 88% of the energy needs (IEA Bioenergy, 2018). According to the 2018 Energy Sustainability Index, developed by the World Energy Council, South Africa is ranked

85th on the Energy Sustainability Index out of 125 countries. Low performance in environmental sustainability in this index is due to the electricity sector's heavy reliance on coal, while increasing petroleum prices, coupled with rising electricity tariffs, contributed to the low score on energy equity (WEC, 2014). While approximately 84% of households in South Africa are electrified, energy poverty is still a significant challenge. As many as 2 million South African households are still without access to electricity (Stats SA, 2017b). Universal access is a key priority for the South African government.

More than 90% of the country's **electricity** is generated from coal by the national utility, Eskom. In recent years, a number of Independent Power Producers (IPPs) have entered the electricity market, predominately generating renewable energy. The main driver of growth in IPPs is the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The REIPPPP is a competitive tender process that is designed to incentivise renewable energy project development. By the end of June 2019, the REIPPPP had achieved the following (DoE, 2019a):

- 6,422 MW of electricity had been procured from 112 Renewable Energy Independent Power Producers (IPPs) in seven bid rounds;
- 3,976 MW of electricity generation capacity from 64 IPP projects has been connected to the national grid;
- 35,669 GWh of energy has been generated by renewable energy sources procured under the REIPPPP since the first project became operational.

Eskom also has an active research programme which looks at renewable energy development amongst topics. Eskom's efforts in this regard have mainly been centred on the development of wind energy, pumped storage and PV projects. The Ingula Pumped Storage Scheme is in commercial operation with four 333 MW generators. Furthermore, Eskom's Sere Wind Farm became fully commercially operational in 2015, with a capacity of 100 MW (DoE, 2019b).

A number of South Africa's existing coal-fired power stations will be retired between 2030 and 2050, and so large investments in additional generation capacity will be needed in order to meet the projected electricity demand and sustain economic growth. Across the country favourable conditions for wind power are found, and the high levels of solar irradiation make it ideal for solar power. Biomass opportunities are available, many of which are along the east coast which is tropical and characterised by large wood and sugar plantations. There is also some potential for small and micro scale hydropower.

South Africa's **liquid fuels** requirements are met through local refining of imported crude oil, sourced mainly from the Middle East and other African countries, through synthetic fuel produced from coal-to-liquids (CTL) and gas-to-liquids (GTL) processes and through refined product imports. The six main liquid fuel producers are Sapref, Enref, Natref and Chevref (refining crude oil) and Sasol and PetroSA (producing synthetic fuels from coal and gas) (SAPIA, 2017). Apart from the production of liquid fuels, crude oil and coal are both used to produce a variety of petrochemical products such as lubricants, bitumen and solvents. Being a net crude oil importer leaves South Africa vulnerable to price fluctuations and volatility on global oil markets.

Natural gas plays a relatively minor role in the primary energy supply. Local production is mainly from the Bredasdorp Basin, which lies offshore on the southern coastline. This basin supplies natural gas to PetroSA's Mossel Bay GTL facility. The bulk of the country's natural gas demand is, however, met through imports from Mozambique's Temane and Pande gas fields. The gas is imported via a high-pressure pipeline and supplied to Sasol and other industrial and commercial customers mainly within Gauteng Province. The finalisation of the Gas Utilisation Master Plan, which has been under development for a number of years, will help to provide policy certainty on the role that gas will play in the energy mix moving into the future.

2.1.2 Mining and the industrial sector

South Africa accounts for a substantial proportion of the world's mineral resource reserves, with non-energy minerals having an estimated value of approximately US$ 2.5 trillion (DMR, 2011). Key mineral outputs include gold, coal, manganese, chrome, platinum and diamonds (dti, 2015). Domestically, coal provides over 70% of the country's primary energy supply (South African Government, 2012). South Africa is also major producer of non-ferrous metals (aluminium, copper, brass, lead, zinc and tin). Non-ferrous metals and stainless steel accounts for about a third of all the country's manufactured products output. Minerals represent an important source of export revenue. Having said that, coal prices and markets are demonstrating volatility due in part to global decarbonisation efforts. This is likely to become even more relevant moving into the future.

The chemical industry is dominated by the emissions-intensive synthetic coal and natural gas-based liquid fuels industry, as well as the petrochemicals industry. South Africa has the largest chemical industry in Africa and is the world leader in coal-based synthetic fuel and gas-to-liquids (GTL) technologies. Other chemicals produced in South Africa include ammonia, nitric acid, carbide, titanium oxide and carbon black.

South Africa also has an active manufacturing sector. However, liberalisation of the markets at the end of apartheid resulted in manufacturing industries in South Africa struggling to remain competitive against more

diversified manufacturing industries in countries such as China, Vietnam and Bangladesh (Bhorat and Rooney, 2017).

2.1.3 Agriculture, Forestry and Land Use (AFOLU)

South Africa's agricultural sector is diverse, with distinct farming regions that vary with climate, soil type and farming practices. The sector includes field crops, horticulture and animal products. Animal products currently generate the highest proportion of gross farm sector income, although the contribution from horticulture products is growing (DAFF, 2017a). Commodities produced include maize, wheat, sugar, deciduous fruit and citrus, wine, beef, dairy, lamb, pork, poultry and game. Livestock farming is the biggest contributor to the sector, and also the largest contributor to AFOLU GHG emissions. Even though its contribution to total GDP is relatively small, and has declined over the years due to the rise of other economic sectors, agriculture, forestry and fishing remains a key provider of rural employment and export earnings (DAFF, 2017a).

2.1.4 Waste sector

As in many other countries, a growing population, a growing middle class and increased rates of urbanisation are putting pressure on solid waste and waste water management facilities. Waste streams are also becoming increasingly diverse in their composition, which affects the complexity of management processes.

The amount of waste landfilled in South Africa significantly exceeds the amount that is diverted, either through reuse or recycling. The recently published Draft South African State of Waste Report shows that around 42 Mt of general waste was generated in South Africa in 2017 (DEA, 2018a). Only about 11% of this was recycled, with the remainder being disposed of to landfill.

Several landfills in the eight larger metropolitan areas are close to reaching their available air space or have already reached their limits. Rapid urbanisation and high costs of building new engineered landfills has led to less suitable landfill space being available. Moreover, the practice of landfilling is becoming less socially acceptable. As such, government is pursuing initiatives to reduce waste generation and divert waste from landfill. These initiatives are discussed further in Section 4.5 .

2.1.5 Other sectors

Tourism remains a priority growth area due to it being highly labour intensive, supports for small businesses and generation of foreign direct investment (dti, 2015, South African Government, 2012). The trade sector is made up

of several divisions, including retail and wholesale, motor, accommodation and catering, food and beverages (dti, 2017). The remaining sectors contributing towards the economy are finance, real estate and business services, government services, personal services and construction (dti, 2017). Finance real estate and business services in particular continue to contribute positively to GDP growth.

2.2 Greenhouse gas emissions profile

The latest National Greenhouse Gas Inventory Report (2015) shows that South Africa's total gross GHG emissions (excluding forestry and other land use) increased by 23% from 439 Mt CO_2-eq in 2000 to 541 Mt CO_2-eq in 2015 (DEA, 2019a). Forestry and land use are a CO_2 sink and reduced gross emissions by 5% in 2015. South Africa's net GHG emissions are 512 Mt CO_2-eq.

The Energy sector accounted for 79.5% of the total gross emissions for South Africa in 2015 (Figure 3), with the percentage contribution of this sector to overall emissions growing by 25% between 2000 and 2015. Energy industries (which includes electricity generation and liquid fuels production from both crude oil and coal) were the main contributor, accounting for 60.4% of emissions from the energy sector and almost half of gross emissions. This was followed by transport, other sectors, and manufacturing industries and construction. Fugitive emissions from fuels contributed another 5% to overall emissions in 2015. Agriculture, Industrial Processes and Product Use and Waste contributed 9.0%, 7.7% and 3.6% to gross national GHG emissions in 2015 respectively.

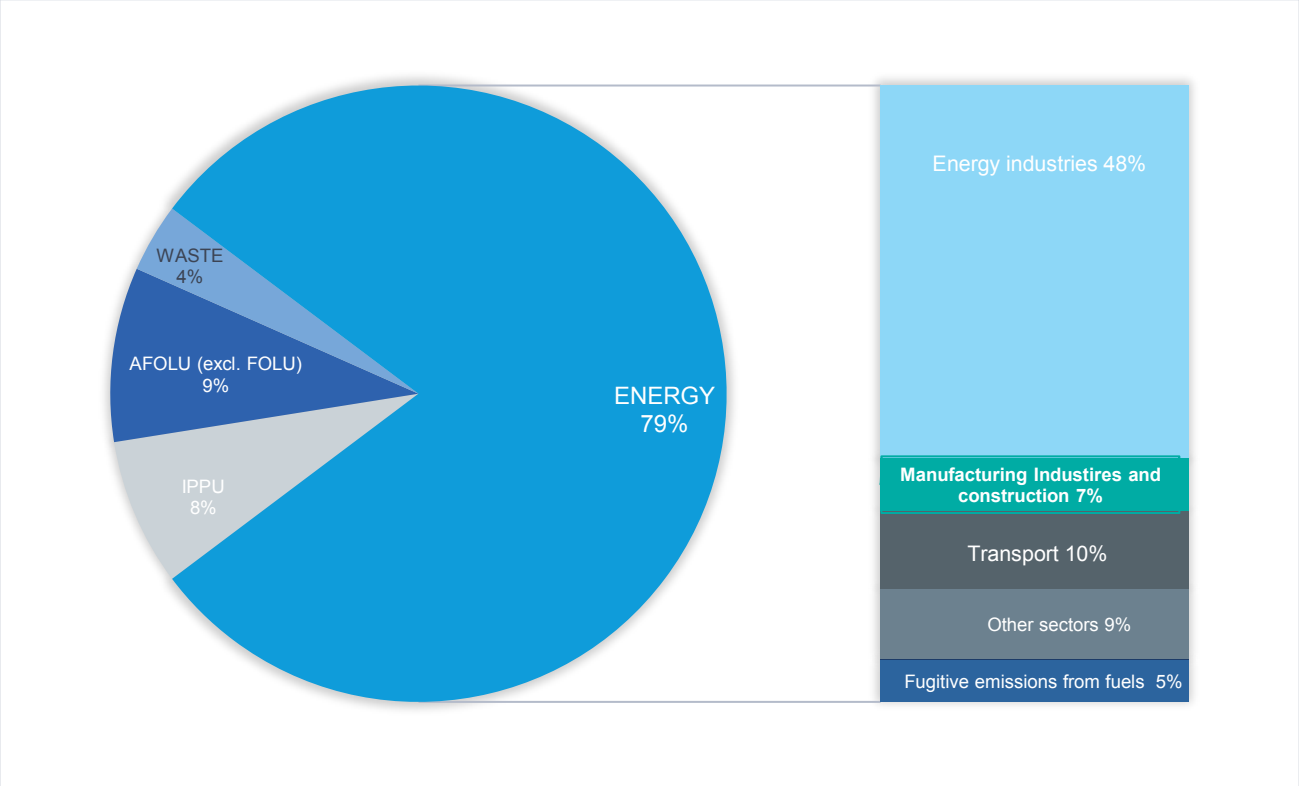


Figure 3: Contribution of main emission categories and energy emission categories to national gross greenhouse gas emissions in 2015

If national emissions are expressed in terms of economic sectors rather than emission categories (see Figure 4), electricity generation contributes 42% of gross national emissions. Industry accounts for 27% of national emissions, with approximately a third of industry emissions associated with process emissions and the other two thirds are as a result of energy use. Emissions from transport and agriculture contribute 10% each, with the residential, commercial and waste sectors making up the remainder. Figure 4 also shows that 85% of greenhouse gas emissions in 2015 are in the form of CO_2. Methane (CH_4) contributes 9%, with over half of these emissions being from agriculture.

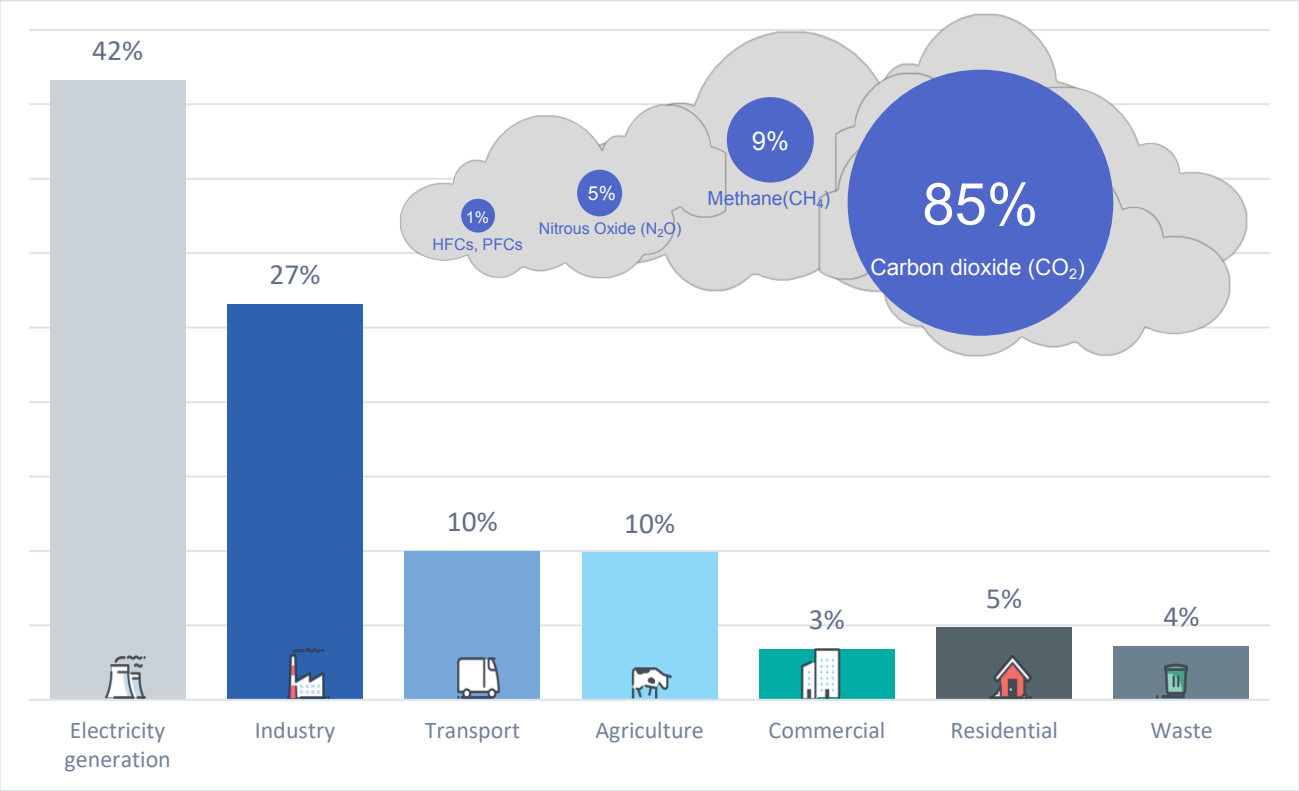


Figure 4: Total gross national GHG emissions by economic sector

The carbon intensity of the economy (tonnes CO_2-eq per R1,000) and the energy intensity of the economy (tonnes oil equivalent (toe) of energy per R1,000) have decreased between 2000 and 2015, by 18.7% and 12.4% respectively. This is attributed to growth in the less energy intensive services and financial sectors together with a decline in manufacturing and mining (DEA, 2019a).

2.3 Policy, legislation and strategies that inform SA-LEDS

Three key climate policy documents provide the foundation on which SA-LEDS has been developed. These are:

- The National Development Plan (NDP)
- The National Climate Change Response Policy (NCCRP)
- The Climate Change Bill (forthcoming)

In addition to these three central documents, various strategies, policies and sector plans have been developed for individual sectors of the economy, which will all contribute to driving emission reductions. These documents

are detailed in later sections to outline a set of discrete measures which serve as a starting point for implementation of the LEDS.

2.3.1 National Development Plan 2030

The overarching objective of the National Development Plan 2030 (NDP) is to eliminate poverty and reduce inequality by 2030. Climate change impacts and mitigation are highlighted as critical issues throughout the document. Chapter 5 is dedicated to "Environmental Sustainability – An equitable transition to a low-carbon economy" and addresses both the use of natural resources and mineral deposits to support the transition of the economy to a diverse, inclusive and low-carbon future, and tackling developmental challenges towards building resilience to the impacts of climate change, particularly in poorer communities. In Chapter 3, economic development and the key drivers of change are discussed – one of which relates to the need for a just transition to a low carbon economy. Chapter 4 focuses on infrastructure, including energy infrastructure, noting the need for diversification of energy supply and for cleaner coal technologies (South African Government, 2012).

The NDP outlines a set of goals and actions to meet the country's environmental sustainability and resilience needs. Those that contribute to climate mitigation include:

- Achieving the peak, plateau and decline trajectory for GHG emissions (See Section 3);
- Entrenching an economy-wide carbon price by 2030;
- Implementing zero emission building standards by 2030; and
- Achieving absolute reductions in the total volume of waste disposed to landfill each year.

The Plan also highlights co-benefits of mitigation action which include increasing energy security and enhancing socio-economic and environmentally sustainable growth.

2.3.2 National Climate Change Response Policy

In 2011, the South African government published a National Climate Change Response Policy (NCCRP), which represents government's comprehensive policy framework for responding to climate change (DEA, 2011)[3]. The two key objectives of the NCCRP are:

[3] Note that this document was published as a white paper but is now considered as a policy document

- Effectively managing inevitable climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity; and
- Making a fair contribution to the global effort to stabilise greenhouse gas concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system, within a timeframe that enables economic, social and environmental development to proceed in a sustainable manner.

The Policy presents a vision for an effective climate change response and the long-term transition to a climate-resilient, equitable and internationally competitive low carbon economy and society. This vision is premised on government's commitment to sustainable development and a better life for all.

In support of achieving these objectives and achieving the vision, the Policy outlines a strategic approach to both mitigation and adaptation. The mitigation components of the strategic approach were later captured in the Climate Change Bill, as discussed in Section 2.3.3 below.

The four key principles that underpin the approach are that actions need to be:

- **Needs driven and customised:** Employ a wide range of adaptation and mitigation approaches, policies, measures, programmes interventions and actions, including those that meet the special needs and circumstances of those most vulnerable;
- **Developmental:** Prioritise climate change responses that have both mitigation and adaptation benefits and that also have significant economic growth, job creation, public health, risk management and poverty alleviation benefits;
- **Transformational, empowering and participatory:** Include policies and measures to address climate change at a scale that enables and supports the required level of innovation, sector and skills development, finance and investment flows needed to realise the full benefit of a transition to a low carbon, efficient, job-creating, equitable and competitive economy; dynamic and evidence-based; and
- **Balanced and cost effective:** Incorporate a balanced approach to both climate change mitigation and adaptation responses in terms of cost-benefit, prioritisation, focus, action and resource allocation; and provide for the integration of sector-related climate change responses into the relevant sector planning processes and their developmental policies and measures.

The Policy was the culmination of an iterative and participatory policy development process started in October 2005, that involved a wide range of stakeholders, including national departments, provincial and local governments, parastatals, academia, research institutions, business, civil society and labour.

2.3.3 Climate Change Bill

The South African government is finalising its Climate Change Bill. Upon adoption, the Bill will form the legislative foundation for the climate change adaptation and mitigation response. With respect to the mitigation response, the Bill provides for future review and determination of the national greenhouse gas emissions trajectory; determination of sectoral emissions targets for emitting sectors and subsectors; and allocation of carbon budgets. Sectoral emissions targets and carbon budgets are discussed further in Section 4.6.3 and 4.6.4. The Bill also makes provision for the development of plans to phase down or phase out the use of synthetic greenhouse gases – in line with the Kigali Amendments to the Montreal Protocol.

2.4 The role of sub-national government and the private sector

In addition to the policies and measures being implemented by national government, sub-national government and the private sector also have a role to play in achieving the vision of SA-LEDS.

2.4.1 Sub-national government

Many of the sub-national (provincial and local) government departments are already undertaking activities that contribute to the national mitigation, adaptation and resilience efforts. Such activities include the development of urban low emissions development strategies and broader climate change strategies, and the implementation of a wide range of projects from embedded generation installations on their own buildings to implementing local building codes that support energy efficiency to interventions in the waste sector.

Sub-national activities have, however, not yet been aligned or coordinated, and different geographical locations see different levels of activity. The Climate Change Act will seek to address this consideration. In terms of the Act, provincial and district municipality intergovernmental forums will be required to serve as Provincial Forums on Climate Change. The Forums will be responsible for coordinating climate change response actions and reporting in their jurisdictions. Furthermore, provinces and district and metropolitan municipalities are required to prepare climate change needs and response assessments (which are updated every five years), and thereafter develop and implement a climate change response implementation plan, which also requires five yearly updates.

A number of Cities are also members of global City movements relating to climate action and city networks that contribute to the climate change agenda such as 100 Resilient Cities, ICLEI Local Governments for Sustainability, and C40 Cities Climate Leadership Group. Many have internal (through their statutory planning documents) and global carbon commitments and targets that apply to the functions of Transport planning, Urban development and Spatial planning, Infrastructure investment and service delivery. Furthermore, there is increasing regional coordination and horizontal integration of climate change responses as municipalities are sharing practice and learning with one another, such as through the Kwazulu-Natal Climate Change Compact.

Some of South Africa's metros are pioneering Net Zero Carbon Building policy and regulations. This requires that buildings exceed the country's energy efficiency and energy consumption standards, and that their remaining energy demand is met by renewable energy. These initiatives are expected to scale the market for zero emission buildings and support the national pathway to net zero carbon buildings.

2.4.2 The contribution of the private sector

A diverse range of actions that contribute to GHG emissions mitigation is being seen across the private sector in South Africa, with significant gains having been made in certain sectors on both energy efficiency and emissions mitigation. The private sector action is being driven by a growth in understanding of the business opportunities, local and global market pressure and existing and forthcoming legislation. Actions range from adopting new products and processes to new service offerings to retrofitting of existing operations to make them more energy efficient and less emissions intensive. With suitable support this growth in action will continue.

2.5 Vulnerability and resilience

Although this strategy focuses primarily on greenhouse gas emissions mitigation, the vulnerability to climate change impacts, as well as the need to build resilience to these impacts is noted, and will be further elaborated in future iterations of SA-LEDS. South Africa has already developed a National Climate Change Adaptation Strategy that highlights nine key vulnerability areas for the country (DEA, 2019b):

- Unreliable and uncertain access to water;
- Risks to agricultural productivity and livestock;
- Human safety from climate related extreme events;
- Poor service delivery in human settlements;
- Vulnerable energy systems and other infrastructure;

- Diminished labour force productivity through exposure and health impacts;
- Risks to markets due to supply and demand volatility;
- Economic risks due to carbon intensity and dependence of the economy; and
- Impacts on ecosystems and challenges for conservation.

The National Adaptation Strategy also outlines a set of six strategic interventions that will contribute to the vision of a climate resilient South Africa. The interventions and target outcomes are shown in Table 1.

Table 1: Strategic interventions outlined in South Africa's National Adaptation Strategy

Intervention	Target outcome
Achieve an effective adaptation planning regime that adequately responds to climate change threats	Achieve an effective adaptation planning regime that covers at least 80% of the South African economy by 2025
Define adaptation practice that integrates biophysical and socio-economic aspects of vulnerability and resilience	Define an adaptation vulnerability and resilience framework implemented from 2020 across 100% of key adaptation sectors
Establish effective governance & legislative processes to integrate climate change in development planning	Define and legislate for adaptation governance through the Climate Change Act by 2019
National and sectoral implementation of adaptation actions	Achieve a 100% coverage of climate change considerations in sectoral operational plans by 2025
Achieve adequate and predictable financial resourcing of adaptation actions and needs, from a variety of sources	Achieve 80% resourcing of national adaptation needs, primarily from national fiscus, including international sources
Develop an M&E system that tracks implementation of adaptation actions and their effectiveness	Development of a national M&E system to track vulnerability, resilience, implementation and resource allocation by 2025

3 VISION STATEMENT

SA-LEDS is grounded in South Africa's climate change response as encapsulated in the documents described in the previous section, while taking cognisance of the country's international climate change commitments and aspirations. The stated vision for SA-LEDS is as follows:

"South Africa follows a low-carbon growth trajectory while making a fair contribution to the global effort to limit the average temperature increase, while ensuring a just transition and building of the country's resilience to climate change".

In the absence of an agreed quantitative articulation of the vision, the national GHG emissions trajectory, as reflected in the National Climate Change Response Policy (NCCRP) and the NDP, is used as the benchmark against which the performance of SA-LEDS will be measured. The GHG trajectory, also referred to as the peak, plateau and decline (PPD), shown in Figure 5 below, indicates that SA's GHG emissions should peak in the period 2020 to 2025 in a range with a lower limit of 398 Mt CO_2-eq and upper limits of 583 Mt CO_2-eq and 614 Mt CO_2-eq for 2020 and 2025 respectively. Emissions will then plateau for up to ten years after the peak within the range with a lower limit of 398 Mt CO_2-eq and upper limit of 614 Mt CO_2-eq. From 2036 onwards, emissions will decline in absolute terms to a range with a lower limit of 212 Mt CO_2-eq and an upper limit of 428 Mt CO_2-eq by 2050. The Climate Change Bill makes provision for regular updates of this trajectory, through which it can be better placed within the context of the Paris Agreement.

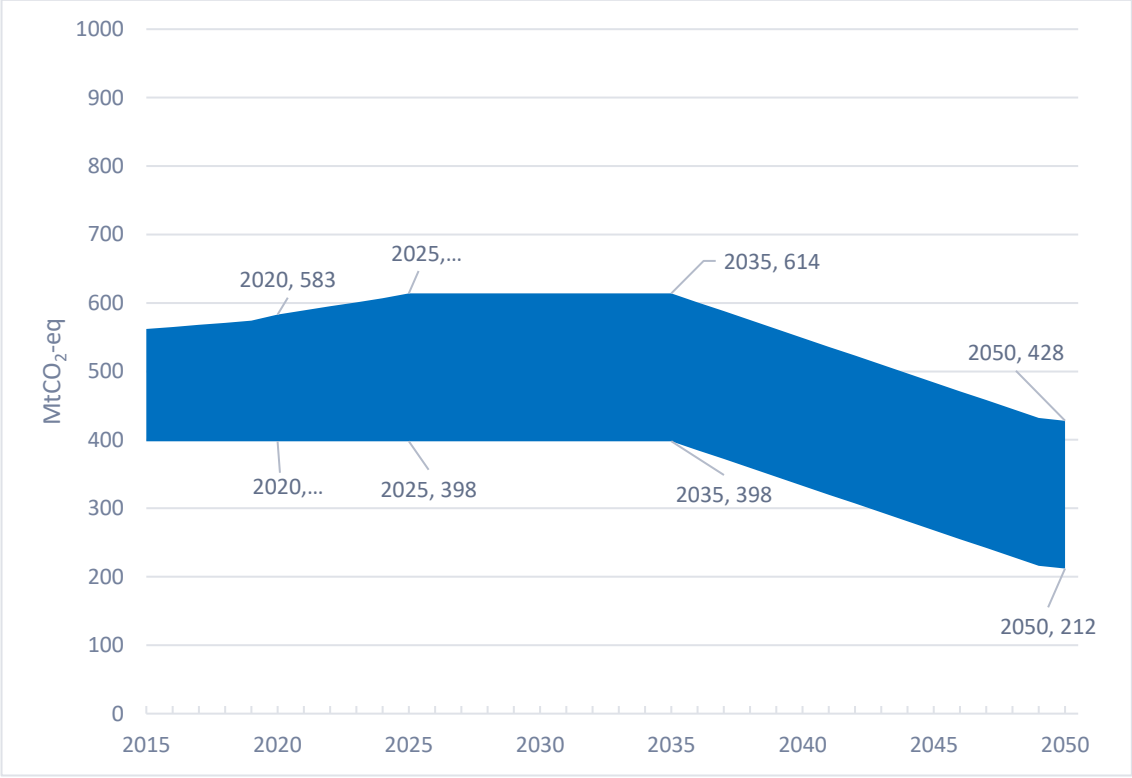


Figure 5: South Africa's Peak, Plateau, Decline Trajectory Range

As indicated previously, a process is currently being undertaken by the National Planning Commission to develop a common vision for the country in 2050. The vision will be used to update SA-LEDS once released. In the development of this vision, South Africa will give due consideration to the IPCC Special Report on 1.5°C, which represents the latest available science regarding this goal. This report sheds new light on the global rate of emissions reductions required to keep warming to 1.5°C with no or low overshoot. While it is agreed that developed countries must take the lead in reducing emissions, in is also imperative that global totals not be exceeded, because developing countries will suffer most from the negative impacts of such a collective failure to limit global emissions. These challenges – which the IPCC Special Report has presented so clearly to the international community – will play a key role in setting our national goals. We thus commit to ultimately moving towards a goal of net zero carbon emissions by 2050, which will require various interventions to reduce greenhouse gas emissions. This goal, how it will be achieved to ensure a just transition, and how the economic advantages of the transition will be maximised, will be formally communicated in future iterations of this strategy.

4 GHG EMISSIONS MITIGATION MEASURES

This section describes measures currently being implemented by government to address GHG emissions mitigation across the four key sectors of the economy, namely energy (supply and demand), industry, AFOLU and waste. It also presents further planned cross-sectoral measures that will contribute to driving mitigation action.

It is recognised that many of the measures presented here address only the short term, and are not considered to be transformational. South Africa puts these forward as a starting point from which we will be able to ratchet up our future ambition towards more integrated, transformational strategy, through the approach described in Section 5 and 6 of this document.

4.1 Energy supply

Energy supply is the mandate of the Department of Mineral Resources and Energy. Decarbonisation of energy supply will largely be driven through the Integrated Energy Plan, the Integrated Resource Plan and the Industrial Biofuels Strategy, issued by the Department of Energy, the predecessor of this Department.

4.1.1 Integrated Energy Plan

Energy planning is guided by the Integrated Energy Plan (IEP). The White Paper on Energy Policy of the Republic of South Africa of 1998 identified the requirement for development of the IEP, with the National Energy

Act of 2008 further defining the objectives thereof. The Energy Act also mandates the Minister of Energy to develop, review and publish the IEP.

The IEP approach analyses current energy supply and demand trends within the different sectors of the economy, across all energy carriers. It then uses this information along with assumptions about future demand and technology evolution to project the country's future energy requirements under a variety of different scenarios, including those with emissions limits and different carbon prices. Based on an analysis of the scenario outcomes, the IEP can define the future trajectories for electricity, liquid fuels and gas in the country.

The current IEP dates from 2003, and the Department of Energy has been working on updates thereof, with a draft IEP outlining various energy scenarios having been issued in 2016 (DoE, 2016a). The draft IEP provides an indication of the sectoral energy demand, as shown in Figure 6. This breakdown is relevant in this document in that it helps to contextualise the mitigation measures presented below. The IEP update with a clear trajectory for the energy sector is critical to guiding overall energy planning for the country, including in the context of this document to support a just transition away from fossil fuels towards a low carbon future.

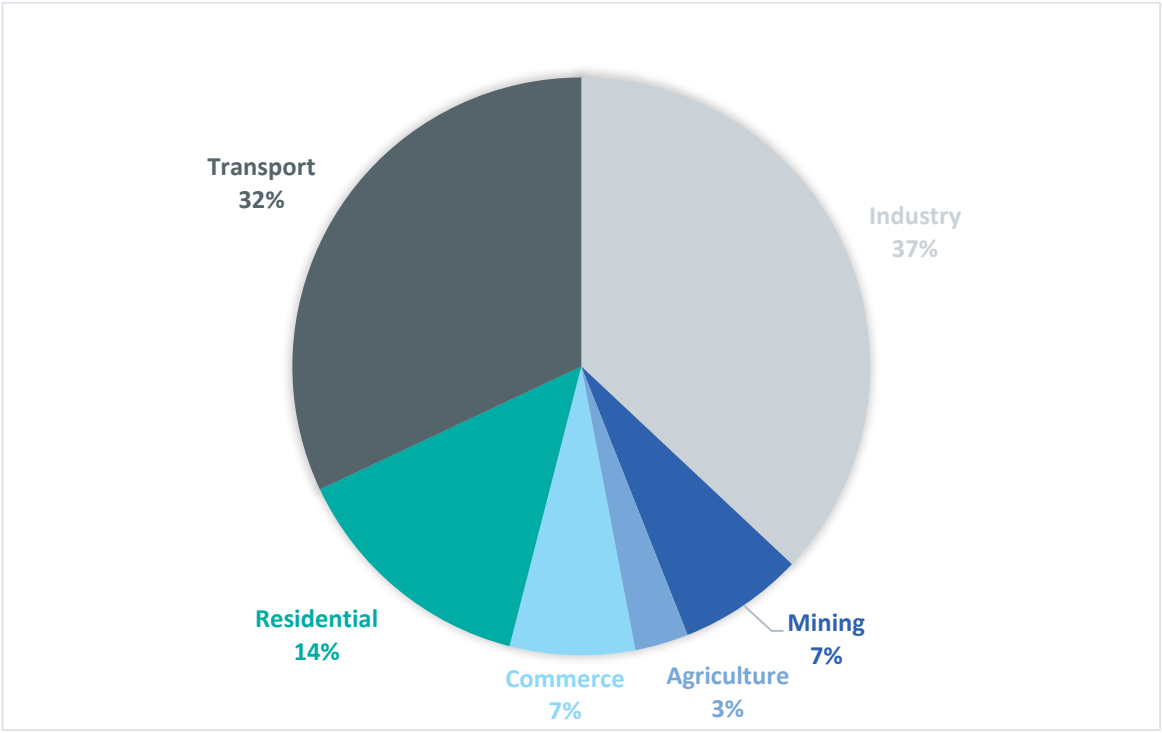


Figure 6: Sectoral energy demand

Source: DoE, 2016a

The Role of the Integrated Energy Plan

- The IEP provides the overall future direction for the energy mix in South Africa, and thus represents a key instrument for driving the move to a low carbon future.
- The IEP update with a clear trajectory for the energy sector is critical to guiding overall energy planning for the country.

4.1.2 Integrated Resource Plan

The Integrated Resource Plan (IRP) guides the evolution of the South African electricity supply sector, in that it identifies the preferred electricity generation technologies to be built to meet projected electricity demand. It thus provides a mechanism for Government to drive the diversification of the country's electricity generation mix and promote the use of renewable energy and other low-carbon technologies.

The 2019 IRP represents South Africa's current policy position, an update on the 2010 IRP (DoE, 2019c). The 2019 update includes:

- Extension of the period of analysis to look at the period to 2050 (the IRP 2010 only looked to 2030), however 2019 IRP only provides a build plan to 2030;
- Updated demand projections; and
- Updated technology costs.

By extending the coverage to 2050, the impact of decommissioning Eskom's coal fired generation capacity on the long-term requirements for new capacity is clearer. According to the IRP, the decommissioning schedule shows that about 10,599 MW of Eskom's coal generation capacity will be decommissioned by 2030, with the figure increasing to 35,000 MW by 2050. For reference, the installed capacity in in 2018 was 37,149 MW.

The IRP is developed by first projecting the country's long-term electricity demand, taking into account the impact of both population growth and economic development, and the role that energy-efficiency and demand-side interventions can play. It then presents a base case and a number of scenarios[4] which all provide an electricity generation supply mix which can meet future electricity demand at least cost, taking into account the need for ensuring security of supply. To explore how the build plan could contribute to a decline in South Africa's GHG

[4] Scenarios explored included those which have no cap on annual build on renewables, changes to gas prices and the application of a carbon budget

emissions in line with the current commitments, modelling of the base case included a carbon constraint to account for the electricity sector's proportional contribution to meeting the PPD trajectory. A scenario was also tested in the 2019 IRP where the emissions space available to the sector under the PPD (5,470 Mt CO_2) is divided into three ten-year carbon budgets.

Drawing on the scenarios analysed in the IRP 2019, an "emerging long-term plan" to 2030 has been developed. The IRP proposes a set of policy adjustments to ensure "a practical plan that will be flexible to accommodate new, innovative technologies that are not currently cost competitive, the minimization of the impact of decommissioning of coal power plants and the changing demand profile." It is noted that although demand projections and decommissioning profiles to 2050 are discussed, the 2019 IRP only provides an indicative generation build plan to 2030. This is attributed to technology uncertainties beyond that time frame.

For the first time, a provision for embedded generation is included in the IRP. Embedded Generation (also referred to as distributed generation) refers to electricity generation installations of capacities of between 1MW and 10MW that are connected to the national grid. Embedded generation using renewable technologies is attracting substantial investment and funding in both the private and public sector (with the latter typically being at sub-national government level), and is set to grow exponentially. In recognition of this growth potential, a provision for 4,000 MW of other generation by 2030 is made, which includes embedded generation as well as co-generation, biomass and landfill gas generation. Government, through the National Energy Regulator of South Africa (NERSA) has been in the process of finalising the regulations governing embedded generation for an extended period, an activity which requires urgent resolution. Although this has not yet been resolved at the national level, number of individual municipalities have already put in place grid feed-in tariffs.

The IRP also proposes a set of research and analysis activities to be undertaken to support the low carbon transition of the electricity supply sector. These include detailed studies on the impact of gas supply options on electricity supply, the appropriate level of penetration of RE in the South African national grid, the cost and economic benefits associated with other clean energy options as well as socio-economic impacts of communities affected by the decommissioning of coal fired power stations. Such activities can help contribute to low emissions transformation of the electricity sector in a manner that is informed, feasible and just.

Transformation of the electricity supply sector

The IRP (2019) makes provision for renewables being added to the electricity supply mix, both to meet growing demand and to replace power stations that will be decommissioned. Short-term additions to the mix include:

- 2,500 MW of new hydro capacity being built by 2030
- 6,814 MW of new PV capacity being built between 2019 and 2030
- 15,762 MW of new wind capacity being built between 2019 and 2030
- 4,000 MW other generation being added to the grid between 2019 and 2030
- 300 MW of Concentrated Solar Power to be built in 2019

Provision is also made for 1,500 MW of new coal-fired power station capacity, beyond that which has already been committed to. The resulting electricity supply mix in 2030 is shown in Figure 7.

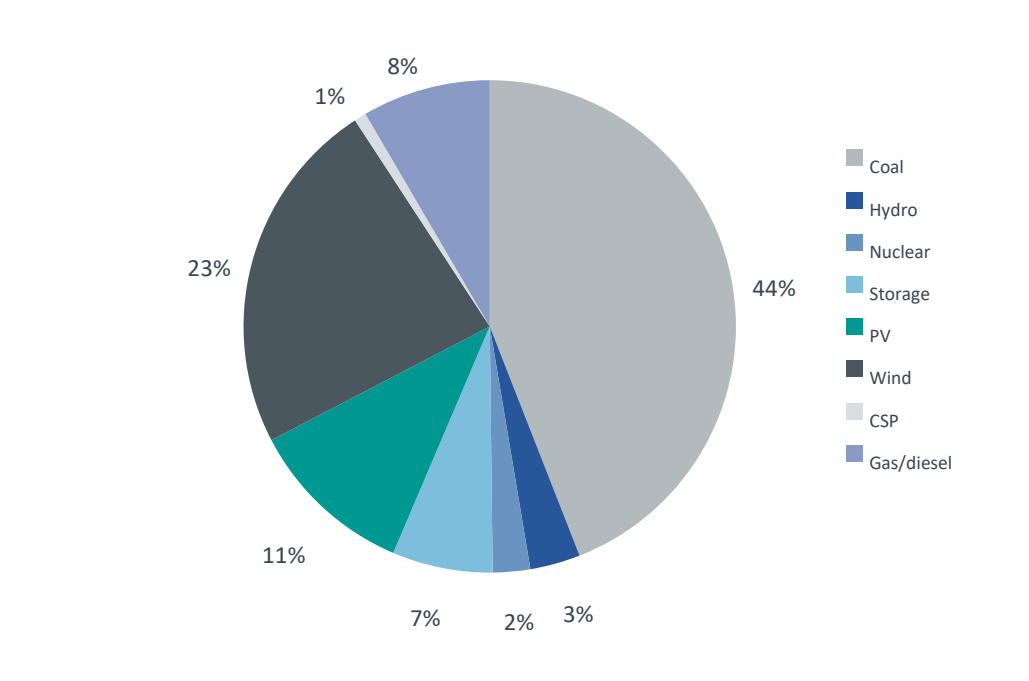


Figure 7: Share of installed capacity in the 2019 IRP in MW[5]

Through regular updates to the IRP, and making early commitments to deep transformation of the sector post 2030, ambition can be increased. However, including new coal-fired power stations in the build plan will result in further lock-in to carbon intensive electricity supply, or the potential for stranded assets in the sector.

[5] Note that the figure excludes embedded generation, due to a lack of information on how much has already been installed.

The 2019 IRP is based on the current articulation of the PPD trajectory. Future updates to the IRP will need to take into account any future modifications to the emissions trajectory. In this way electricity supply planning will be aligned with the country's increasing national ambition.

4.1.3 Biofuels opportunities

The Biofuels Industrial Strategy of the Republic of South Africa (DMR, 2007) outlines Government's approach to the development of a biofuel sector in the country. The primary aim of the Strategy is to address poverty and unemployment, although the role in climate change mitigation in the liquid fuels sector is recognised. The Strategy proposed a 2% penetration of biofuels in the national liquid fuel supply (400 million litres per annum), within five years of its publication.

In support of the strategy, the Regulations Regarding the Mandatory Blending of Biofuels with Petrol and Diesel were published in the Government Gazette in August 2012. The Regulations describe the eligibility and process for purchasing biofuels for blending and specify the type of records that need to be kept. The Regulations also specify that (i) the minimum concentration to be allowed for biodiesel blending is 5% by volume; and (ii) the permitted range for bio-ethanol blending is between 2 and 10% by volume.

Although the regulations were published in 2012, implementation has not yet begun. However, in 2019 the Energy Minister signalled a commitment to implementing the biofuels regulatory framework to support a local biofuels industry. Through inclusion in SA-LEDS the intention to support implementation of the Strategy is signalled.

Since the development of the Strategy, advancements have been made on second and third generation biofuels technologies.[6] These process routes could potentially increase the volumes of biofuel that could be produced in South Africa, without competing with food products for feedstocks.

[6] Second generation biofuels are made from lignocellulosic feedstocks, and thus do not compete with food crops for feedstocks. Third generation biofuels are made from algae.

Biofuels in mitigation of emissions from liquid fuels

- The Biofuels Industrial Strategy and Regulations provide an instrument that, once implemented, can later be ratcheted up to increase mitigation impact.
- Ongoing work will be required to ensure availability of feedstocks to meet increased demand without jeopardising food security (which is primarily a concern in the case of first-generation biofuels), and prioritise which sectors should be allocated limited biomass resources based on a lack of other mitigation options such as long-haul aviation.

4.2 Energy demand

SA-LEDS supports the implementation of a selection of measures to reduce energy demand, or limit growth in energy demand, as the economy and population grows:

- The National Energy Efficiency Strategy;
- Support for increased uptake of Solar Water Heaters;
- The National Building Regulations and Buildings Standards Act; and
- Promotion of cleaner mobility.

These measures not only contribute to reductions in emissions associated with fossil fuels, but also to energy security and energy access.

4.2.1 National Energy Efficiency Strategy

In 2005, the Department of Energy launched the first National Energy Efficiency Strategy (2005). Building on this document, the Department of Minerals and Energy is finalizing the post-2015 National Energy Efficiency Strategy (NEES), which outlines a set of goals for energy efficiency improvements across the economy to 2030 (DoE, 2016b). Table 2 captures the targets included in the NEES, with the explanation of how each of these targets was established being provided in the NEES document.

Table 2: Energy efficiency targets outlined in the post-2015 NEES

Sector/subsector	Goal
Public buildings sector	- 50% reduction in specific energy consumption (measured as GJ annual energy consumption per m^2 of occupied floor area), by 2030.
Municipal services	- 20% reduction in the energy intensity (measured as energy consumption per capita of population served) of municipal service provision, by 2030. The specific services included are street lighting, traffic lights, water supply and waste water treatment. - 30% reduction in the fossil fuel intensity of municipality vehicle fleets (measured as total fossil fuel consumption by municipal vehicles per capita of population served), by 2030.
Residential sector	- 33% reduction in the average specific energy consumption of new household appliances purchased in South Africa, by 2030. - 20% reduction in the average specific energy consumption of the residential building stock, by 2030.
Commercial sector	- 37% reduction in the specific energy consumption (measured as GJ annual energy consumption per m^2 of lettable/habitable floor area), by 2030.
Industry sector	- 16% reduction in the weighted mean specific energy consumption for the manufacturing industry, by 2030 - 40 PJ cumulative total annual energy saving from specific energy saving interventions undertaken by in the mining subsector.
Agriculture sector	1 PJ verified electricity saving from officially supported projects, annually
Transport sector	20% reduction in the average vehicle energy intensity (measured in MJ/km) of the South African road vehicle fleet, by 2030.

The NEES also identifies a set of measures to be implemented in each sector to achieve the stated targets. These are shown in Table 3.

Table 3: Measures outlined in the post-2015 NEES

Sector	Measures	Time frame
Public sector	Introduce mandatory Energy Performance Certificates in all rented properties and publicly accessible buildings	2 years
	Develop the public sector awareness raising campaign to facilitate the "leading by example" approach	5 years
	Introduce standards and labelling relevant for public sector appliances and equipment	2 years
	Announce a 15-year trajectory for the successive tightening of the energy performance component of building standards and successively tighten standards	5 years
	Roll-out the provision of energy and activity data to the public sector	1 year
Municipal sector	Develop municipal energy efficiency strategies	3 years
	Support the implementation of energy savings measures	5 years
Residential sector	Announce a 15-year trajectory for the successive tightening of minimum energy performance standards for household appliances and successively tighten standards	5 years
	Develop a strongly branded energy performance certification mark for household appliances (modelled on the "Energy Star" brand), in addition to the planned energy efficiency labels.	5 years
	Announce a 15-year trajectory for the successive tightening of the energy performance component of building standards for residential buildings and successively tighten standards	5 years
	Build on the existing awareness-raising activities targeting households and the school curriculum	5 years
	Roll-out the provision of energy and activity data from the residential sector	1 year
	Support technology innovation and dissemination of energy efficient cookstove technologies	5 years
Commercial sector	Introduce mandatory Energy Performance Certificates in all rented properties and publicly accessible buildings	2 years
	Revise 12L to ensure it provides an incentive to commercial property owners	4 years
	Introduce standards and labelling relevant for commercial sector appliances and equipment	2 years
	Roll-out the provision of energy and activity data from the commercial sector	1 year
	Adjust the 12L tax incentive scheme	4 years

Sector	Measures	Time frame
Industrial sector	Develop minimum energy performance standards for motors and motor-driven systems	4 years
	Provide targeted support and advice on energy efficiency to enterprises	3 years
	Incentivise enterprises to introduce Energy Management Systems and achieve ISO50001 certification standards	5 years
	Roll-out the provision of energy and production data from the manufacturing sub-sector	1 year
	Develop standardised tools for voluntary reporting of energy savings from initiatives in the mining sector	2 years
	Create technology/ learning hubs for energy efficiency	2 years
Agricultural sector	Explore the potential for savings in agricultural vehicle use, and develop appropriate awareness-raising material	2 years
	Develop targeted awareness-raising and training material on potential savings in motor-driven systems	2 years
	Provide direct grants to small farmers / smallholders for all or part of the cost of interventions	4 years
Transport sector	Develop fuel efficiency standards for light and heavy vehicles to improve the overall efficiency of the vehicle stock	5 years
	Improve systems for ensuring road worthiness	5 years
	Roll-out the provision of energy and activity data from the transport sector	1 year
Production and distribution sector	Develop the enabling framework for cogeneration and trigeneration	3 years
	Expand internal efficiency programmes for producers	3 years

The Post-2015 NEES makes provision for a review every five years.

Energy efficiency in South Africa

- South Africa continues to support efficient energy utilisation, by setting of energy efficiency targets across the economy
- Five yearly reviews provide the opportunity to ratchet up ambition to align with South Africa's contribution to global mitigation goals, and to extend the Strategy to 2050.

4.2.2 Support for uptake of Solar Water Heaters

Solar Water Heaters (SWH) provide the opportunity to partially offset use of electricity for water heating in middle- and high-income households, and to service low-income households that did not previously have ready access to hot water or used fuels other than electricity for water heating.

Since 2005 a number of goals have been set, and associated support programmes have been established, to drive the uptake of SWH in South Africa, with the National Development Plan introducing a goal of five million SWHs by 2030. In 2015 Department of Energy (DoE) took over responsibility for the National SWH programme from Eskom, making 5,000 subsidies available (further to those that had already been granted). The DoE aims to roll out new, fully subsidised low-income installations as part of their Social Programme, and is seeking to drive an increase in localised manufacture to have the positive co-benefit of local economic development. In addition to government programmes that act as drivers, the uptake of SWH continues to be supported by rising energy prices and electricity supply challenges.

Solar Water Heaters in South Africa

- SWH not only provide an opportunity for replacing fossil electricity or gas in water heating in middle- and high-income households, but also for provision of clean energy services to low income households.
- Ongoing implementation of and increased ambition in the SWH programme will drive uptake of these technologies.
- The target of five million SWH installed by 2030 included in the NDP is ambitious in this regard.

4.2.3 National Building Regulations and Buildings Standards Act

To further efforts to decrease energy consumption and the associated GHG emissions of new commercial and residential buildings, the South African government has implemented energy efficiency and energy consumption standards under the National Building Regulations and Buildings Standards Act. Compliance with the Standards is required in order to ensure compliance with the Act.

The first of the relevant standards is South African National Standard (SANS) 204 – Energy Efficiency in Buildings. This standard “specifies the design requirements for energy efficiency in buildings and of services in buildings with natural environmental control and artificial ventilation or air conditioning systems.” It includes provisions for orientation, maximum energy demand and the maximum annual energy consumption for various kinds of buildings

in various climate zones across the country, and design provisions for all parts of buildings' construction. The second standard, SANS 10400-XA – Energy Usage in Buildings includes the provisions of SANS 204 and other standards, towards providing a standard for energy efficient buildings.

Energy efficiency in buildings

- South Africa has standards, supported by legislation, to govern energy efficiency of buildings. These standards are based on global best practice, but adapted to local context. However, capacity building and training of local councils is critical to ensure compliance with the standards.
- Consideration may be given to revising the standards over time, as new building materials and building requirements emerge, to make them more ambitious.
- Further revisions may also help to make these standards more understandable and readily implementable.

4.2.4 Promotion of Cleaner Mobility

Emissions from energy supply in the transport sector are addressed through a number of policy documents. The Public Transport Strategy of 2007 set out an action plan for accelerated modal shifts and for the development of integrated rapid public transport networks (DoT, 2007). Since then, the successful implementation of the bus rapid transport (BRT) system in Johannesburg has led to it being adapted and implemented in other major South African cities, including Cape Town, Rustenburg, Ekurhuleni and Tshwane, with further roll-outs being planned.

In 2018 the Green Transport Strategy (GTS) for 2018 to 2050 was launched (DoT, 2018). The GTS provides the strategic direction for the transport sector regarding the reduction of GHG emissions, the contribution of transport to the green economy and the promotion of sustainable mobility. The Strategy aims to support reductions in the contribution of the transport sector to national greenhouse gas emissions by at least 5% by 2050.

Some examples of the measures in the GTS that are relevant to SA-LEDS include:

- Exploring the potential for local electric vehicle and battery production, and growing the number of public charging stations, powered by solar panels, by 40 stations per year[7];

[7] It is recognised that for the full mitigation benefit of electric vehicles to be realised, concurrent electricity grid decarbonisation is required.

- The continued use of fuel economy norms and standards for fuel efficiency and GHG emissions of vehicles. Baseline studies on the adoption of more stringent fuel standards will help to provide a platform for introducing cleaner fuel standards; and
- Facilitating a shift of freight from road to rail. This is in recognition that freight transport was previously moved off rail onto road as a result of constraints in the country's rail service, with road-based freight transport currently accounting for around 75% of total freight moved. The road-to-rail shift will be supported by the implementation of Transnet's[8] Market Demand Strategy. The Market Demand Strategy aims to create a more balanced and appropriate market between road and rail freight transport, thereby reducing overloading of the road network and road infrastructure deterioration and contributing to a reduction in GHGs associated with rail transport.

In September 2010 a CO_2 tax was introduced on the selling price of new motor vehicles that exceed a certain emissions limit, in order to increase the move towards lower emissions vehicles. The levy has grown incrementally over time, and offers an established instrument that government could use for ratcheting up ambition in the transport sector.

Mitigation in the transport sector

- The Green Transport Strategy provides a comprehensive framework for introducing a wide range of interventions that can help to drive cleaner, lower emissions mobility in the sector.
- Other instruments that will be leveraged to support emissions reductions in this sector include the Public Transport Strategy and the CO_2 tax on vehicles.
- Future work will, however, be required to accelerate implementation and increase ambition of these and other activities.

4.3 Industry

Two sets of policies that directly and indirectly support emissions reductions in the industrial sector are identified, beyond those discussed in Section 4.2.1 that target energy efficiency. These are the Industrial Policy Action Plan (IPAP) and tax rebates for green project development.

[8] Transnet is the state-owned entity responsible for managing rail infrastructure and operation, ports and pipelines

4.3.1 Industrial Policy Action Plan (IPAP)

The National Industrial Policy Framework (NIPF) was adopted as a broad framework governing industrial policy in South Africa, and thus articulates the overarching approach to industrial development (dti, 2007). The implementation plan for the framework is contained in the Industrial Policy Action Plan (IPAP), which is revised at various intervals. The most recent revision of the IPAP, which covers the period 2018/19 to 2020/21, provides updates on key focus areas within the industrial sector, one of which is green industry investment. Some of the green industry Action Programmes that will contribute to climate mitigation in the short term included in the IPAP are:

- Developing a Policy Roadmap for Climate-Compatible Industrial Development;
- Systemised resource efficiency data collection and reporting;
- The Industrial Water Efficiency Project (which has a primary focus on water savings which is a resource efficiency/adaptation focus, but will have a mitigation benefit through saving energy associated with water supply);
- The Industrial Energy Efficiency Project;
- Resource-efficient and cleaner production skills development; and
- Specialist skills development in resource-efficiency and cleaner production.

The IPAP also supports fuel cell industry development.

How the IPAP can contribute to mitigation

- The IPAP defines key milestones to be reached in the implementation of the various industry support programmes.
- While the IPAP implementation period is short term, the Plan is updated regularly which provides the opportunity for ongoing reflection on both the Programmes themselves and their targets/milestones, and how they can be refined or expanded towards contributing to the national mitigation effort. This includes limiting support for interventions that could lead to a growth in emissions.
- The IPAP provides the platform from which to drive step changes in the industrial sector, to ensure new installations follow global best practice, and to allow for adoption of new/alternative materials and process substitutions.

4.3.2 Tax incentives for green project development

The implementation of technologies with potential for contribution to emissions reductions in the industrial sector is supported by various tax incentives, contained in the Income Tax Act of South Africa:

- **Section 12B** allows companies to deduct the cost incurred from investing in assets that are used directly for the production of renewable energy from their taxable income;
- **Section 12I** offers support for both capital investment and training related to Greenfield (new) and Brownfield (expansions or upgrades) projects within South Africa's manufacturing sector. A mandatory requirement for qualification for this incentive is that projects demonstrate use of energy efficient equipment (in the case of greenfield projects) or at least 15% energy improvement relative to a baseline (brownfield projects)
- **Section 12K** provides for tax exemptions on proceeds gained from the disposal of certified emission reductions derived from activities registered with the Clean Development Mechanism. The tax window runs up to 31 December 2020, in line with termination of the second commitment period of the Kyoto Protocol;
- **Section 12L** provides for a tax incentive to support implementation of energy savings. Since its inception in 2013, major benefits have been realised in terms of energy savings of approximately 5.9 GWh, with associated avoidance of GHG emissions, through a spend of ZAR 3 billion by government. Major beneficiaries have been the mining and manufacturing subsectors. This incentive has been extended until the end of the first phase of the carbon tax (31 December 2022) in line with requests from stakeholders; and
- **Section 37B** allows companies to deduct the costs, incurred due to expenditures on environmental pollution control and monitoring equipment and/or disposal sites, from their taxable revenues.

Tax incentives and mitigation

- The National Treasury provides a range of tax incentives that contribute to mitigation activities in South Africa

4.4 Agriculture, Forestry and Land Use (AFOLU)

South Africa's land cover is dominated by open ecosystems in the form of shrublands (covering just under 40% of the total land area), savanna woodlands (33%) and grasslands (27%). Both indigenous forests and exotic forest plantations make up the remainder, with indigenous forests occupying less than 0.3% of South Africa's land area (GeoTerraImage, 2013) and forest plantations occupying 1% of the overall land area.

Changes in land use can result in the release of carbon stocks. The National Terrestrial Carbon Sinks Assessment (NTCSA) (2015) indicated that transformation of land through land uses including crop agriculture can reduce soil carbon by 40 to 60% from what existed in a natural grassland and savannah. Further, urban expansion and mining reduces above and below ground carbon, as does degradation, which increases soil erosion. In terms of total carbon sequestration, despite the small overall land coverage by forests, over 90% of CO_2 absorbed in 2015 was attributed to forest land, with the remainder being absorbed by grassland and savannah.

Mitigation actions identified in the AFOLU sector include Policies and Measures developed by line departments including the Department of Agriculture Forestry and Fisheries (DAFF)[9]. These include the draft Climate Change Adaptation and Mitigation Plan for the South African Agricultural and Forestry sectors, the Conservation Agriculture Policy (DAFF, 2017b) and the Agroforestry Strategic Framework for South Africa (DAFF, 2017c).

In terms of the draft Climate Change Adaptation and Mitigation Plan, for mitigation in the agricultural sector it is proposed that a strategic and integrated approach is taken that addresses sustainable agriculture more broadly and "to build synergies and avoid conflicts between climate change mitigation and other policy objectives, and to avoid offsetting mitigation efforts through intensification of production or land use change." In the forestry sector, there is a specific objective to reduce GHG emissions through afforesting 100,000 hectares of land in the Eastern Cape and KwaZulu-Natal as well as strengthening and expanding current initiatives including forest rehabilitation, working for woodlands and the Subtropical Thicket Ecosystem Project (STEP). The implementation of the national Reducing Emissions from Deforestation and Forest Degradation (REDD) will lead to conservation of forest carbon stocks, sustainable management of forests and enhancement of the forest carbon stocks. Protecting and preserving existing carbon stocks in other ecosystems (those with high organic soil carbon, wetlands and some grasslands) is also identified as a mitigation priority.

[9] Note that with a government restructure Forestry and Fisheries has now been combined with Environmental Affairs, while Agriculture has been combined with agriculture and the department of rural development and land reform. The implications of this restructuring on policy implementation has not yet been considered.

The DAFF Draft Conservation Agriculture Policy (DAFF, 2017b) provides a basis for national and sector policy support for increasing the uptake of conservation agriculture (CA), including no-till, conservation till, precision agriculture and meat production efficiency. GHG emission reduction occurs by reducing fuel consumption of farm vehicles, increasing yields and reduced fertiliser use. Current CA adoption by grain growers is between 20 and 30% at a national scale.

Both the establishment of plantations and agroforestry could lead to the sequestration of atmospheric carbon in soils and biomass. The DAFF Agroforestry Strategic Framework for South Africa (DAFF, 2017c) presents a broad overview of the potential for agroforestry in a South African context by providing a set of principles and strategic themes and goals. It recognises the carbon sequestration potential role of agroforestry.

Mitigation in the AFOLU sector

- The policy framework already provision for a selection of actions that will support emissions reductions and expansion of the carbon sink. These include promotion of land afforestation, conservation agriculture farming methods and agroforestry.
- Further interventions in this sector are currently being explored by government.

4.5 Waste

Waste management activities in South Africa are legislated through the National Environmental Management: Waste Act (NEM:WA) (DEA, 2009). To provide further policy direction in terms of establishing fully integrated waste management practices in the country, the National Waste Management Strategy (NWMS) was developed (DEA, 2012). The Strategy adopts the internationally accepted waste management hierarchy of waste avoidance and reduction, re-use, recycling, recovery, treatment and disposal. Implementing activities in accordance with the prioritisation afforded by the hierarchy potentially contributes to a reduction in emissions from material life cycles[10] as follows:

- Avoidance and reduction of waste avoids emissions with production and transport of the waste that would have been ultimately sent to landfill;

[10] Emissions savings achieved through actions in the waste sector will not all be reflected in that sector's inventory, however they may contribute indirectly to national emissions savings.

- Reducing the quantity of recyclable waste sent to landfill, through the implementation of separation at source programmes in metropolitan municipalities and through the establishment of material recovery facilities (MRFs) for separation after the waste has been collected, avoids emissions with primary material production in the case of inert materials and avoids generation of methane in landfill in the case of organics; and
- Recovery of value through waste-to-energy (WtE) facilities avoids generation of methane from organics sent to landfill, and at the same time the electricity generated offsets electricity generation from fossil fuels. It is noted that, although included in the 2012 Strategy, WtE is no longer considered to be a preferred technology option, but is rather recognised to be a last resort for managing wastes for which higher value cannot be recovered.

Subsequent to the Waste Act and National Waste Management Strategy, twenty national waste management initiatives, with annual targets, have been established by the DEA through a process known as the Waste Phakisa. Jointly, these initiatives aim to achieve landfill diversion of 20 million tonnes of waste per year (75% industrial and 50% municipal). Of the twenty initiatives, those that are likely to have direct and indirect impacts on the total national greenhouse gas emissions include (GreenCape, 2018):

- Achieving a minimum of 50% of households separating organics at source by 2023;
- Introduction of Material Recovery Facilities (MRFs) and pelletising plants to increase plastic recycling rates, and formalising packaging industry producer responsibility plans;
- Developing capacity through a specialised programme which upskills agri-stakeholders to minimise food loss, and running a consumer awareness campaign to use and consume “ugly” food, towards saving 245,000 tonnes of food waste to landfill per year;
- Establishing refuse derived fuel plants across South Africa, towards diverting 120,000 tonnes of waste from landfill; and
- Establishing a refrigerant reclamation and reusable cylinder industry to reduce emissions of refrigerant gases.

The importance of circular economy thinking in guiding the Waste Phakisa initiatives was noted. A circular economy framing has positive benefits in terms of reducing greenhouse gases.

Mitigation in the waste sector

- The actions contained in NEM:WA provide a framework for implementation of actions that have the potential to reduce emissions from both the waste and other sectors such as electricity supply, industry and transport. The outcomes of the Waste Phakisa provide quantitative targets for implementation of these actions, albeit over the short term. These will need to be ramped up over time.
- Capacity for implementation at the local government level remains a significant hurdle that needs to be overcome to allow for effective implementation of the Act and realisation of the associated emissions savings benefit.

4.6 Cross-Cutting Measures

In addition to the measures specific to individual sectors, four cross-cutting measures that will support low carbon development are in various stages of being implemented.

4.6.1 Carbon Tax

The Carbon Tax Act was brought into effect from 1 June 2019. The Act gives effect to the "polluter pays principle" and aims to price carbon by internalising the negative costs of emitting GHGs. The tax rate is set at R120 per tonne of CO_2-eq produced. To allow businesses time for transition, a basic tax-free allowance of 60% will initially apply to all emissions, with a number of further allowances depending on the activities. These provide for maximum tax-free allowances of between 60 and 95%. The allowances include those on fugitive emissions; for trade exposure; for performance above the industry benchmark; for purchasing offsets; and for voluntarily being allocated a (non-enforceable) carbon budget. The allowances bring the effective tax rate to between ZAR 6 and ZAR 48 per tonne.

Post-2020, the carbon tax and the carbon budgeting system (discussed in Section 4.6.3 below) will be aligned. This may include the option of imposing a higher tax rate as a penalty for emissions exceeding the carbon budget. This interface option will help to ensure a credible price signal to drive mitigation and provide the required regulatory policy certainty. At this stage some of the allowances are likely to be reduced, and the voluntary carbon budget allowance will be completely removed.

Emissions covered by the carbon tax are those that need to be reported in terms of the Department of Environmental Affairs' Mandatory Reporting Regulations, although the tax is administered by the South African Revenue Services in the same way as other environmental levies.

The role of the carbon tax

- Through passing of the Carbon Tax Act, the government is providing a strong signal of an intention to implement the "polluter pays principle".
- At present, with the prescribed allowances, the tax rate is low. However, the ratcheting of this policy intervention will be achieved through reducing the allowances and increasing the tax rate.
- A higher rate of tax on emissions exceeding the carbon budgets, as is being proposed once the carbon budgets are mandatory, will further drive mitigation action.

4.6.2 Sectoral Emissions Targets (SETs)

South Africa's national emissions trajectory will be translated into Sectoral Emission Targets or SETs, which are quantitative greenhouse gas emission targets allocated to an emitting sector or sub-sector, over a defined time period. The sectors or sub-sectors to which SETs are allocated are still being defined, but will be aligned with the IPCC (2006) emissions categories to facilitate alignment with other GHG reporting. Individual national government departments will be tasked with developing and implementing Policies and Measures (PAMs) to ensure emissions from within a sector or sub-sector remain within SET limits. The allocation of the SETs will be based on the socio-economic benefits of introducing the Sectoral Emissions Targets; the best available science, evidence and information; and the mitigation options available to the sector. SETs will be determined for three rolling five-year periods.

Sectoral Emissions Targets

- Constraining the cumulative SETs applied across the sectors and sub-sectors within the GHG emissions trajectory will ensure that, as the trajectory is revised towards meeting the requirements of the Paris Agreement, a consistent message will be sent to all government departments about the requirements for implementation of PAMs to drive down emissions.

4.6.3 Carbon Budgets

Carbon Budgets set a maximum volume of emissions from certain activities that individual entities are allowed to emit over three rolling five-year periods. By assigning a Carbon Budget to an entity, a signal is provided as to the degree of GHG mitigation that is required within a specific time period, with a penalty being imposed if the budget allocation is exceeded. Furthermore, by providing entities with an understanding of how the budgets are likely to be assigned in future phases to keep overall national emissions within the bounds of the national emissions trajectory, which will continue to be revised downward in keeping with the Paris Agreement, they are sensitised to how mitigation requirements may change in the future. The system thereby provides an opportunity for entities to plan ahead.

The first phase of the Carbon Budgets, which runs from 2016 to 2020, is currently being implemented, with the allocation of company-level Carbon Budgets for a small group of companies. This phase is voluntary as there is no legal basis to set emission limits for sectors or companies. The second and subsequent phases (i.e. the post-2020 period) will become mandatory when the Climate Change Bill is formally approved by government.

Carbon Budgets

- Carbon budgets provide a mechanism for driving mitigation action in the private sector.
- Penalties for not complying with the budgets (which will take the form of the carbon tax), will need to be sufficient to drive continued mitigation ambition.

4.6.4 Phasing out of inefficient fossil fuel subsidies/incentives

Fossil fuels are used across a number of the economic sectors in South Africa. As a member of the G20, where countries have committed to phasing out inefficient fossil fuel subsidies, South Africa has indicated willingness to identify and minimise their harmful impacts, taking cognisance of its developmental state. The subsidies undermine the competitiveness of renewable energy, divert financial resources from development of priority sectors and services such as education, health, and infrastructure; and encourage the extraction and overconsumption of fossil fuels (as they are under-priced). Inefficient fossil fuel subsidies act as a negative fuel tax or work as a negative price on carbon, and hence their phase-out entails removing market distortions which would result in greater efficiencies in the economy, including restructuring taxes to reflect their environmental impacts. An economy-wide carbon tax has been implemented from 1 June 2019 (as described above) and this provides a price signal to nudge the economy towards low carbon development. South Africa should consider participating in a fossil fuel subsidy peer review within the G20 framework to facilitate the sharing of experience

and mutual learning among G20 members as the next step in identifying inefficient fossil subsidies within the economy.

Phasing out of inefficient fossil fuel subsidies

- South Africa will continue to participate in global forums, monitor global developments and consider their relevance within the domestic context given our developmental state, and make informed decisions in tandem with international developments.
- Implementation of appropriate pricing of carbon through an economy-wide carbon tax should help eliminate under-pricing of fossil fuels in the economy.

5 GOING FURTHER TO ACHIEVE THE PARIS GOALS

Section 4 focused on a set of stand-alone, sector-based policies and measures as well as a selection of cross-cutting interventions that government is busy implementing. However, Section 1 highlighted that a broad range of structural changes will be necessary across economic sectors, in order to ensure the global economy achieves carbon neutrality within the second half of the century. Changes will be required in terms of service demand, technology fleet, infrastructure, operating practice, and energy sources, for all sectors of activity.

Ensuring South Africa plays its role in the achievement of the Paris Agreement is the overarching purpose of this strategy. Therefore, as the science of climate change evolves, and our understanding matures to permeate our public awareness and policy processes, we will adjust our strategy accordingly. This is a living document, and ongoing work will ensure adequate updates are brought forward at appropriate times.

As it continues to strengthen its response to climate change as part of a global effort, South Africa will increase its focus on a range of strategic elements that will together promote the change to low carbon growth, while continuing to align with the goals of the Paris Agreement. These are:

- Enhancing the vision for development
- Enhancing institutional capabilities and arrangements for the transition
- Creating the right financial environment through aligning fiscal strategy with sustainable growth
- Providing broad access to funds
- Driving innovation, research, and skills for future value capture
- Ensuring a just transition with jobs for all

- Promoting sustainable development through education and culture
- Enhancing information and metrics

Each of these is elaborated upon in the sections that follow.

5.1 Enhancing the vision for development

The SA-LEDS vision described in Section 3 is guided by the peak-plateau-decline trajectory as defined in the NCCRP and the NDC. The trajectory represents the contribution South Africa commits to the global response to climate change at this time, aligned with its vision of development.

As a signatory to the Paris Agreement, South Africa subscribes to the view that a progression in climate ambition will be necessary to achieve the global long-term goals, with all parties taking part in this progression in ambition with regards to mitigation, adaptation, and means of implementation, in accordance with the principles of the Convention. As climate science continues to further our understanding of the challenges and potential solutions to climate change, and economic reality broadens the range of options and global willingness to invest in them, South Africa will continue to both strengthen its commitments and communicate in a compelling manner how they represent our fair contribution to the global achievement of the Paris Agreement.

The IPCC Special Report on the impacts of global warming of 1.5°C has provided significant new understanding on the targets of the Paris Agreement, as briefly discussed in Section 1.2. It is clear that Parties must find a way to ensure that emissions over time decrease rapidly as part of a sustainable development pathway, consistent with the goal of carbon neutrality in the second half of this century. Changes in all productive sectors, and important enhancements of international cooperation, are required. All of these elements must be kept in mind as we enhance our long-term development vision.

Determining a trajectory to carbon neutrality will require a number of processes. Sectoral scenario analyses will be required to inform on the range of options. For these, traditional “incremental” modeling techniques will be insufficient, so a transformational approach will be required. Uncertainties in speed of response and investments required should not limit the scenario work, but rather become part of the output, to enable policymakers to appreciate what conditions will be required to enable different trajectories.

Creating a national picture out of sectoral pathways will be essential to ensure balance between the sectors can inform national deliberations. Stakeholders from all sectors will play a vital part, providing insights into opportunities, challenges, trade-offs and requirements which will inform the national debate and also enrich our

position with regards to the international community, be it as part of the UNFCCC negotiations or in discussions with donors and investors.

The analyses will seek to determine requirements for enablers from other participants in the global community, as appropriate. As South Africa play its part within a global effort, a range of technical pathways will be developed for low carbon development. The strategy development process will evaluate the opportunities within a new model of development, and the benefits of achieving net zero carbon emissions by 2050, alongside the challenges to the transition and the international enablers available.

National life, from local politics, business decisions, and mass media communications, will have to reflect these ideas, preparing citizens and decision-makers for a new perspective on economic development. The climate challenge will only be tackled under the paradigm of sustainable development.

5.2 Enhancing institutional capabilities and arrangements for the transition

Regardless of the details of the path followed towards a carbon-neutral world, in-depth sectorial transformation plans will need to be developed over the coming years, with significant public and private sector collaboration, to lay out the transformation pathways which will lead South Africa to achieve its goals. Such planning requires political will, coordination, a participatory process, and specific analytical resources and expertise.

Thus, a critical area in which institutional capabilities and arrangements should be enhanced is for the planning and policy-making processes themselves. These processes will have to develop targets across the whole economy, plan detailed actions over several timescales, and ensure the right changes can take place in the right way. The institutional capabilities required for these planning efforts and their implementation will require improved capabilities, as well as closer links to the research community, civil society, and the business community.

As the sectoral pathways are fully identified, the required sequence of steps for their implementation should be mapped onto the current institutional framework in order to establish where current coordination arrangements, as shown in Table 4, are suitable, and where it would make sense to consider adjustments. It is important to recall that these will be pathways of transformation, spanning 30 years and requiring multi-step processes which should be mapped out in somewhat detailed sequence. Topics such as ministerial attributions, levels of government, chains of command, and decision-making, as well as the scope for different institutions to access resources such as finance, skills, or regulatory authorization, should all be taken into consideration, as they can make a significant difference to the success of the transformation.

Table 4: Current institutional arrangements to address climate change response actions

Structure	Function
Parliament and Portfolio Committees	Oversee and monitor the implementation of the national climate change responses
	Make laws to support climate change responses in the country
Presidential Climate Change Coordinating Commission (PCCCC): (Yet to be established)	Coordinate and oversee the low carbon and just transition, including how to maximise the opportunities for jobs.
The Inter-Ministerial Committee on Climate Change (IMCCC): Executive level committee. The Minister of the Environment and Minister responsible for planning monitoring and Evaluation in the Presidency co-chair meetings	Coordinate and align climate change response efforts, including statutory and regulatory needs
Intergovernmental Committee on Climate Change (IGCCC): Consists of relevant national, provincial departments and local government	Operationalise cooperative governance on the climate change issues
Ministers and Members of Executive Councils (MINMEC) and the Ministerial Technical Advisory Body (MINTECH): Facilitate a high level of policy and strategy coherence among the three spheres of government – national, provincial and local government	Guide climate change work across the three spheres of government
National Committee on Climate Change (NCCC): Multi-stakeholder Committee	Consult with stakeholders from key sectors that impact on or are impacted by climate change – academia, business, NGOs, labour, government and civil society
	Advise on matters relating to national responsibilities
	Advise on the implementation of climate change-related activities

In addition to the institutional arrangements, training and capacity building that will be required to support the transition at the national government level, infrastructure and skills will need to be developed at the sub-national

level. Many of the sub-national government structures are currently dysfunctional and lack the capacity to support implementation of and manage funding for the actions required to support the low carbon transition.

5.3 Creating the right financial environment through aligning fiscal strategy with sustainable growth

The need for investment at scale and the change in purchasing choices of businesses and citizens over the coming years makes the fiscal regime of a country a determining factor in its ability to achieve the structural changes required by the joint objectives of achieving the Paris Agreement aims and eradicating poverty. The correct incentives will accelerate positive change, while misalignment can hold back action.

Several considerations should inform fiscal adjustments over time. Overall tax revenue must be decoupled from volumes of fossil fuel sales and exports in order to ensure that financial sustainability of the state does not become a brake to the changes which are needed. Negative externalities should be considered for a greater share of intake, supported by detailed analysis including market responses over time, which itself should inform the pathway planning approach.

Capital investment should be encouraged in technology and implementation choices to support Paris-compatible pathways. The incentives provided will have to be coherent with the long-term development pathway in order to ensure short-term mitigation actions do not lead to emissions lock-in, nor a boost for assets which may become stranded later.

Fossil fuels subsidies and incentives which have the effect of fostering inefficient management of resources such as water, food, fertilizers, or public goods should be reviewed to support the transition to cleaner development. While such a subsidy review may cause resistance in some sectors, it provides an opportunity to ensure the use of state funds is progressive in terms of its distribution and enhances growth through the development of new businesses and investments which align fully with national objectives. Support for renewable energy options must be considered to accelerate their market acceptance, without building excessive distortions which may limit future competitiveness or stagnate the transformation.

Significant work will be required to create an environment which is nurturing and inviting to new business models. From shared ownership to provision of service/experience rather than goods/commodities, different ways of satisfying demand – supported by ever more powerful and accessible digital platforms and networks – will generate tremendous growth opportunities within a population increasing its per-capita income as poverty is reduced. A forward-looking fiscal strategy, aware of the options and flexible to the evolution of new markets, will

enhance such opportunities for South Africa, which will in turn bring export opportunities to Africa and the rest of the world.

Additional opportunities for investment and growth will follow if the fiscal regime is inviting to new business which seek to on-shore significant portions of the value chain of the industries which will lead the sustainable transition; rather than zero-sum tariffs or restrictions, long-term policies which encourage investment, innovation, skills development, and early leadership of local markets which are likely to evolve later in neighboring countries, will all contribute to national wealth creation.

Carbon prices must evolve over time to effectively discourage fossil fuel and other emissions, while providing clear market signals to investors in zero emission technologies that their investments will provide suitable returns over their useful lifetimes. Visibility over future carbon prices, such as legislating for a ramp-up over several years, provides clarity that carbon-intense investments will become uncompetitive and thus stranded, thereby informing decisions which may lock the country into future emissions.

In summary, fiscal strategy over time must reconsider the balance of taxation, planning for falling sales of fossil fuels and seeking to reduce negative externalities, while incentives will focus on both the emissions implications of investments, favoring the route to net zero, and stimulating investments which take advantage of the opportunities created by this transition, both in the short term (such as business creation) and in the medium to long term, (such as by favoring skills development, innovation, and research).

The fiscal strategy must therefore form its own pathway to 2050, balancing the needs of the transformation, economic and social development, with the viability of private sector companies and the state.

5.4 Providing broad access to funds

Access to funds in sufficient volume to meet the investment needs across a broad range of activities will be crucial to the success of our efforts to tackle climate change. Significant work is already underway to illustrate this need and help facilitate such access.

South Africa's National Climate Change Response Policy emphasises the importance of mobilising a wide range of financial and non-financial resources for both mitigation and adaptation. The Policy emphasises the need to draw on all available sources of domestic and international financing (DEA, 2011). South Africa's National Determined Contribution goes further, and frames the ability to "catalyse, at an economy-wide scale, financing of and investment in the transition to a low carbon and climate resilient economy and society" as a key challenge for South Africa (DEA, 2015). Both these documents highlight the importance of international support given South

Africa's status as a developing country, and the magnitude of the challenge. Adaptation costs are difficult to quantify, but it could cost South Africa more than US$ 30 billion per annum to adapt to climate change for the period 2021-2030, and the incremental cost of mitigation action is estimated at more than US$ 1,350 billion in total over the period 2020-2050, or roughly US$ 44 billion per year (DEA, 2015; DEA, 2019b). Furthermore, Diffenbaugh and Burke (2019) find that the 1°C increase in global temperatures over the last century has already reduced the size of the South African economy by between 10 and 20%.[11]

Internationally, it is estimated that an additional US$ 13.5 trillion (in 2014 dollars) is required to remain below two degrees of climate change from 2015 to 2030 (Meltzer, 2016; Bhattacharya et al, 2016). This additional investment is, however, coupled with a reduction in investment in fossil fuel energy generation, transmission and distribution of US$ 5.7 trillion and US$ 3.7 trillion in upstream oil, coal and gas investments. A further US$ 5.1 trillion could also be saved in operating expenditure because of the reliance on low carbon technologies like renewables. Meltzer (2016) points out that the challenge is thus how to deal with the high upfront cost of these investments, since they are likely to more than pay for themselves over time.

5.4.1 Climate finance flows to date

Oliver et al (2018) find that US$ 472 billion of climate finance was deployed in 2015, US$ 455 billion in 2016 and between US$ 510 billion and US$ 530 billion in 2017. Of the US$ 463 billion average annual flow over 2015 and 2016, an average of US$ 45 billion flowed from developed to developing countries, and only US$ 12 billion per annum (including domestic resources) was deployed in Sub-Saharan Africa. Of the US$ 463 billion average annual value, more than 80% originated from domestic sources (US$ 162 billion from within OECD countries and US$ 214 billion from within non-OECD countries). These numbers, however, cover all climate finance deployed, and are not comparable to the pledge by developed countries, first made at COP15 in Copenhagen, to provide US$ 100 billion of climate finance to developing countries by 2020. Timperley (2018) mentions that there is disagreement about how close this pledge is to being met. According to the UNFCCC (2018), US$ 74.5 billion of climate finance flowed to developing countries in 2016. International public climate finance flows to developing countries, however, averaged US$ 58 billion for 2015 and 2016. Oxfam (2018) believes public climate finance flows from developed to developing countries are much lower at between US$ 16 billion to US$ 21 billion. The OECD (2019) estimated the value to be US$ 46.9 billion in 2016 and US$ 54.5 billion in 2017. Using project-level

[11] According to the World Bank Development Indicators the size of the South African Economy was US$ 366 billion in 2018.

data which doesn't cover all climate finance flows, Timperley (2018), calculates a lower value for OECD climate finance to developing countries of US$ 37 billion in 2016.

For 2015 to 2017, approximately US$ 160.7 million of bilateral and US$ 45.4 million of multilateral climate finance flowed to South Africa. Over the same period, however, the South African government deployed almost US$ 690 million of climate finance (DEA, 2019c).[12] The distribution of local public sector climate finance is shown in Figure 8. Even though South African climate finance deployment was small by international standards, it is nowhere near the levels that will be required from 2020 as discussed in the previous section. The percentage of climate finance generated from domestic versus international sources is in line with international trends over this period.

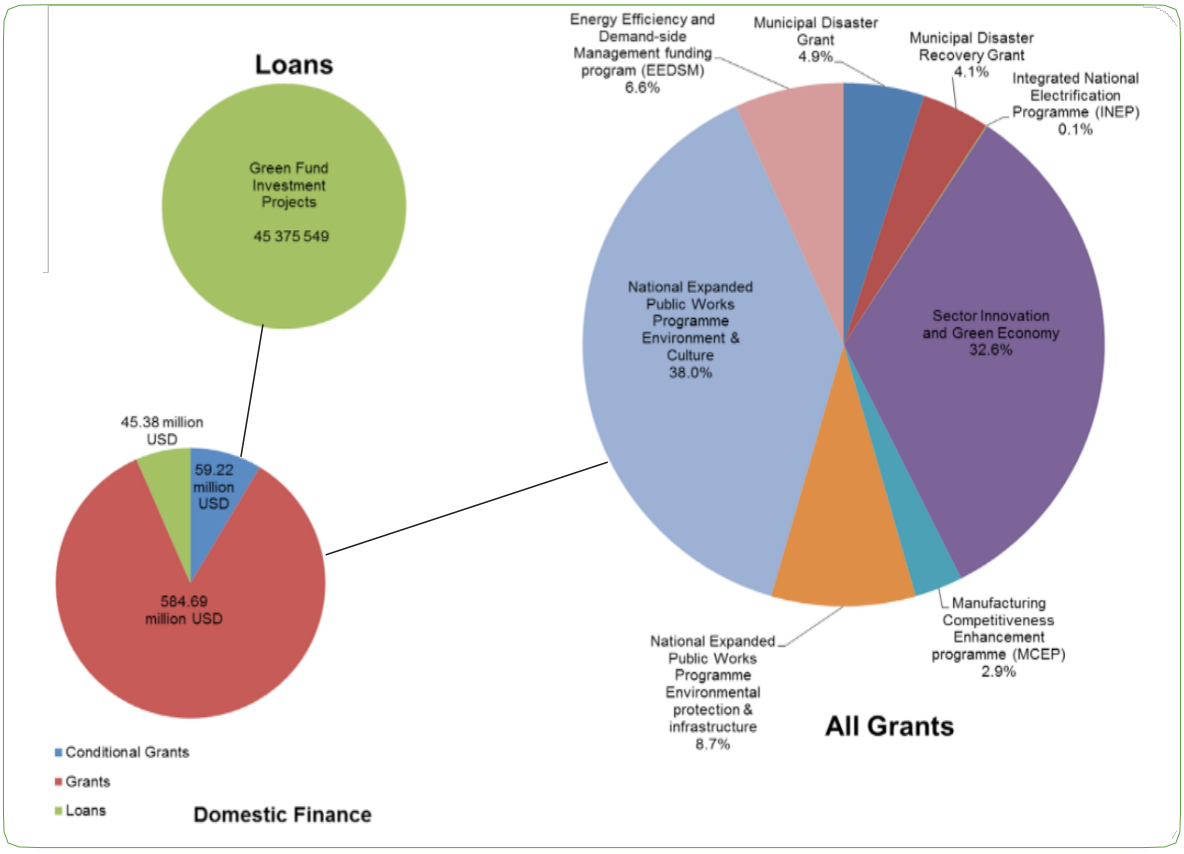


Figure 8: Domestic climate finance (2015 - 2017)

Source: DEA (2019c)

[12]South Africa's 3rd Biennial Update Report (BUR-3) mentions that lags in reporting may lead to an underestimate of 2017 values. Climate finance information for the periods 2000-2010 and 2010-2014 can be found in BUR-1 and BUR-2.

Even without considering the contribution of domestic private sector financing for climate change-related activities, which is likely to be significant given recent investments in renewable energy and energy efficiency in South Africa, it is clear that international support contributes a relatively small proportion of climate finance being utilised in South Africa. The contribution of domestic climate finance is also likely to increase further given the broad-based carbon tax that was put in place during 2019.

International support is also highly concentrated in the form of one bilateral and one multilateral development partner for the period under consideration. Germany contributed 55% of bilateral and 43% of total international climate finance to South Africa, while the Global Environment Facility accounted for 93% of multilateral and 20% of total international climate finance. The bulk of international climate finance was in the form of grants, with only US$ 950,000 (0.5%) originating from multilateral loans (DEA, 2019c).

5.4.2 Formalising climate finance structures

While South Africa has made great strides in understanding its mitigation and adaptation challenge, and particularly in understanding the availability and attractiveness of mitigation policies and measures and the ways these will have to be combined to meet its international climate commitments, it has not been successful in accessing climate finance on a transformational scale. The climate finance that has been accessed is concentrated in two entities, and this creates risks in terms of the long-term certainty of flows and climate governance and independence.

To address this shortcoming, South Africa is developing a comprehensive climate finance strategy. The strategy will take a holistic view of climate finance activities and will cover all aspects of climate finance, including: the quantum of climate finance required; identifying stakeholders and activities along the climate finance value-chain; increasing climate finance flows from different types of finance providers (e.g. bilateral finance, multilateral finance, domestic public finance and private sector finance), monitoring and evaluation, and climate finance governance structures. The strategy will ensure that climate finance frameworks are compatible with local conditions and ambition. Furthermore, in order to best contribute to the strategy development process, it should seek to identify financing pathways commensurate with technology transformation pathways and economic development pathways required by the transformation to a low-emissions economy (see remarks on planning for implementation contained in Section 6).

South Africa has a framework for tracking climate finance in place, which is being operationalised as part of the national integrated climate change monitoring and evaluation (M&E) system. The climate change M&E system,

however, is still under development and monitoring and reporting activities will only be automated during the final phase of implementation (2021-2025) (DEA, 2017; DEA, 2019c). At present climate finance is therefore being tracked on an ad hoc basis via informal engagements between the Department of Environmental Affairs and the National Treasury. The national climate finance strategy will formalise local climate finance governance, coordination and reporting structures. M&E will be a key focus area of the strategy, and it will seek to strengthen the current climate finance M&E framework by extending monitoring and reporting to include all elements of the climate finance value chain, including private sector finance. Furthermore, the strategy will consider the development of mechanisms for evaluating the outcomes of climate finance to understand the extent to which it is accelerating South Africa's climate change mitigation and adaptation responses. In addition to supporting climate change planning by the government, it will reassure the providers of finance that it is being effectively deployed. It will also serve to illustrate the positive impact that climate finance can have in South Africa.

5.4.3 Climate finance opportunities

South Africa's climate finance strategy will seek to quantify the financing requirements and identify areas where climate finance should be targeted. This will complement significant research that has been undertaken to identify sectors and activities that should be prioritised in terms of mitigation and adaptation actions. Research already undertaken includes the Technology Needs Assessment (which is currently being updated) (DST, 2007), the Long Term Adaptation Scenarios (LTAS), Long Term Mitigation Scenarios (LTMS), the latest GHG Inventory, the Mitigation Potential Analysis (MPA), Climate Change Mitigation Technology Implementation Plan (DEA and DST, 2015), Global Change Research Plan and national government departmental plans (DEA, 2018b; DEA 2019c). Explicitly linking climate finance requirements with mitigation and adaptation needs could also create the opportunity to use climate finance to support technology development and transfer. Both the Green Climate Fund and the Global Environment Facility, for example, provide support for the development of Technology Needs Assessments and/or consider the results of these assessments in their lending programmes (Resende, 2019; Kaung-Idba, 2019).

The climate finance strategy will also seek to understand why South Africa has not been successful in attracting more climate finance, and will attempt to significantly increase the amount of climate finance flowing to South Africa. As part of this process, a 5-year high-level climate finance implementation plan will be developed that will include a pipeline of financeable projects.

One area where South Africa has demonstrated that it has the capacity to effectively absorb large amounts of climate finance, and where a scaling up of climate finance could have a positive mitigation impact relevant on a global scale, is the electricity supply sector (as outlined in Section 4.1.2). South Africa's electricity supply industry is set for significant change in coming years as a result of an electricity supply crisis and reform of the current poorly performing vertically integrated utility model. South Africa has one of the most carbon-intensive electricity grids in the world, and recent research has shown that aggressive decarbonisation can have significant economic, social and environment benefits (Wright, et al., 2017; Steyn, Burton, & Steenkamp, 2017; Bischof-Niemz & Creamer, 2019). Significant decarbonisation of the electricity grid in the short term, however, is likely to incur significant transition costs, and may not happen without significant international support. The current situation, however, provides and unprecedented opportunity to avoid long-term carbon lock-in and significantly accelerate a just transition to a low carbon and inclusive economy.

South Africa has a number of features that make it attractive as a destination for climate finance. The country has a well-developed financial system and a history of developing and rolling out innovative instruments for raising and deploying donor, public and private sector climate finance. The well-regarded Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), for example, managed to raise US$ 15.83 billion of finance for utility-scale renewable energy projects, 80% of which originated from domestic sources (IPPP Office, 2019).[13] By the end of March 2019, the REIPPPP had procured 6,422 MW of capacity (3,976 MW of which had been connected to the national grid). 35,669 GWh of renewable electricity had been generated, saving 36.2 Mt of CO_2 and 42.8 million kilolitres of water. 53,339 full-time equivalent (FTE)[14] jobs were also created, 48,085 of which went to locals (DoE, 2019a). The economics of energy generation has changed in South Africa, and a growing body of evidence shows that renewable energy is now the cheapest form of electricity generation locally. Given the very carbon-intensive nature of South Africa's national grid, and local energy investment needs going forward, this creates an unprecedented opportunity for South Africa to absorb climate finance.

South African banks have also started developing financing tools aimed at the smaller-scale renewables market (GreenCape, 2019). Tools for aggregating and effectively deploying public sector climate finance also exist in the form of, for example, the Green Fund managed by the Department of Environmental Affairs (DEA) and the

[13] Calculated at the annual average South Africa Rand-US dollar exchange rate for 2018 from the South African Reserve Bank.
[14] "FTE" means Full Time Employment Created. It refers to one person-year of employment. In the calculation of this number one person year is equivalent to 230 person days of work.

Development Bank of Southern Africa (DBSA), and the Energy Efficiency and Demand-side Management Fund managed by the Department of Energy.

The REIPPPP is also an example of using green public procurement to raise climate finance. This is an approach that is also being considered in other countries (see, for example, the UK Government's Green Finance Strategy (HM Government, 2019)) and could be expanded in South Africa.

Two municipal green bonds have been released in South Africa, by the City of Cape Town and the City of Johannesburg, and the Johannesburg Stock Exchange currently has three green bonds listed by financial institutions with a total value of US$ 385 million (PWC, 2019; Khumalo, 2019)

South Africa has well capacitated development finance institutions, like the DBSA and the Industrial Development Corporation (IDC) that routinely channel climate finance from multilateral and bilateral donors, and private sector banks have also partnered with international donors to roll out innovative climate finance vehicles. An example of this is the US$ 98 million FIRST fund that offers long term debt finance to local small renewable energy projects (FIRST fund, undated). The fund is a collaboration between a local bank and the German KfW Development Bank (KfW), and is underpinned by a first-loss debt facility and grant-type funding from KfW (Hawarden, undated).

Despite the sophistication and depth of South African financial markets, a number of barriers remain that restrict the flow of funding to climate change projects. These are not unique to South Africa and include, amongst others, a relatively high degree of risk aversion among local financial institutions, difficulty in accessing longer-term financing, credibility of off-takers, high transaction costs for smaller projects, relatively long pay-back periods and a lack of attractive large low carbon investment options, difficulty in raising financing for technologies that have not been proven locally, a lack of concessionary wholesale finance, uncertainty about future electricity prices, complexity and regulatory burden of environmental regulation, a lack of public sector capacity in key areas, and an investment environment that is not conducive to investment due to policy uncertainty (Nicholls et al, 2015; Cloete et al, 2016; Cloete et al, 2018). These barriers, coupled with the scale of funding that is required to address mitigation and adaptation, means that there is a significant need for scaled-up international support to finance the transition to a climate-resilient inclusive low-carbon economy in South Africa.

Positioning South Africa as an attractive destination for climate finance offers opportunities beyond enabling a transition to a just, sustainable and prosperous low carbon economy as discussed below. It also creates the opportunity to leverage its sophisticated and deep financial markets to serve as a gateway for climate finance to the rest of the continent, which, as mentioned earlier, is struggling to access its fair share of climate finance. Following the example of a country like the UK (see HM Government (2019)), South Africa should use its climate

finance strategy to support the local financial sector to develop a competitive advantage in accessing and channelling climate finance. To do this, however, the emphasis should be placed on greening the financial sector as a whole, and not just developing a climate finance niche.

The reasons for this are multiple. Not only is the scale of the challenge such that countries cannot afford to misallocate capital, particularly while domestic sources still make up the bulk of climate finance, but carbon lock-in and a reluctance to allow stranded assets could jeopardise mitigation targets. Finance is a critical driver of the low carbon transition, and without targeting finance effectively, climate goals will not be achieved. Equally important, it is now well understood that neglecting to asses and price the risks inherent in climate change creates systemic risk within financial systems (see, for example, TCFD (2017), Vermeulen et al (2018), Poloz et al (2019), Giuzio et al (2019)). The Task Force on Climate-related Financial Disclosure has created a common language for considering both physical and transition risk related to climate change. It is important that the recommendations of the Task Force be mainstreamed into the South African financial sector to ensure that these risks are understood and managed, to provide the information required to effectively deploy finance in a climate compatible way (TCFD, 2017). Furthermore, as illustrated by the UK's Green Finance Strategy, it is also important that all local financial regulators recognise climate-related financial factors as part of their mandate and actively monitor climate-related risk and exposure within the South African financial sector.

During the transition it is critical that the financial sector enables the redirection of funds from the high-carbon activities that are no longer consistent with a just, sustainable and prosperous low carbon economy to the new industries and activities that will underpin it.

5.5 Driving innovation, research, and skills for future value capture

Boosting innovation, research and skills is a crucial lever to increase South Africa's international competitiveness, and to ensure that higher-value economic activity spearheads future growth by becoming an ever-greater proportion of GDP over time. The transitions required to support low-carbon development present clear opportunities for the innovation, research, and skills agenda, particularly given that global compliance with Paris implies a large, ongoing investment over decades.

South Africa's existing research and industrial capabilities, as well as its natural resources, present a compelling starting point for such an expansion. The national research agenda is largely guided by the priorities set by national government and in particular the Department of Science and Innovation (DSI), as the national department responsible for provision of leadership, an enabling environment and resources for science, technology and

innovation. With 17% of funding for the South African climate change research and technology development system coming from international sources, international research agendas also have some impact on the local agenda. The White Paper on Science, Technology and Innovation (STI) (DST, 2019) also emphasises the core themes of inclusivity, transformation, and partnerships, and recognises the important role that STI would play in mitigating and adapting to climate change impacts. The paper recognises the role of a circular economy in driving the shift to a green economy by accelerating eco-innovation.

A range of existing research activities are already setting the basis for the low carbon transition. These include:

- The Hydrogen South Africa (HySA) Research Programme, that aims to make South Africa a global player in fuel cell technology, through prototyping, demonstration and commercialisation of fuel cell technologies;
- The Renewable Energy Hub and Spokes initiative aims to develop national technical capacity in wind, solar photovoltaic and solar thermal power. Research capacity is built at various universities throughout the country. Research focusses on specific individual components, as well as system design and production.
- The Lithium Ion Battery Programme that was established to initiate the development of advanced energy storage technologies which play an essential role regarding the integration of solar and wind power.
- The South African Centre for Capture and Storage (SACCS) was established to drive the activities required to realise commercial scale Carbon Capture and Storage in South Africa, towards sequestering a portion of the emissions from coal-fired power plants, iron and steel, cement and coal gasification.
- The Waste Research, Development and Innovation Roadmap implemented by the CSIR was developed to assist DEA in realising the ambitions of the NWMS through research, science, technology and innovation. If a recycling and circular economy is realised this will drastically reduce the volumes of waste to landfill and mitigate GHG emissions.

Over time, the scale of the planning related to the low-carbon transition will increase, and further research and innovation challenges will arise. Preliminary sectoral analyses have already suggested such specific research and innovation challenge areas that will need to be addressed. Examples of future research direction include:

- As mentioned in Section 4.1.2, the IRP proposes a set of research and analysis activities to be undertaken to support the low carbon transition of the electricity supply sector. These include detailed studies on the impact of gas supply options, the appropriate level of penetration of RE in the South African national grid,

the cost and economic benefits associated with other clean energy options as well as socio-economic impacts of communities affected by the decommissioning of coal fired power stations.

- Developing robust data on the long-term implications of implementing mitigation policies and measures across the sectors, where such information does not exist. Notable here are the transport, waste and AFOLU sectors.

A rigorous analysis of South Africa´s competitiveness in the different commercial and industrial sectors which are likely to present the greatest opportunities from the sustainable transformation should inform the specific support provided to this agenda. This analysis should look across a spectrum of economic benefits, from value-chain analysis of likely technology rollouts, to regional and global competitive advantages under different scenarios.

Key to the innovation, skills and value capture strategy is the idea of a 30-year transition. The planning approach presented in Section 6 allows for a staged approach to building up the necessary policy environment, drive investment, and train a diverse workforce while supporting entrepreneurial activity. Coupling this planning with sectoral scenario analyses will help identify concrete areas of opportunity, for which additional work will be required to fully flesh out plans.

5.6 Ensuring a just transition with jobs for all

South Africa's transition to a low-carbon society and economy will have uneven socio-economic impacts. The transition will bring about efficiencies, investment and growth, opening up many opportunities in new areas of activity. However, activity will also reduce in areas linked with GHG emissions, leading to declining operations, diminished returns for companies, and fewer jobs in specific sectors. Impacts will differ across scales, timeframes, and locations. The South African government is committed to ensuring that the transition is just; that its negative impacts are not disproportionally borne by the most vulnerable poor and working-class communities who are simultaneously bearing the brunt of the physical impacts of climate change.

To ensure that government's commitment to a just transition is realised will require a clear vision around which the various initiatives, policies, sectors, geographical areas and communities can organize. The vision being developed by the National Planning Commission (NPC), through a consultative, bottom-up process, will help to define such an end-state, together with pathways to achieve this in the key areas of land, water and energy.

Appropriate and sufficiently resourced plans and policies will be necessary. International examples exist of initiatives to support workers and communities who currently depend on fossil fuel and other industries, on which the South African government can draw. These include initiatives in training, re-tooling, relocation, early

retirement, and other forms of support. A number of such initiatives are in the planning or pilot phase, led by various stakeholders. A broader macro-economic view is also important. Two key policy instruments are being developed to manage the just transition to a low carbon economy: the National Employment Vulnerability Assessment (NEVA), and Sector Jobs Resilience Plans (SJRPs). The NEVA will assess the employment characteristics of key economic sectors in the context of the low carbon transition. The SJRPs will be tailored to address the job losses in each sector, together with future opportunities.

All policy measures targeting the low carbon transition should be aligned with the fulfilment of the country's developmental objectives, which include alleviating poverty and reducing inequality, creating sustainable jobs and increasing the provision of basic services to all South Africans. In addition, specific policies and interventions will be required to support vulnerable communities in particular locations and scales, at particular times.

5.7 Promoting sustainable development through education and culture

Education can be a key factor in promoting sustainable development, by helping people develop knowledge, skills, values and behaviors which enhance their understanding and appreciation of how sustainability means a better life for them and their communities. Specific actions range vary the education curriculum, and must also include cultural and citizen awareness campaigns. Significant work is already underway globally to promote education surrounding climate change and sustainable development, and best practices are available, such as through the "Education for Sustainable Development" program of UNESCO.[15] The concepts of economic transformation, pathways, and just transition must also be included into the educational and cultural work.

South Africa should see the opportunity to obtain support for education for sustainable development as a core element of its overall strategy to improve education, and so should urgently set about developing a comprehensive, integrated approach to realising this opportunity.

5.8 Enhancing information and metrics

Ensuring availability of data is central to tracking the low carbon transition, and monitoring that this transition is being achieved in a way that is just to all. South Africa has already implemented mandatory reporting regulations to support reporting by emitters falling within certain emissions categories. Furthermore, the Department of Environmental Affairs is in the process of establishing the national M&E system, which will be used to monitor

[15] See http://www.unesco.org/new/en/harare/about-this-office/single-view/news/southern_africa_celebrates_awarding_of_unesco_japan_esd_priz/

implementation of mitigation actions by stakeholders across the economy and ultimately to the implementation of this and subsequent versions of SA-LEDS.

Future work needs to ensure that data is collected in a coherent, consistent and transparent manner, and that the "right" data to support decision making and planning is collected – including towards informing future updates of this strategy.

6 CONCLUDING REMARKS: PLANNING FOR IMPLEMENTATION

This strategy sets out a direction of travel for South Africa as we refine our low carbon emission development pathway to meet our commitments to the international community and address our developmental agenda/priorities and needs. We know that success will require decades of dedicated effort. Therefore, we present this Strategy as a living document, the beginning of our journey towards ultimately reaching a net zero carbon economy by 2050.

The first step will thus be to ensure national targets are aligned with the Paris Agreement, as stated in Section 5.1. Thereafter, planning teams with analytical and sectoral expertise will engage in detailed scenario work to develop transformation pathways towards achieving the national targets (see discussion in Section 6.1 below). Building a scenario is, however, not enough to plan for its delivery. The work of translating such a plan to policy is a challenge which all Parties will have to grapple with over the coming months and years. South Africa aims to inform rollout plans through the use of a dedicated change framework (Section 6.2).

SA-LEDS will thus be reviewed at least every five years or at an earlier date, should there be significant changes in sectoral or national plans/programmes that can result in a big structural changes, growth or decay of the economy and major global events that impact on its content or implementation.

6.1 Detailed sectoral work to explore transformation pathways

The Paris Agreement sets out the long-term climate change goals for the international community. While countries establish their own goals in a nationally determined manner, sectoral details will have to be analyzed in significant detail, laying out different scenarios to understand trajectories of investment, technology take-up, emissions reduction, and market change. This work has already commenced in South Africa through a number of studies:

- The Greenhouse Gas Emission Mitigation Potential Analysis (MPA), the overall objective of which was to conduct an updated, bottom-up assessment of mitigation potential in key economic sectors in order to

identify a set of viable options for reducing GHGs. Marginal abatement cost curves (MACCs) for key sectors and subsectors were constructed. The MACCs provide estimates of mitigation potential and marginal abatement costs for broad mitigation measures. Estimates of national mitigation potential have been derived from the sectoral MACCs and ranked in terms of level of implementability at national level for each of the technologies.

- The Pathways study to explore the impact of alternative economic growth trajectories on the country's emissions trajectory, looking at the implementation of structural changes rather than the implementation of purely technical interventions. This study, which also used the single national emissions model, had not been released at the time of writing of this document.
- The Policies and Measures (PAMs) analysis, which explored the impact of existing PAMs, many of which were included in Section 4 of this document, on the emissions trajectory.

It is recognized that detailed forecasting is unlikely to accurately predict the evolution of markets. However, "failing to plan is planning to fail", which is why systematic planning is recommended for all sectors. Common characteristics between scenarios that succeed and those that do not will help policymakers identify those conditions which must be met in order for the transition to succeed, aligned with Paris in a manner consistent with the latest science from the IPCC.

Based on the sectoral pathways work, which will identify the requirements of the different sectors, a cross-cutting analysis of such pathways will help identify common needs. An aggregate understanding of the evolution over time of such critical factors such as levels of capital investment, consumer prices of different energy options, and requirements for skilled workers in various industries (increasing and decreasing), will set out the parameters for the cross-cutting approaches detailed in Section 6.2.

6.2 Creation of policy package roadmaps across three phases

The likelihood of policy action leading to long-term transformation results would require the application of new planning techniques.

Pathway planning has emerged as an analytical tool that can inform national policy development over time towards objectives that sit beyond a typical policy horizon. Pathways aim to visualize the whole timespan between the present and the time for which a target is set, seeking to establish what steps make sense now in the context of reaching the long-term goal. When establishing potential pathways, the desired end-state should be linked to the present, but by "backcasting" rather than forecasting. This means that requirements for intermediate steps

between today and the long-term goal are deduced not on the basis of how compatible they may be with the current context, but rather in terms of what is required for the end-state to be achieved. This leads policy-makers to consider the question "what would have to be true" regarding short and medium-term checkpoints, deriving the answer from the evolution to the goal. Since many actions have long lead times to achieve full effect, backcasting can help identify by when core changes must take place.

Once pathways are clearly drawn out, regulatory, institutional, or other structural changes which are required for the transformation can be identified, from which necessary changes can be deduced and used to suggest concrete policy action. In this manner, a rigorous pathway analysis towards a long-term target can produce a number of concrete actions which must be carried out by a certain time, to enable other actions. It can be helpful to structure the time interval into three parts: short, medium and long-term, organising and communicating such actions on a three-stage timeline. These stages are:

- Starting Right (to be completed prior to end of 2021 financial year)
- Turning the Corner (to begin in parallel with the Starting Right stage and continue to 2025)
- Massive Rollout (2025 to 2050)

The "Starting Right" stage will focus on actions relating to the current government administration, or perhaps also address the initial years of the following one. The most important aspect of the "Starting Right" stage is to ensure that a true transition is kicked off. On the one hand, rapid implementation must begin in all areas where pathways to achieving the Paris Goals are already clear (such as investments in renewable energy power generation, solar water heaters, etc) while on the other, steps taken will need to enable future action at scale, as much as (or perhaps more than) drive immediate emissions reductions. Clearly, the "Starting Right" stage cannot be successfully executed without a long-term pathways analysis to provide confidence on the Paris-compatibility of implemented measures as well as the overall direction of travel. Indeed, the search for immediate emissions reductions in the short-term can often lead to investments in technologies or business models which, while emitting less than traditional options, are not on track to drive the large reductions demanded by the long-term transformation. Because of this, avoiding decisions which will lead to emissions lock-in is a core priority of the "Starting Right" stage.

The second stage, "Turning the Corner" would typically take five to seven years. This phase will begin to be implemented in parallel with the "Starting Right" stage, where appropriate, and continue to 2025. This period is decisive, since within it new decision and investment criteria are broadly applied, bringing about changes to the day-to-day operation of many sectors of the economy at the same time. Resistance to change can become

challenging if not well handled, and must be anticipated and addressed with social acceptance and just transition actions. It is at this stage that multiple policies will need to work in concert for the new technological options to make economic sense for businesses and consumers. An overall understanding of the sectoral narratives of change and how they collectively feed into the national vision will be core to the success of this stage.

"Massive rollout" is the final phase, in which the low-emissions climate resilient options have become the new normal. The constant application of transformative action will drive large volumes of investment towards transformational change. Perseverance on the application of all aspects of change will be required to avoid imbalances or injustices which will compromise the change, and sectors which achieve important milestones must not be allowed to become complacent, but rather contribute to the broader change by supporting areas of natural synergy.

Examples of activities that might be taken during the three phases of implementation of the transition are shown in Table 5. All along the way provision needs to be made for regular review of the Strategy and the implementation plan, and M&E of implementation.

Table 5: The three phases of the just transition

Starting Right (start immediately and complete by end of 2020/21 financial year)	• Start the process of developing long term plans for each sector, to avoid lock-in to emissions intensive infrastructure and establish the basis for transformation at scale • Develop approaches for allocation of Sectoral Emissions Targets (SETs) and carbon budgets to high emitting entities • Develop Sector Jobs Resilience Plans (SJRPs) to support the transition to the low carbon economy and climate resilient society in a Just manner • Identify the institutional, legislative, finance and other changes required to achieve the transformation • Develop an understanding of the relevant government decisions which need to be taken to achieve the long-term plans • Develop a monitoring plan
Turning the corner (start immediately, as appropriate, and complete by 2025)	• Develop and begin to implement detailed transformation plans for each sector, which is supported by the implementation of the SETs, carbon budgets and SJRPs • Develop investment pathways to support the transformation • Implement foundational changes to drive down the national trajectory • Implement the institutional changes to accelerate the rate of transformation and remove barriers
Massive roll-out (to 2050)	• Roll-out the implementation plans for each sector along with measures to support changes until they become the new reality • Refine strategies as required, to account for changes in technologies, society and markets

Successful rollout of the pathway across the three stages will thus require policy action to be taken in a coordinated manner. It is helpful to present policies not as stand-alone actions but rather as parts of *policy packages*, that is to say, combinations of measures which may include planning, regulatory, financial, and other instruments to collectively drive towards the desired outcome, providing capabilities and overcoming barriers to change. Complementarity and sequencing are both crucial to building effective policy packages.

Proposed components of policy packages could include those that focus on:

- Planning;
- Institutional / regulatory;
- Project implementation;
- Financing;
- Acceptance, skills and just transition; and
- Avoiding lock-in.

Policy packages should be built up in sequence over time to ensure the full implementation of the pathway, in the form of a *policy pathway* which is required to implement the low-carbon transition.

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