Zimbabwe Long-term Low Greenhouse Gas Emission Development Strategy (2020-2050)

Government of Zimbabwe

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Preface

His Excellency, Cde E.D. Mnangagwa

Climate change has been widely recognized as a major global issue as it threatens to alter the natural environment, disrupt the well-being of society, and deter economic development, making climate change mitigation imperative to reduce any further deterioration in the climate system.

Zimbabwe joins other Nations that have agreed on the need to cut greenhouse gas (GHG) emissions over the coming decades and adapt to the impacts of climate change, as guided by the United Nations Framework Convention on Climate Change (UNFCCC) and its Paris Agreement. My Government regards Low Emission Development Strategies (LEDS) as indispensable to sustainable development and has thus developed forward-looking national development plans or strategies that encompass low-emission and climate-resilient economic growth.

Zimbabwe's Low Emissions Development Strategy (2020-50) presents emissions reduction options across the four Intergovernmental Panel on Climate Change (IPCC) reporting sectors namely the Energy Sector, Industrial Processes and Product Use (IPPU), Waste Sector and the broad Agriculture, Forestry and other Land Uses (AFOLU), covering the whole economy.

Zimbabwe's commitment to sustainable environmental management including climate change mitigation is undoubtable. Currently 26% of its total land area is gazetted and protected area under forestry, national parks, and wetlands. The protected areas are contributing to atmospheric carbon sequestration through the abundant vegetation.

Zimbabwe adopts its Low Emissions Development Strategy at a time implementation of its National Development Strategy 1: 2021 – 2025 is fully in motion towards meeting our own Vision 2030, under which we seek to transform Zimbabwe into an upper-middle income economy. The National Development Strategy 1 recognizes the threat of climate change and has fully mainstreamed climate change across all its thematic areas. Some of the strategies adopted as we pursue green growth include increased adoption of renewable forms of energy such as solar; waste to energy initiatives; greener industries; energy efficiency; reducing energy transmission and distribution losses. A host of climate change adaptation measures towards disaster risk reduction and food and nutrition security have also been adopted. In this regard, Zimbabwe will pursue a holistic and balanced development trajectory, which seeks to balance national development and fulfilment of our international obligations on emissions reduction as guided by the LEDS.

While the country has integrated most of the actions in its development policies and strategies, I call upon potential partners and stakeholders to come on board to support the implementation of this Strategy towards meeting Zimbabwe's development aspirations and the obligations to the world platform.

H.E. Dr E. D. Mnangagwa
President of the Republic of Zimbabwe

Foreword

Climate change poses one of the defining challenges of our time and its impacts both nationally and globally are becoming more apparent. In response to the climate challenge, in 1992, countries adopted the United Nations Framework Convention on Climate Change (UNFCCC), as a framework for international cooperation towards achieving stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The Kyoto Protocol under the UNFCCC, adopted in 1997 mandated developed country parties to undertake economy wide emission reduction actions whilst giving flexibility to developing countries to reduce their emissions on a voluntary basis. The coming to an end of the Kyoto Protocol in 2020 necessitated the need for a new binding agreement to guide future efforts to address climate change, this saw the adoption of the Paris Agreement in 2015. The Panis Agreement calls upon all its Parties to take actions towards reducing greenhouse gas emissions, enhancement of carbon sinks and take action on adaptation within their territories.

Zimbabwe is a Party to UNFCCC and its subsequent protocols; Kyoto Protocol and Paris Agreement. The Paris Agreement requires countries to submit and frequently update their greenhouse gas emission reduction targets through the Nationally Determined Contributions (NDCs). Article 4 paragraph 19 of the Paris Agreement also calls upon countries to communicate mid-century low greenhouse gas emission development strategies to the UNFCCC Secretariat by 2020 to guide countries development pathways in the wake of climate change. The Government of Zimbabwe in response to this call developed the long-term Low greenhouse gas Emission Development Strategy (LEDS) and the attendant Measurement, Reporting and Verification (MRV) Framework for the period 2020-2050. The LEDS will inform subsequent NDC revisions and updates.

This LEDS is in line with Zimbabwe's Vision of becoming an upper-middle income economy by 2030. Key strategies that anchor the attainment of this Viston include;

Hon. M. N. Ndhlovu

implementation of renewable energy and energy efficiency initiatives, climate smart agricultural practices, low carbon transport systems, sustainable forest management, solid waste management and sustainable industrial development among others which have been elaborated in this LEDS.

The LEDS was developed through a consultative process that involved the participation of government departments and state-owned enterprises, development agencies, research and academia, private sector, civil society organisations, and women and youth organisations. I call upon all stakeholders to embrace the LEDS and mainstream the identified climate change mitigation actions that relate to their activities towards a low carbon development pathway.

As I conclude, I would like to acknowledge the technical and financial support received from our cooperating partners, the United Nations Development Programme (UNDP) Russia Trust Fund, UNDP Zimbabwe and GFA Consulting Group who led the development of the LEDS. Last but not least, gratitude goes to all experts and stakshOlders who contributed to the development of this Strategy in support of the Ministry through the Climate Change Management Department.

Hon. M. N. Ndhlovu
Minister of Environment, Climate, Tourism and Hospitality Industry

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List of Abbreviations

AGB	Above Ground Biomass
AC	Air Conditioning
AfDB	African Development Bank
AFOLU	Agriculture Forestry and Other Land Use
AFR	Alternative Fuels and Raw Materials
BAT	Best Available Technology
BAU	Business-As-Usual
BF-BOF	Blast Furnace to Basic oxygen furnace
BFS	Blast Furnace Slag
BGB	Below Ground Biomass
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BRT	Bus Rapid Transport
BTI	Building Technology Institute
BTRs	Biennial Transparency Reports
BUR	Biennial Update Report
C	Carbon
CA	Conservation Agriculture
CAPEX	Capital Expenditure
CCMD	Climate Change Management Department
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CIFOZ	Construction Industry Federation of Zimbabwe
CIMMYT	International Maize and Wheat Improvement Centre
CoM	Chamber of Mines
CSA	Climate Smart Agriculture
CSI	Cement Sustainability Initiative
CSP	Concentrated Solar Power
CZI	Confederation of Zimbabwe Industries
ECA	Export Credit Agency
EMA	Environmental Management Agency
EMS	Environmental Management System
EV	Electric Vehicles
FCPF	Forest Carbon Partnership Fund
FeCr	Ferrochromium
GCF	Green Climate Fund
GCI	Green Cooling Initiative
GFEI	Global Fuel Economy Initiative
GHG	Greenhouse Gas

GHGI	Greenhouse Gas Inventory
GJ	Gigajoule
GoZ	Government of Zimbabwe
GST	Global Stocktake
GWh	Gigawatt Hour
GWP	Global Warming Potential
ha	Hactor
ICA	International Consultation and Analysis
ICE	Internal Combustion Engine
ICRISAT	International Crops Research Institute for the Semi-arid tropics
IDBZ	Infrastructure Development Bank of Zimbabwe
IEA	International Energy Agency
IES	Institute of Environmental Studies
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IRR	Internal Rate of Return
ITMOs	Internationally Transferred Mitigation Outcomes
KPI	Key Performance Indicator
kVAr	Kilo Volt Ampere Reactive
kW	Kilowatt
kWh	Kilowatt Hour
LC	Lifecycle Cost
LDVs	Light Duty Vehicles
LEDS	Low Emission Development Strategy
LFG	Landfill gas flaring
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land Use Change and Forestry
MAC	Marginal Abatement Cost
MACC	Marginal Abatement Cost Curve
MD	Maximum Demand
MEPS	Minimum Energy Performance Standard
MICED	Ministry of Industry, Commerce and Enterprise Development
MIT	Mitigation Scenario
MLAWRR	Ministry of Lands, Agriculture, Water, and Rural Resettlement
MLGPWNH	Ministry of Local Government, Public Works and National Housing
MoEPD	Ministry of Energy and Power Development
MPGs	Modalities, Procedures and Guidelines
MRV	Measurement, Reporting and Verification
MTID;	Ministry of Transport and Infrastructure Development
MWh	Megawatt hour
NACAG	Nitric Acid Climate Action Group
NAMAs	Nationally Appropriate Mitigation Actions

NCCRS	National Climate Change Response Strategy
NCs	National Communications
NDC	Nationally Determined Contribution
NEPS	National Environment Policy and Strategies
NIR	National Inventory Report
NMT	Non-motorised Transport
OPEX	Operational Expenditure
PA	Paris Agreement
PBP	Payback-Period
PET	Polyethylene Terephthalate
PF	Power Factor
PLR	Prime Lending Rate
PPC	Pretoria Portland Cement
PV	Photovoltaic
QA/QC	Quality Assurance/Quality Control
RERA	Regional Electricity Regulators Association of Southern Africa
RPC	Reactive Power Compensation
SAPP	Southern African Power Pool
SAZ	Standards Association of Zimbabwe
SDP	System Development Plan
SDR	Social Discount Rate
SE	Standard Error
SIRDC	Scientific Industrial Research and Development Centre
SME	Small to Medium Enterprise
SOC	Soil Organic Carbon
SWDS	Solid Waste Disposal Sites
t	Tonne
TD	Transmission and Distribution
TNC	Third National Communication
TSP	Transition Stabilisation Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WBCSD	World Business Council for Sustainable Development
WHR	Waste Heat Recovery
yr	Year
ZBCA	Zimbabwe Building Contractors Association
ZEDTC	Zimbabwe Electricity Transmission and Distribution Company
ZERA	Zimbabwe Electricity Regulatory Authority
ZimAsset	Zimbabwe Agenda for Sustainable Socio-Economic Transformation
ZimStat	Zimbabwe National Statistics

Executive Summary

Climate change is a defining challenge for humanity. The Government of Zimbabwe (GoZ) is committed to taking urgent action to mitigate and adapt to the effects of Climate Change. As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), the country seeks to contribute to the ambitious global mitigation goals as agreed under the Paris Agreement (PA). Zimbabwe's Low Emission Development Strategy (LEDS) sets the course for reducing emissions, while at the same time ensuring sustainable socio-economic development for the country. It is based on the government's economic planning up to 2050 and covers mitigation measures across the four key sectors of Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU) and Waste.

Zimbabwe, as a developing country, is projected to experience decades of economic growth with its GDP increasing from 19.6 billion USD in 2020 to 119.1 billion USD by 2050, based on constant prices (a seven-fold increase). Economic development will drive Zimbabwe's Business-As-Usual (BAU) emissions of greenhouse gases (GHG), which are projected to increase from 36.6 $MtCO_2e$ in 2020 to 65.3 $MtCO_2e$ in 2050 (a doubling over this period).

Energy: Currently, energy use is the country's largest source of GHG emissions; the sector's emissions are expected to increase to 26.5 $MtCO_2e$ in 2030 and 37.5 $MtCO_2e$ in 2050 with increasing demand for power generation, transport and other uses of fossil fuels. GoZ, private sector and civil society identified 21 mitigation measures including large hydropower projects (Batoka and Devils George) accompanied by other renewable energy measures such as the introduction of solar PV at the commercial and residential scale. Clean generation measures will be complemented by a series of energy efficiency measures reducing electricity demand and the reduction of technical losses in the power system. An important efficiency measure identified is the introduction of fuel economy standards for vehicles, reducing lifecycle costs to consumers. This will also result in the reduction of Zimbabwe's emissions and dependence on fuel imports. The aggregated set of mitigation measures identified has the potential to reduce the projected BAU emissions from the energy sector from 37.5 to 16.2 $MtCO_2e$ in 2030 (57% reduction).

Industrial Processes and Product Use (IPPU): Emissions from this sector represents a relatively small share of Zimbabwe's total national emissions, estimated to total around 0.70 $MtCO_2e$ in 2020. The BAU emissions are based on assuming growth in clinker and cement, fertilizer and ferroalloys production, as well as a return to iron and steel production within the coming decade. BAU emissions are expected to rise to around 1.7 $MtCO_2e$ in 2030 and 2.5 $MtCO_2e$ in 2050. GoZ and stakeholders identified five key mitigation measures, most importantly the reduction of N_2O emissions from fertilizer production and use of alternative fuels in the ferrochromium and iron and steel categories. Implementing these measures could reduce projected emissions to around 1.4 $MtCO_2e$ by 2050 (44% reduction compared to BAU).

Agriculture, Forest and Other Land Use (AFOLU): This sector is a significant source of GHG emissions that is estimated to emit 18.8 $MtCO_2e$ by 2020. BAU emissions are projected to peak in around 2034 (at 32.4 $MtCO_2e$) and fall thereafter to 22.7 $MtCO_2e$ by 2050. Stakeholders identified five mitigation measures to reduce deforestation and emissions from agriculture. Besides stopping net-deforestation by 2030, the most important intervention is increasing the use of conservation agriculture, which increases soil organic carbon as well as revenues from farming and livestock management. Implementation of these measures are estimated to reduce projected GHG emissions to 14.5 $MtCO_2e$ by 2050 (reduction of 36.2%).

Waste: The waste sector represents a small proportion of national emissions. The BAU emission trends in the waste sector are driven by economic development (GDP) and population growth. The GHG emissions are expected to increase from 1.18 $MtCO_2e$ in 2020 to 2.62 $MtCO_2e$ by 2050. Two key mitigation measures have been identified: flaring of landfill gas and increased use of composting, which together have the potential to significantly reduce emissions to just 0.08 $MtCO_2e$ by 2050 (a reduction of over 95% of sector emissions).

Finance and policy amendments: The implementation of all 38 identified mitigation measures is expected to have a significant positive economic impact with a net present value of USD 7,130 million. Their implementation will reduce the costs of power, agricultural and industrial products improving the overall livelihood of Zimbabweans and increasing the country's economic competitiveness. Similarly, the LEDS mitigation actions support SDG achievements beyond the SDG 13 on Climate Action.

Successful implementation of the LEDS will depend on the availability of a suitable financing mechanism. Total investment needs are estimated at USD 7,880 million, corresponding to 25.4% of the national GDP (2019). This financing needs to be provided at a low cost of capital for mitigation projects to be viable and bankable.

The successful implementation of the mitigation measures will depend on the availability of a large-scale financing facility, providing concessional lending rates, making the economically viable abatement potential also financially viable. This financing instrument will need to be supported by an enabling framework of new policies and regulations (e.g. fuel economy standards) to incentivise companies and consumers in making purchase decisions minimizing lifecycle costs and GHG emissions.

1. Introduction

The Government of Zimbabwe (GoZ) is committed to taking urgent action to mitigate the causes and adapt to the effects of climate change. As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), the country seeks to contribute to the ambitious goal of limiting temperature rise to 1.5°C above preindustrial levels as agreed under the Paris Agreement (PA) (UNFCCC, 2015). The GoZ submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC in 2015 (GoZ, 2015a), and this was approved and advanced to Nationally Determined Contribution (NDC) following the rati- fication of the PA in 2017.

Zimbabwe's National Climate Policy (GoZ, 2017a) guides the mainstreaming of climate change within national development plans. Action on climate change is supported by several other instruments such as the National Climate Change Response Strategy (NCCRS) (GoZ, 2015b), the National Renewable Energy Policy (GoZ, 2019a) National Bio-fuels Policy (GoZ, 2019b), National Transport Master Plan (2018-2038) (GoZ, 2018a), Forestry Policy (draft), Climate Smart Agriculture (CSA) manual (GoZ-CTCN, 2017) and Climate Smart Agriculture Framework (GoZ, 2018b), as well as the National Environmental Policy and Strategies (GoZ, 2009). The GoZ acknowledges that more work is needed so that all key economic players, including private sector can participate in climate change mitigation. Zimbabwe's first Nationally Determined Contribution (NDC) is limited to climate change mitigation in the energy sector covering prominently the power and transport sectors, as well as adaptation in agriculture. Zimbabwe's initial NDC targets is to reduce energy-related GHG emissions per capita by 33% below the Business-As-Usual (BAU) scenario by 2030.

In 2019 GoZ launched the NDC Implementation Framework to guide implementation of the current energy sector focused NDC. Building on these achievements, Zimbabwe long term Low greenhouse gas Emission Development Strategy (LEDS) follows an economy-wide approach. The LEDS covers mitigation in all Intergovernmental Panel on Climate Change (IPCC) sectors (Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), and Waste). The LEDS also provides a framework for developing an economy wide NDC.

Zimbabwe's LEDS does not only address mitigation measures, it places equal emphasis on the country's economic development. Zimbabwe's 2019 Gross Domestic Product (GDP) per capita amounted to USD 2,788 compared, to e.g. USD 6,339 /capita in South Africa or the EU average of USD43,150/ capita, all in purchasing power parity). Hence, strengthening the national economy and improving the livelihoods of Zimbabweans is an important priority, as outlined in Vision 2030 (GoZ, 2018c) and Zimbabwe's Transition Stabilisation Programme (TSP) (GoZ, 2018d). The TSP builds on the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset) (2013-2018) (GoZ, 2013).

Against this background, the LEDS explores measures that aim to reduce GHG emissions or increase carbon sequestration in forests and soils while contributing to socio-economic development. The LEDS is based on the assessment of 38 sectoral mitigation measures, identified following a comprehensive stakeholder consultation process. These 38 sectoral mitigation measures are, to a large extent, economically viable at a Social Discount Rate (SDR) of 6%. High level modelling of the mitigation measures indicates an aggregated Net Present Value (NPV) of USD 7,130 million. The implementation of these measures will reduce the costs of electricity, agricultural production, fuel con- sumption and overall provide a significant impulse for economic growth.

While being economically viable, mitigation measures will require an investment of USD 7,880 million up to 2030 (corresponding to 25.4 % of Zimbabwe's GDP in 2019). Both, public and private investments, will be needed to deliver on the climate change mitigation targets. In 2019 the cost of capital was around 15% and hence significantly exceeded the SDR of 6%. The success of Zimbabwe's LEDS will depend, to a large extent, on the availability of a large- scale climate financing facilities. These facilities should bridge the gap between prevailing lending rates and the SDR enabling private sector investment in economically viable mitigation measures.

2. Methodology

Zimbabwe's LEDS was developed according to the methodology described in this section.

2.1 Stakeholder Engagement

The Climate Change Management Department (CCMD) in the Ministry of Environment, Climate, Tourism and Hospitality Industry (MECTHI) led the LEDS development with support from the United Nations Development Programme (UNDP) and financial support from the Russian Federation. The development of the LEDS employed a participatory approach. The CCMD organised stakeholder consultations during the inception, development and validation phases of the strategy formulation. Key stakeholder groups included the relevant Government Ministries; agencies or parastatals; academia and research institutions; local authorities; private sector associations and individual companies, as well as various organisations representing civil society (including youth- and women organisations) also participated in the process. The Legal and Transparency, as well as the Mitigation Technical Sub-committees for the implementation of Zimbabwe's NDC provided technical guidance in the LEDS development process.

2.2 BAU Modelling and Assumptions

The BAU scenarios were developed using GHG data from Zimbabwe's Third National Communication (TNC) to the UNFCCC (GoZ, 2016), and the NDC Implementation Framework (GoZ, 2017b). For each sub-sector, assumptions around future activity growth rates and factors determining change in GHG emissions were applied. In general, population, economic and industrial growth rates were based on the Zimbabwe National Statistics Agency (ZimStat) forecasting model, which represents an outlook for economic growth based on strong recovery:

- The GDP forecast bases on a forecasting approach, which assumes that the country overcomes its current financial crisis and recovers through a series of years with strong economic development. The GDP forecast model bases on population growth, consumer price index and employment data.
- For some sectors, where GoZ conducts detailed planning processes (i.e. development of the electricity demand), the LEDS development considered such sector specific planning
- Population forecasts were based on the medium case growth scenario from ZimStat;
- Detailed approaches to BAU modelling are described within each of the sector-specific chapters and in relevant Annexes of this document.

For modelling the costs and benefits of diesel and gasoline related activities, the obtaining fuel price as provided by ZimStat and a global price forecast model were used. The global price forecast model assumes a modest fuel price increment (i.e. accumulated 16%) up to 2030 and constant prices thereafter.

Zimbabwe has implemented a tobacco tax to support sustainable afforestation and a carbon tax on fossil fuel use. As of 2019, the collected carbon tax amounted to fuel diesel and gasoline[1] use is equivalent to around USD12.24/tCO_2eq.

Moreover, a constant electricity cost of 16 USDc/kWh was assumed. The cost is related to the current price for electricity (10 USDc/kWh, ZERA, 2014). Indirect subsidies related tariffs which are not fully cost reflective since CAPEX is not fully recovered; (Trimble et al., 2016).

2.3 Mitigation Modelling and Economic Analysis

Climate change mitigation modelling was done using sector specific tools. The alternative GHG mitigation pathway presented in this document is based on a strong climate-financing framework. The underlying assumption is that the LEDS implementation is supported by a national Low Emission Development Financing Facility, which offers debt capital and concessional lending rates based on sustainable and measurable GHG emissions reductions. This would eliminate the gap between the economically

1 *Gasoline is generally referred to as petrol in Zimbabwe*

viable abatement potential and those measures that may be financially viable/attractive. The Marginal Abatement Cost (MAC) functions were used to prioritize the mitigation options. The high capital expenditure (CAPEX), required for cleaner technologies has driven private sector to opt for cheaper emission intensive technologies. However, the cheaper technologies have larger operational expenditures (OPEX) in the long run.

The modelling of a mitigation scenario (MIT) is based on brief sectoral studies for i) Reduction of load dependent technical losses in the electricity transmission and distribution system, ii) introduction of Minimum Energy Performance Standards (MEPS), iii) abatement potential in the Solid waste subsector, iv) transport, v) cement and vi) AFOLU.

2.4 Sustainable Development Impacts and Co-benefits

While the LEDS mitigation actions support Sustainable Development Goals (SDGs) achievements beyond the SDG 13, the SDG impacts of each mitigation action have not been analysed and quantified. There are however clear linkages, exemplified for instance in the energy sector, where fossil fuel-based energy production and transport has severe air pollution effects. A shift to cleaner forms of energy has clear health benefits. Similarly, increased uptake of renewable energy also has a positive impact on employment creation, in that the industry offers significant direct and indirect green jobs potential across the full supply chain.

There is need for an analysis of how to make the transition to a low carbon economy a just and inclusive transition for all. When carbon-intensive industries are phased out, there is need to make sure that cleaner industries are ready to sustain growth and employment and that both positive and negative effects on jobs and livelihoods are considered. While the development of the LEDS has been centred on identification of cost-effective, low carbon solutions for reaching the country's ambitious climate targets, the GoZ intends to include a deeper analysis of the social and employment dimensions. These dimensions will include gender issues, SDG impact and elements of decent work and just transition as an integral part of the development of a LEDS implementation framework.

3. Energy

3.1 Business-as-usual Emissions

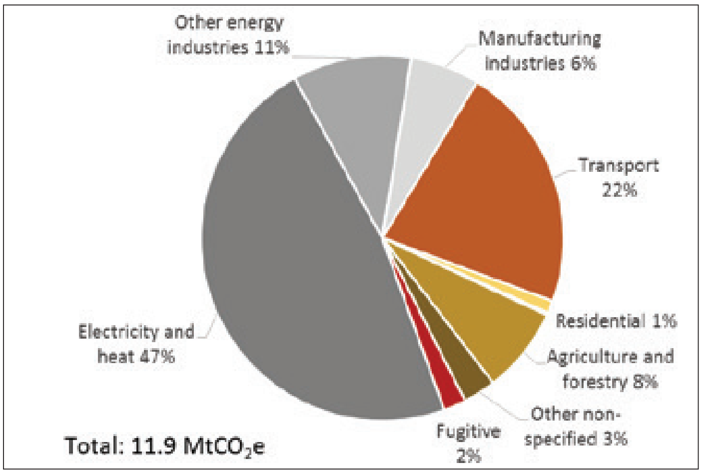


Figure 3.1: GHG emissions from energy use, 2015

Energy use in power generation, transport, manufacturing industry and agriculture accounts for the largest share of national GHG emissions. Emissions totalled around 11.9 MtCO$_2$e in 2015, of which CO_2 accounted for over 99%. Electricity generation accounted for the largest share of the total, mainly associated with coal and oil combustion - followed by the transport sector emissions, mainly from gasoline and diesel use in road vehicles (Figure 3.1). Diesel, coal and liquefi ed petroleum gas (LPG) fuel use in other sectors such as industry, commercial, institutional, residential and agriculture accounted for the remaining share of emissions.

Figure 3.2 shows GHG emissions from energy use projected through 2050 under a BAU scenario. Energy use and emissions projections were developed for each energy-using sector, reflecting a number of assumptions using a bottom up approach (GoZ, 2016). Key drivers and the outlook for growth through 2050 determining changes in economic output, energy supply, technology, economics and policy choices. The approach taken to developing a BAU projection for each contributing sector is summarised in Table 3.1.

Total emissions are expected to increase significantly over the coming decades, rising to around 26.5 and 37.5 $MtCO_2e$ in 2030 and 2050, respectively. The fastest growth and overall contribution is expected to come from power generation, in particular with the official planned expansion of thermal power generation over the coming decade. Emissions from transport are also forecast to rise significantly as demand for vehicles and transport services increases with economic growth, particularly for passenger cars. Other sub sectors are expected to see a steady increase in activity and associated emissions, assuming robust economic growth, industrial output and rising standards of living over the medium and long term.

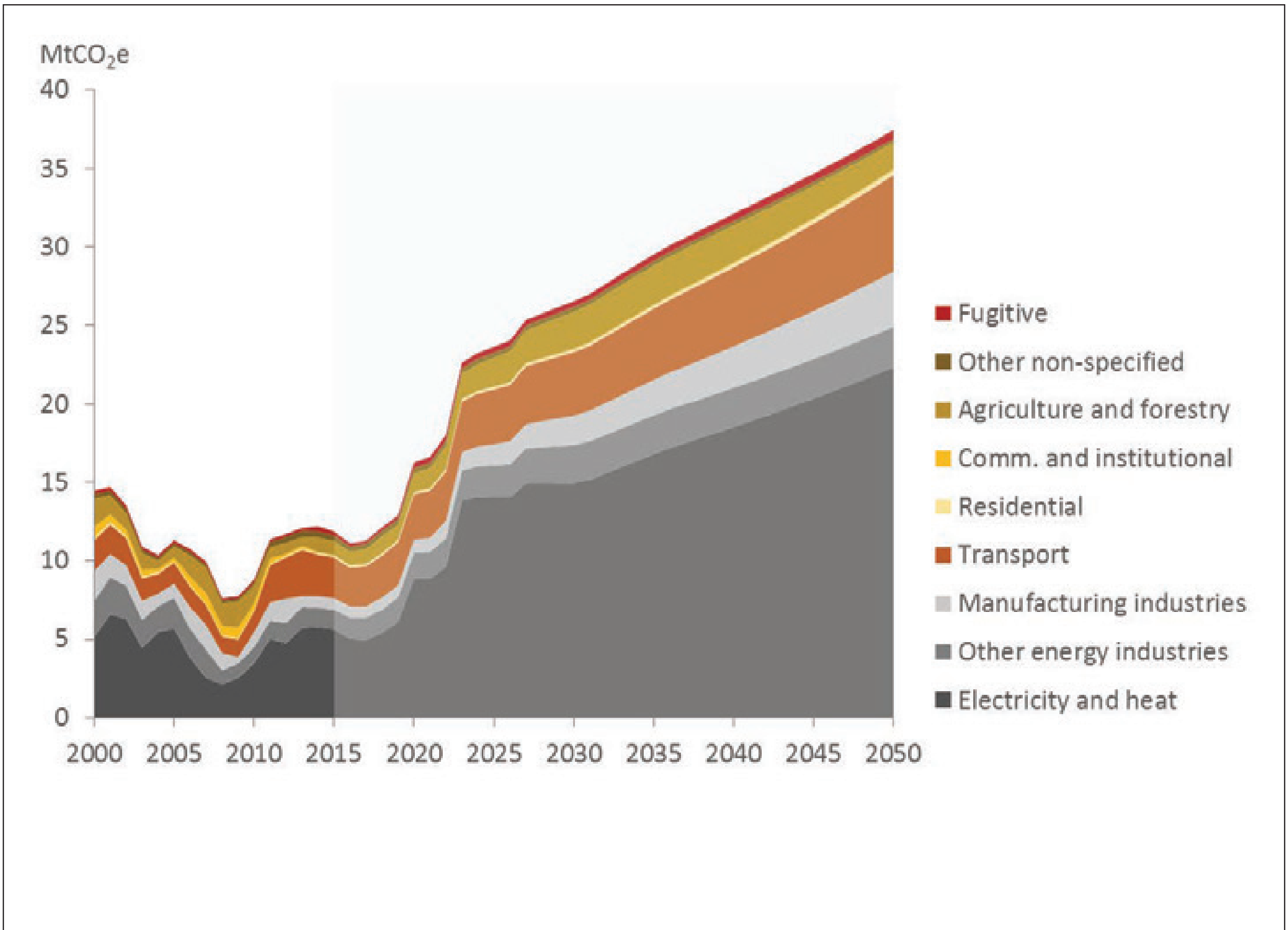


Figure 3.2: GHG Emissions from energy use, historic and projected to 20250 under BAU

Table 3.1: Summary of approach to BAU energy emissions projections according to IPCC category

IPCC sub-sector	IPCC category	Sub-category	Approach	Assumptions
1.A. Fuel Combustion Activities	1. A.1. Energy Industries	1. A.1.a. Electricity and Heat Production	Based on analysis of forecast electricity demand and planned generation through 2038 by power plant (ZETDC, 2017). A counterfactual BAU was developed excluding NDC projects being included, using ZPC plant-level information and data assumptions.	Increased energy demand and generation to 2050 based on growth trend and final grid mix in 2038.
		1. A.1.c. Manufacture of Solid Fuels and Other Energy Industries	Surrogate approach.	Use of coking coal and other energy use assumed to grow as a function of projected GDP growth and decreasing energy per unit GDP intensity (MJ per USD).
	1. A.2. Manufacturing Industries and Construction		Surrogate approach	Energy demand to grow in most manufacturing sectors as a function of projected GDP growth and decreasing energy per unit GDP intensity.

IPCC sub-sector	IPCC category	Sub-category	Approach	Assumptions
	1. A.3. Transport	Road	Fuel consumption forecast for different vehicle classes based on transport demand, fuel use and fuel economy assumptions, and detailed vehicle fleet modelling through 2030. Vehicle demand by type linked to GDP per capita growth forecasts using regression analysis from historic data (see Annex IV for details and data sources used).	Increased vehicle fleet based on historical trend
		Railways	Forecast coal, diesel and electricity consumption based on data provided by National Railways of Zimbabwe (NRZ) and MTID. Extrapolated to 2050 based on GDP growth trends.	Increased energy demand with increasing GDP
		Aviation	Energy demand assumed to grow in line with GDP growth outlook. Assumes resumption of flight activity over medium term to previous levels of year 2000.	Increased energy demand with increasing GDP
	1. A.4. Other Sectors		Surrogate approach.	Energy demand assumed to grow in line with GDP

3.2 Mitigation Measures

Table 3.2 summarises the mitigation measures identified to contribute to the LEDS, according to each of the key energy sub-sectors. The table provides only a high-level summary, indicating the nature of the mitigation effect; furthermore, some of the options shown comprise several different actions or specific projects (e.g. municipal biogas power projects) grouped together.

The list of options builds upon those identified in Zimbabwe's first NDC. Several of those measures have been extended or scaled-up through to 2050.The table also includes other additional measures considered feasible over the long-term with sufficient technical and financial support. Some of these measures were included as part of the low carbon road transport, the use of Reactive Power Compensation (RPC), and Minimum Energy Performance Standards for appliances used in buildings.

An important contribution to the LEDS is the assumed expansion of new and as-yet unplanned renewable power generation projects to meet increasing demand in the last 15-20 years of the forecast period. These power generation projects assume the need to balance base load and peaking power whilst moving towards low carbon generation as renewable generation costs fall over time. An equal split between solar Photovoltaic (PV, utility), Concentrated Solar Power (CSP) and hydropower is assumed.

Table 3.2: List of mitigation measures for Zimbabwe LEDS in the energy sector

Sub-sector	Category	Mitigation measure	Principal mitigation
Energy Industries	Electricity and heat generation	Large hydropower (including Batoka and Devil's Gorge).	Replacement of existing and/or planned fossil-fuel generation from grid.
		Solar PV micro-grids.	Replacement of generation and GHG emissions from Harare coal plant, and other fossil generation.
		Solar PV utility projects.	
		Municipal biogas power projects.	Displacement of existing coal-fired power on grid.
		Renewables 2032-2050 (solar PV, CSP, hydro).	Increase in power demand met from renewables from 2032 onwards to reduce grid GHG intensity.
		Reactive power compensation.	Reduced transmission system losses, increasing efficiency of power generation supply.
Manufacturing Industries		Energy efficiency (EE) programme.	Reduced on-site fuel use and grid power.
		Energy efficient electric motors in mining.	Reduced power consumption.
Transport	Road transport	Local biofuel production	Reducing fossil fuel component in the energy mix through blending.
		Fuel economy policy.	Reduction in gasoline and diesel consumption
		Electric- and hydrogen vehicles.	Reduction of gasoline and diesel demand by Internal Combustion Engines (ICE) vehicles through the uptake of electric and hydrogen vehicles.
		Public transport (modal shift).	Reduced carbon intensity of travel system by shifting away from passenger car use to modern buses and non-motorised transport (NMT).

	Railways	Rail refurbishment and electrification.	Displaced diesel consumption (rail + road) by less CO_2- intensive electricity provided from the grid.
Other sectors	Agriculture	CSA: Solar pumping for irrigation.	Replacing diesel, gasoline and grid electricity in water pumping.
		CSA: On-farm bio-digesters.	Avoided emissions from manure management.
	Commercial & residential	Solar water heating programme.	Replacing grid electricity consumption.
		Rooftop solar PV for SMEs.	Replacing diesel and gasoline in back-up generators.
		Off-grid solar electrification.	Replacing kerosene (lighting) and diesel/gasoline (gen-sets).
		Solar LED street and traffic lighting.	Reduced grid electricity for street lighting.
		Replacement of inefficient lighting devices. Minimum Energy Performance Standards.	Increased energy performance of appliances leading to reduced grid power consumption.

Figure 3.3 summarises the estimated emissions reduction potential in 2030 for all the mitigation options identified in Table 3.2. In terms of overall mitigation contribution, electricity supply from the large hydropower projects of Batoka and Devil's Gorge dominate the estimated mitigation potential, accounting for 8.1 $MtCO_2e$ of the total 10.8 $MtCO_2$ potential estimated in 2030 – equivalent to almost 75% of the total effort. After renewable electricity generation, low carbon transport contributes the largest share of mitigation potential, mainly through a combination of fuel savings and the use of alternative and low carbon fuels and vehicles.

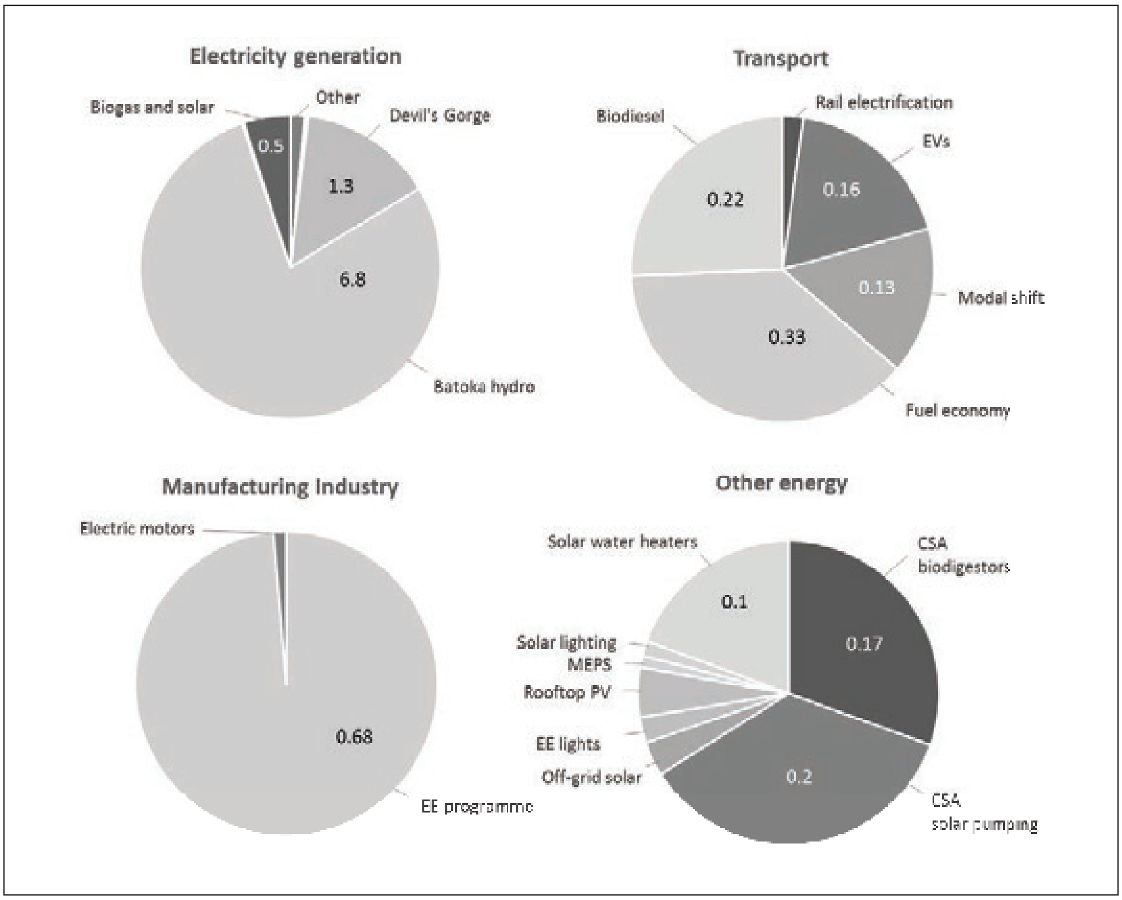


Figure 3.3: GHG mitigation potential of the energy sector amounting to 10.8 MtCO2e in 2030

The contribution from the key mitigation options over the long-term to 2050 is shown in Figure 3.4. The projections show that with the implementation of all mitigation measures, total emissions could be limited to around 16MtCO$_2$e in 2050, compared to 37.5 MtCO$_2$e under BAU. This represents a more than halving of energy sector emissions. The figure shows that achieving this level of mitigation will be highly determined by the ability of large-scale hydropower to meet future electricity demand, followed by a mix of other renewables meeting incremental demand over the longer-term.

Additional mitigation could be achieved through use of clean coal technologies for thermal power generation and other policy instruments to remove inefficient vehicles, equipment and appliances.

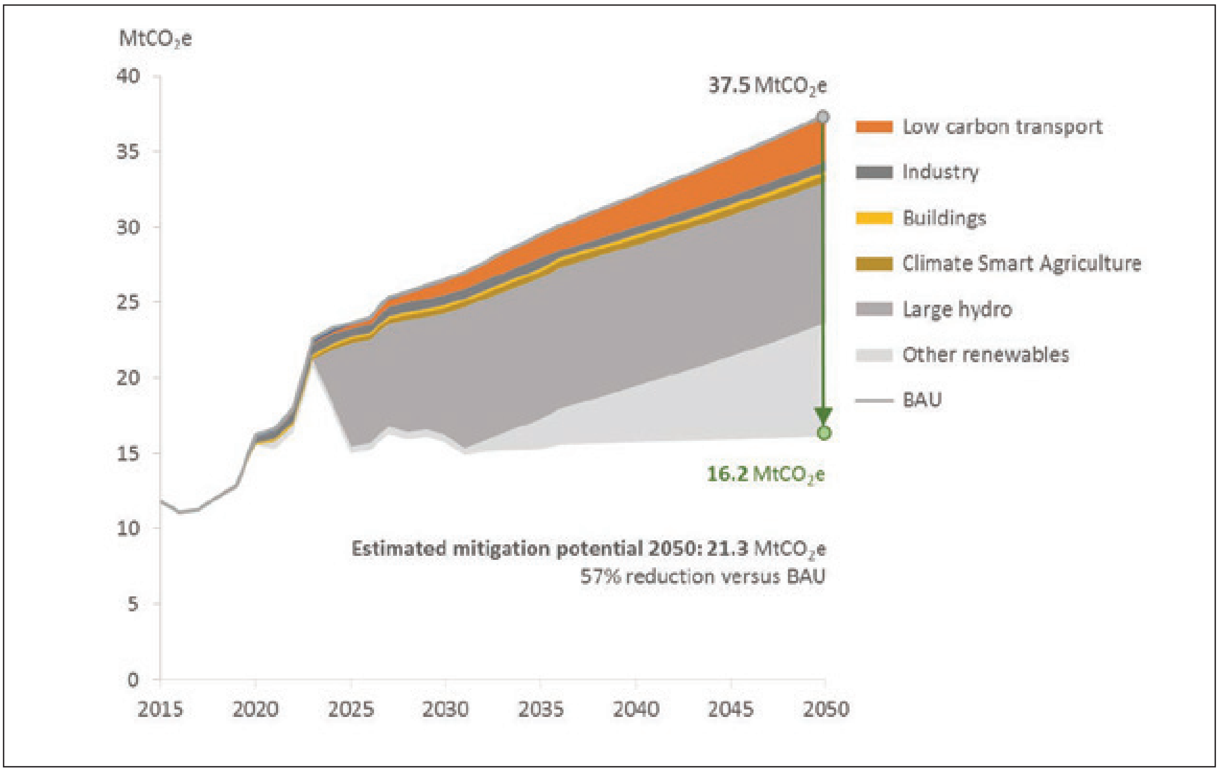


Figure 3.4: GHG emissions projections from energy use under BAU and with mitigation

3.3 Economic Analysis

The Marginal Abatement Cost Curve (MACC) for the energy sector is presented in Figure 3.5. As described earlier, the costs shown represent the socio-economic costs of abatement, reflecting both costs and benefits to the wider economy.

Some key assumptions for modelling the costs and benefits of mitigation measures were applied specific to the energy sector, including;

- A cost reflective price for electricity generation and supply (cp. ZERA, 2014 and Trimble et al., 2016) of 16 USDc/kWh;
- While the general modelling approach assumes constant prices, international projections for the generation of additional, currently unplanned, renewable energy projects were considered. These unplanned projects will be required to close the gap from 2032 onwards between i) the currently planned generation assets and ii) the increment of the energy demand projected from 2030 onwards. For these projects, international projections for investment costs for utility

PV, CSP and hydropower (NREL, 2018)[1] were considered. Moreover, it was assumed that this 'unplanned' generation is provided by small-scale hydropower, PV and CSP in equal shares[2].

The MACC highlights the large potential for achieving mitigation principally through the introduction of increased renewable supply most noticeably from large hydropower projects such as Batoka and Devil's Gorge to meet Zimbabwe's rising demand for grid electricity. Abatement is also achieved indirectly through the impact that reduced electricity demand has in the electricity generation sector, arising from energy efficiency measures. Importantly, most of the projects are seen to have significant net benefits, shown here as 'negative' abatement costs. This is most noticeable for energy efficiency projects and those involving the replacement of imported diesel fuel use (Table 3.2).The focus is instead on those options, which can deliver significant cost-effective GHG reductions whilst also offering important co-benefits such as reduced energy imports, green growth and local job creation.

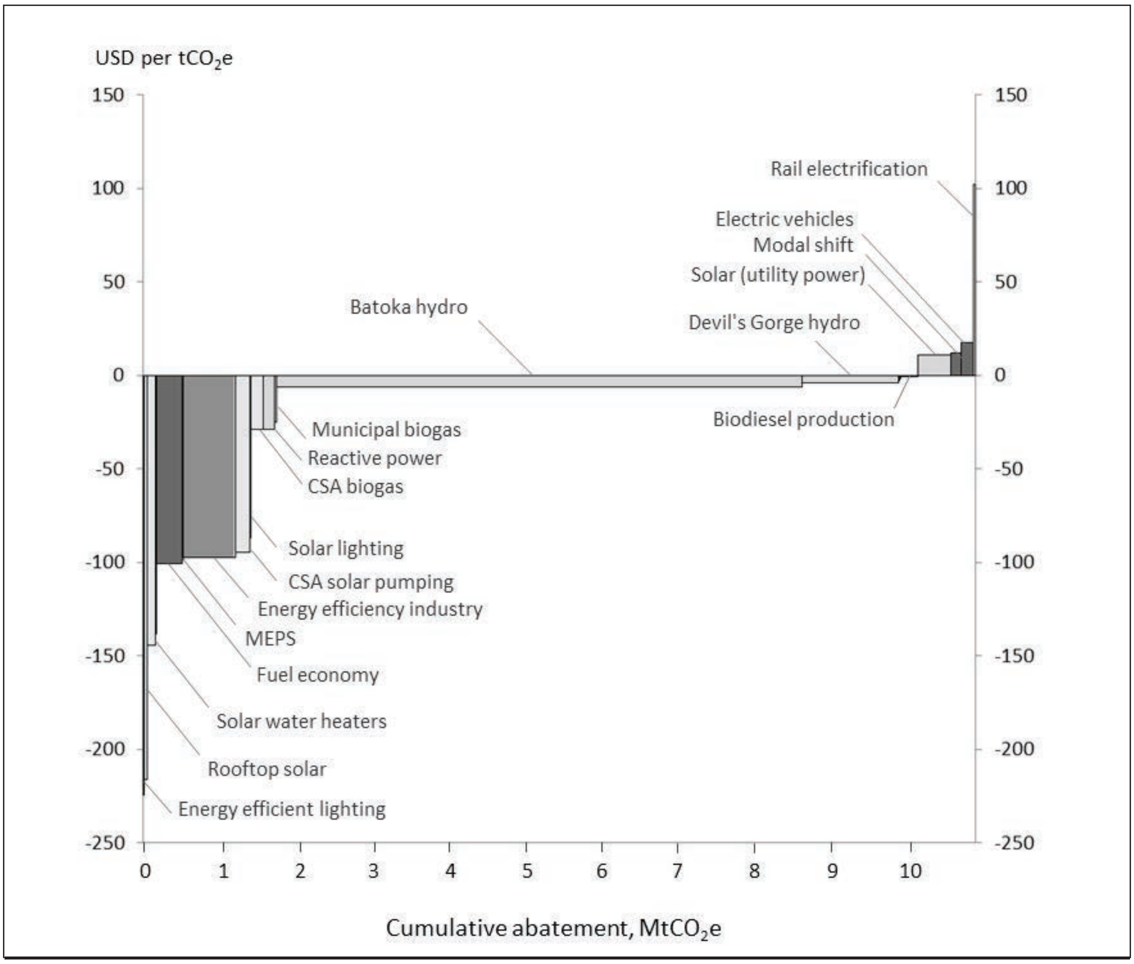


Figure 3.5: Marginal abatement cost curve for energy use, 2030

1 *2018 ATB Cost and Performance Summary, NREL. See: https://atb.nrel.gov/electricity/2018/summary.html*

2 *Given limited information and lack of a robust and comparable RE assessment and because detailed energy system modelling fell outside the scope of the LEDS development, making an equal split was deemed the most transparent approach. Wind was excluded based on the low resource potential in Zimbabwe, whilst the assumption was that solar will have a larger potential than hydro, given falling unit costs (hence the 2/3 solar compared to 1/3 hydro). Hydro in turn comes with environmental challenges, mainly for large scale hydro. It should be noted that because all Renewable Energy options assume zero emission grid power, the actual split chosen doesn't actually impact the GHG reductions and the LEDS mitigation outlook. The costs would be slightly different depending on the mix, although these become broadly similar going out to 2050.*

3.4 Roadmap of Actions

The mitigation effort to be achieved over the long-term through to 2050 will require the formulation and implementation of policies, programmes and investments over the short and medium term. Figure 3.6 shows a summary timeline for the development and implementation of each of the mitigation measures and actions proposed to implement the LEDS in the Energy sector. These will be essential in providing the basis and clear direction for subsequent scaling up of low carbon energy use and investment needed to decouple energy consumption from emissions.

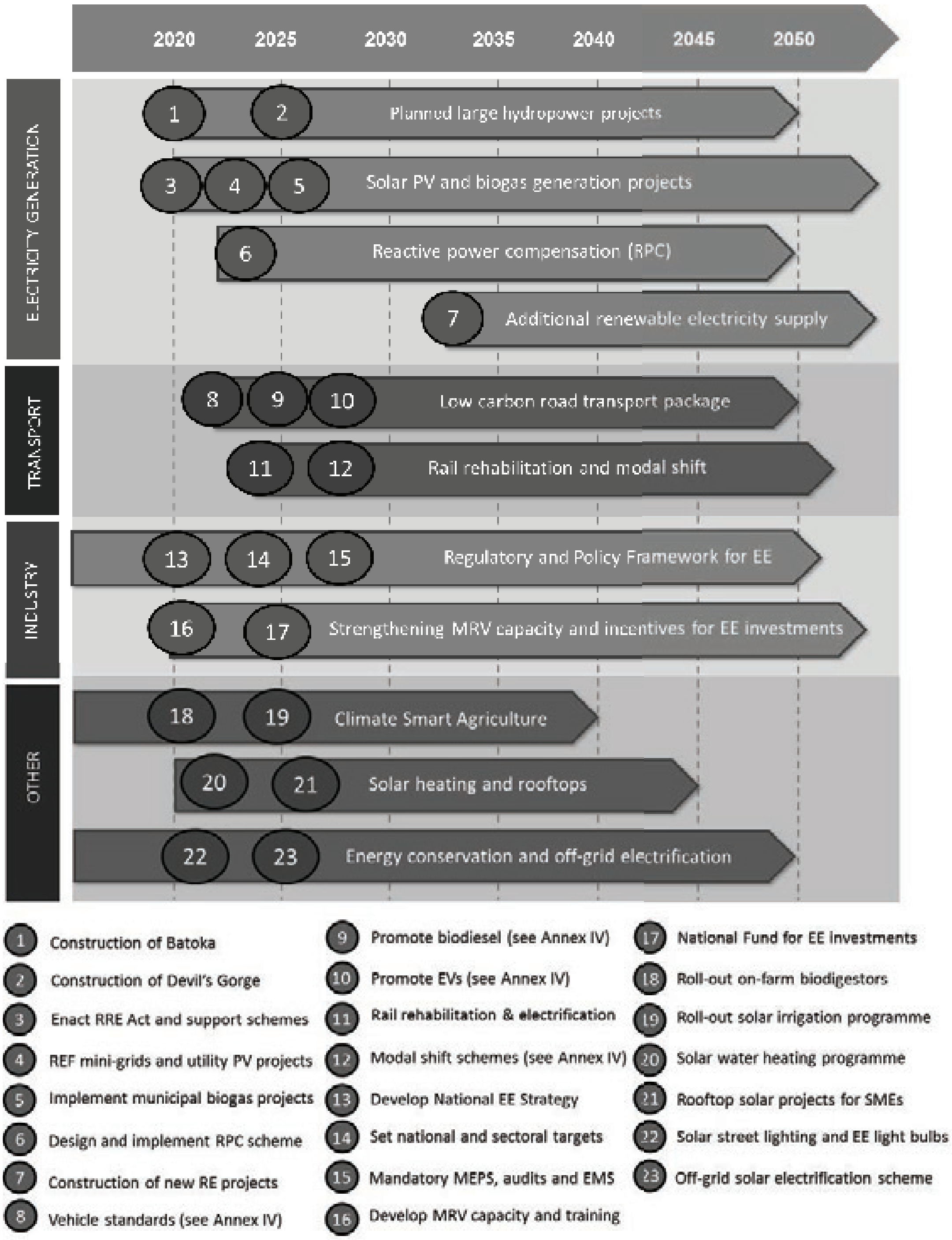


Figure 3.6: Timeline of mitigation actions to support LEDS implementation in the energy sector

4. Industrial Process and Product Use

4.1 Business-As-Usual Emissions

Industrial Processes and Product Use GHG emissions are released from a wide range of physical and chemical industrial processes, as well as the use of GHG emitting products. According to the TNC GHG inventory data, emissions from these sources represented a relatively small share of Zimbabwe's total national emissions, totalling approximately 0.54 $MtCO_2e$ in 2015 (GoZ, 2016).

The cement sector accounted for the largest share of total IPPU emissions in 2015, in the form of CO_2 produced during calcination of limestone in cement kilns (Figure 4.1). This sub-sector was followed by release of process CO_2 from ferrochromium smelting and N_2O emissions from the production of nitric acid within the country's only nitrogen fertilizer manufacturing plant. A large number of much smaller sources and activities accounted for the remaining share of emissions. The smaller sources included glass production, soda ash use, secondary lead production, lubricant use, paraffin wax and solvent use (other IPPU).

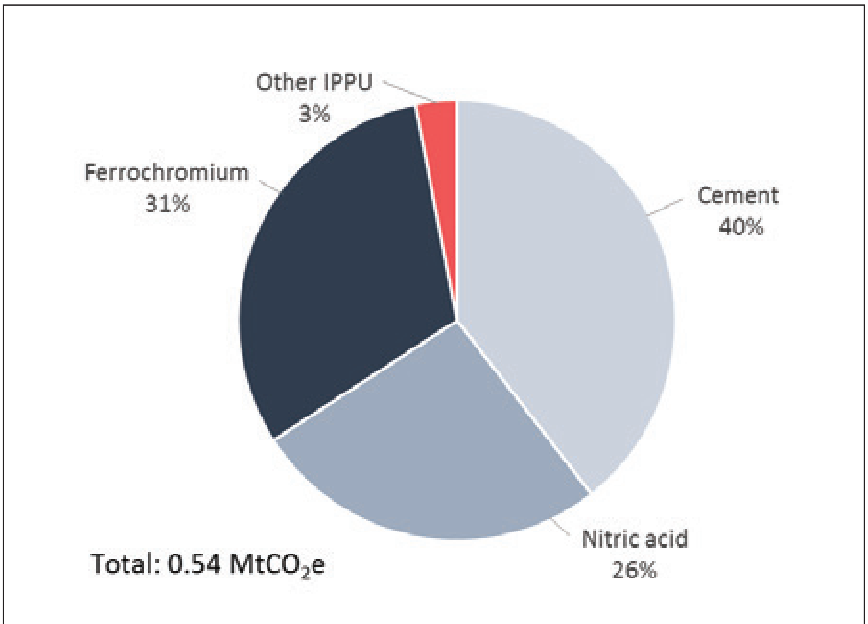


Figure 4.1: GHG emissions from IPPU, 2015

Figure 4.2 shows historical GHG emissions from the IPPU sub-sectors well as emissions projected through 2050 under a BAU scenario. The historical data shows how emissions have fallen significantly since 2000. Iron and steel production was a key emitter until around 2008 when the country's only integrated iron and steel works ceased production. Nitric acid production from the nitrogen fertilizer industry has significantly decreased due to operational challenges.

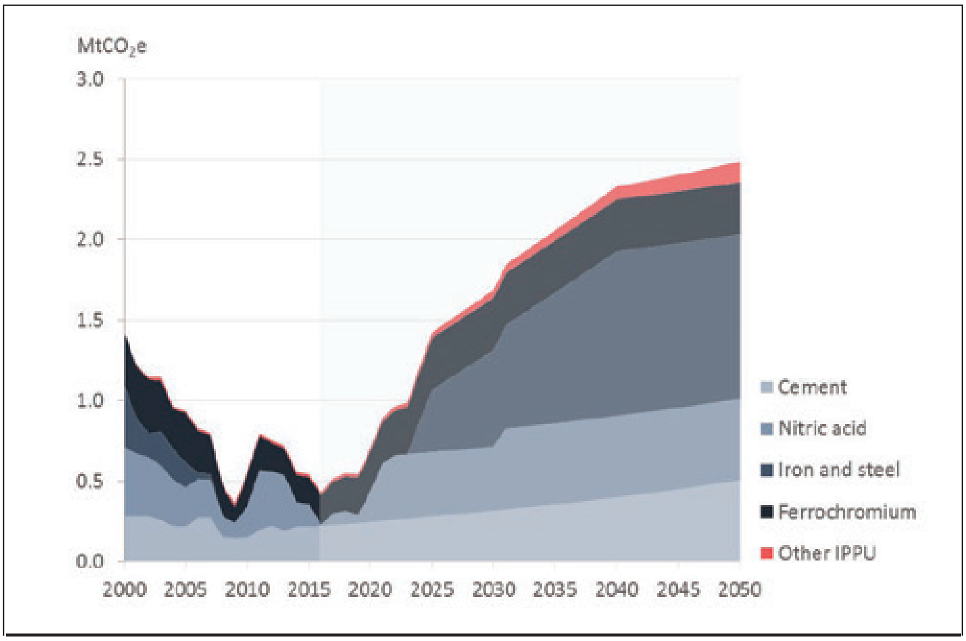


Figure 4.2: GHG emissions from IPPU, historical and BAU projection to 2050 by source

Emissions projections were developed separately for each emitting sub-sector, reflecting assumptions around the forecast outlook for industrial recovery and increased output growth through 2050. The approach taken to developing a BAU projection for each contributing sub-sector is summarised in Table 4.1. According to this approach, total BAU emissions are expected to increase significantly over the coming decades, from an estimated 1.7 MtCO2e in 2030 to 2.5 MtCO2e in 2050. However, this increase is highly dependent upon the assumption that renewed industrial output and investment can be achieved in the medium-term, in particular within iron and steel and fertilizer production, resulting in activity and emissions returning to early 2000 levels. Over the longer term, most IPPU sub-sectors are expected to have an increase in activity and associated emissions, assuming robust economic growth and industrial output. In the absence of national mandatory GHG reporting requirements for companies, GHG emissions were calculated based on IPCC Tier 1 methodology. Figure 4.2 presents historical and projected BAU GHG emissions from IPPU.

Table 4.1: Summary of assumptions to BAU IPPU emissions projections according to IPCC category

IPCC Sector	IPCC sub-sector	IPCC category	Assumptions
2. IPPU	2.A. Mineral Industry	2.A.1. Cement Production	Clinker production assumed to return to historical levels of around 550kt (early 2000s) by 2025; subsequent annual growth to occur in line with trends at around 2-3% p.a.
		2.A.3. Glass Production	Glass production assumed to return to historical levels of around 20kt (mid 2000s) by 2025; subsequent annual growth occurs in line with trends at around 5% p.a.
		2.A.4b. Other Uses of Soda Ash	Sodium carbonate use assumed to return to early 2000s levels of around 10kt by 2025; subsequent annual growth occurs in line with trends at around 5% p.a.
	2.B. Chemicals Industry	2.B.2. Nitric Acid Production	Assumes target nitric acid production of around 150kt reached by 2024, with subsequent expansion to achieve ammonium nitrate production capacity of 240kt p.a.
	2.C. Metal Industry	2.C.1 Iron & Steel Production	Assumes return to early 2000sproduction levels by 2025, subsequently increasing to 700kt by 2040.
		2.C.2. Ferrochromium	FeCr production assumed to return to early2000 levels of around 250kt by 2025.
	2.D. Non Energy Products	2.D.1 Lubricant Use	Increased non-energy product use linked to manufacturing industry activity within Category 1.A (Energy); assumed to increase as a function of projected GDP growth and decreasing energy per unit GDP intensity.
		2.D.5 Paraffin Wax Use	

Note: Growth rate and industrial output assumptions are based on Zimbabwe National Industrial Development Policy (2019-2023) and expert judgement

4.2 Mitigation Measures

Figure 4.2 summarises the mitigation measures identified to contribute to the LEDS, according to each of the key sources of IPPU emissions. Within the cement sector, process CO_2 emissions from the calcination process account for around 60% of total plant emissions. The primary option for reducing these is to substitute the clinker content within cement production with other materials such as fly ash from power generation and Blast Furnace Slag (BFS) from steel production. These materials are currently used in cement production, but experiences globally show that these rates could be increased over time subject to the availability of low-cost substitutes and the acceptance of lower clinker products within the market and regulatory framework. These measures are therefore proposed as an important element within a broader package of measures to increase the sustainability of the cement sector in Zimbabwe.

The main GHG emission from fertilizer production in Zimbabwe is nitrous oxide (N_2O). The gas is produced from nitric acid generated during the production of ammonium nitrate fertilizer. Use of nitrous oxide abatement technology is expected to reduce nitrous oxide emissions from ammonium nitrate production by up to 80%. Technical feasibility analysis supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) Nitric Acid Climate Action Group (NACAG) has identified the potential to install secondary catalyst technology at the facility, which could result in N_2O emissions abatement of around 80%.

Globally, the iron and steel industry is the largest industrial source of CO_2 emissions due to the energy intensity of steel production and its reliance on carbon-based fuels and reductants (primarily coking coal).[1] Although currently there is low output from the steel industry in Zimbabwe, a return to large scale production within the next decade, as assumed in the BAU scenario, based on the integrated blast furnace to basic oxygen furnace(BF-BOF) steelmaking route would result in a large increase in process emissions.

Currently, the main route to reducing non-energy emissions from BF-BOF steelmaking is to substitute coke input with biomass source (IPCC, 2006)[2]. Studies estimate that CO_2 emission reductions of up to 1.3 1.3kg CO_2 e/kg of steel may be possible with 100% coke substitution (Norgate and Langberg, 2009)[3], equivalent to abatement of around 80-90% of total process emissions. However, technical factors currently limit the use of biomas in large blast furnaces to 20%. The use of a processed type of biomas with better mechanical properties, known as bio-coke, is currently under development and could enable larger substitution rates over the longer-term. Only biomas feedstock from sustainable forests will be considered, as well as bio coke from crop residues and other sustainably produced biomass.

Production of ferrochromium (FeCr) is an energy-intensive industry involving a high consumption of coking coal. The GHG intensity of FeCr production from modern closed furnaces deploying Best Available Technology (BAT) can be up to half as that from older facilities using open furnaces. It is expected that a phased replacement of existing open furnaces in Zimbabwe's ferroalloy sub-sector, with modern closed furnace technology employing BAT, could deliver significant energy savings and GHG reductions. Similar to iron and steel, there is also the potential to replace the carbon content provided by coking coal with sustainable biomass alternatives such as bio-coke, resulting in significant reductions in IPPU emissions. This has been estimated, based on similar assumptions for substitution in steel making.

1 Carbon is supplied to the blast furnace mainly in the form of coke produced from metallurgical grade coking coal, but can also be in the form charcoal made from wood or other forms of carbon. Carbon serves a dual purpose in the iron making process, primarily as a reducing agent to convert iron oxides to iron, but also as an energy source to provide heat when carbon and oxygen react exothermically.

2 Reporting Guidelines for National GHG Inventories: IPPU Chapter (IPCC, 2006).

3 Environmental and Economic Aspects of Charcoal Use in Steelmaking. In ISIJ International 49(4):587-595. T.Norgate and D.Langberg, 2009.

Table 4.1: List of mitigation measures for Zimbabwe LEDS in IPPU

Sector	Category	Mitigation measure	Principal mitigation effect
IPPU	Cement production	Increased clinker substitution with fly ash (up to 16% by 2030, 20% by 2050).	Increasing the content of clinker substitutes within cement products reduces CO_2 emissions associated with clinker production.
		Increased clinker substitution with BFS (up to 16% by 2030, 20% by 2050).	
	Fertiliser (nitric acid production)	Decomposition of N_2O emissions through use of a secondary catalyst.	Selective De-N_2O catalyst results in abatement of approximately 80% of all N_2O emissions produced during nitric acid production.
	Iron and steel	Substitution of coke input to BF/BOF steel making with biomass	Replacement of up to 50% fossil carbon input by sustainable biomass supply (starting at 20% in 2025, rising to 50% by 2040) results in large reduction in IPPU emissions.
	Ferrochromium production	Substitution of coke input to FeCr-production with biomass	Replacement of up to 50% fossil carbon input by sustainable biomass supply (starting at 20% in 2025, rising to 50% by 2040) results in large reduction in IPPU emissions.

Figure 4.3 summarises the estimated emissions reduction potential in 2030 for the IPPU mitigation options identified in the Table 4.1. In terms of overall mitigation contribution, N_2O decomposition from nitric acid production accounts for half of the estimated mitigation potential of approximately 32MtCO_2e in 2030. Coke substitution within the metals industry (iron and steel and ferrochromium production) account for the majority of the remaining mitigation potential.

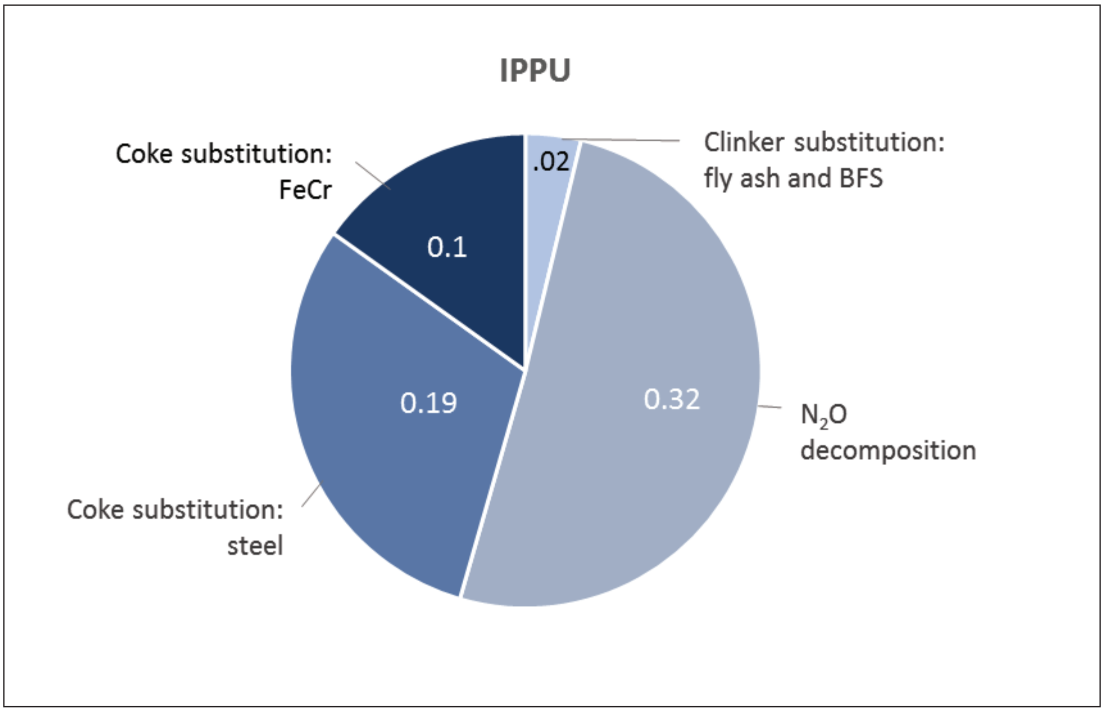


Figure 4.3: GHG mitigation potential of the IPPU sector amounting to 0.81MtCO_2e in 2030

The estimated contribution from these key mitigation options over the long-term to 2050 is shown in Figure 4.4 The projections show that with the implementation of all mitigation measures, total emissions could be limited to around 1.3 $MtCO_2e$ in 2050, compared to 2.5 $MtCO_2e$ under BAU representing around half of total IPPU emissions. The future recovery of industrial activity in Zimbabwe over the coming decade will clearly determine the pathway of BAU emissions as well as the feasibility of implementing different mitigation options. Investment in new equipment, plant and practices offers an opportunity to build in low carbon options and cost-effective energy saving technologies.

Subject to accessing finance and (in the case of cement) overcoming non-economic barriers, cost-effective mitigation could be achieved within fertiliser production and cement production based on already well-established abatement technology. The GHG emissions abatement within the metals industry is uncertain. This uncertainty arises from the outlook for these sectors in Zimbabwe, the types of technology used and the inability of the measures such as coke substitution to be economically viable over the coming decades.

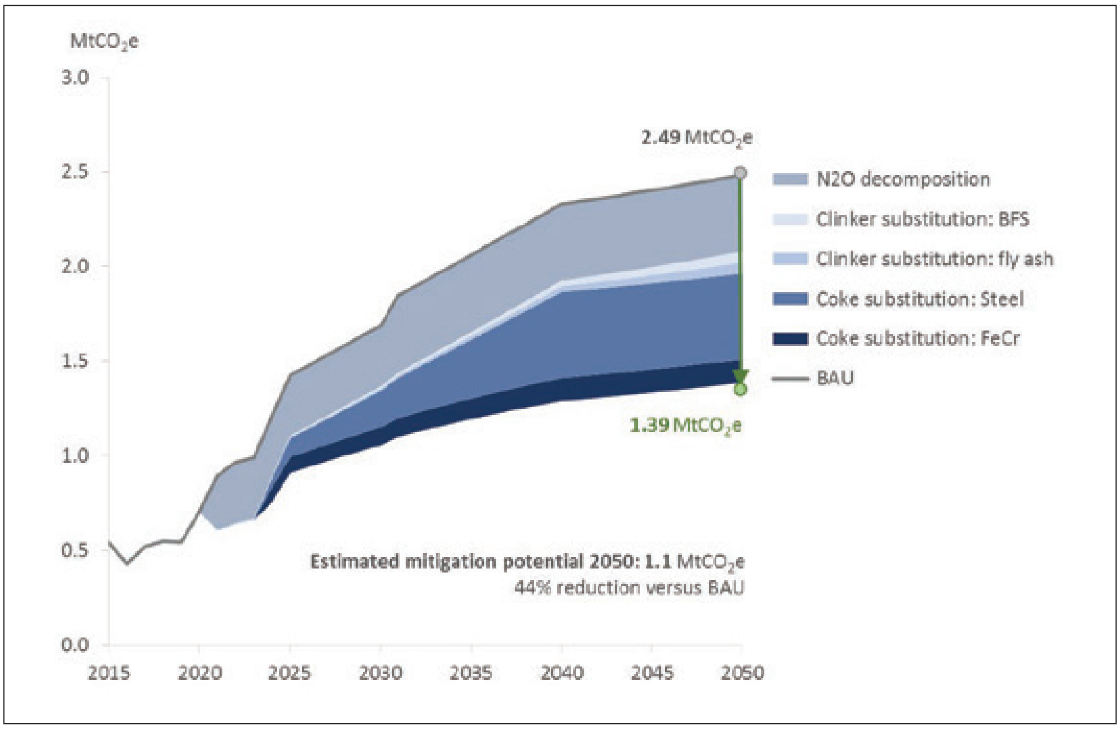


Figure 4.4: GHG emissions projections from IPPU under BAU and with mitigation

4.3 Economic Analysis

Figure 4.5 shows the marginal abatement cost curve for the IPPU sector. The figure shows that around half of the mitigation potential could be achieved at low or negative cost. Subject to materials being available and non-economic barriers overcome, clinker substitution can result in a reduction in both industrial process emissions and production costs. Application of secondary catalytic technology to N_2O emissions from nitric acid production is a proven technology delivering large emissions reductions for a relatively low capital cost. The economics of reducing emissions through the use of coke substitution will be largely determined by the relative costs of biomass fuels for example, bio-coke – and metallurgical coking coal.

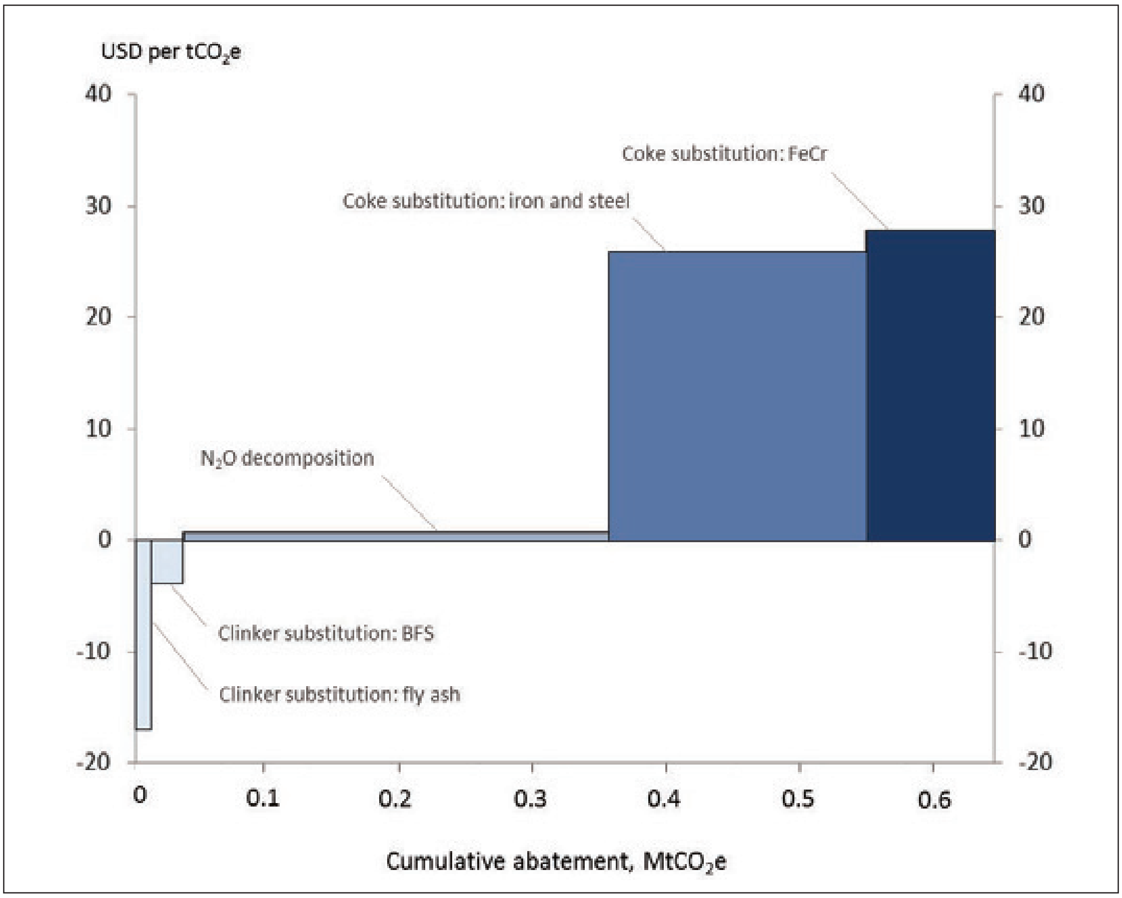


Figure 4.5: Marginal abatement cost curve for IPPU, 2030

4.4 Roadmap of Actions

Figure 4.6 shows a summary timeline for the development and implementation of each of the actions proposed to implement the LEDS in the IPPU sector.

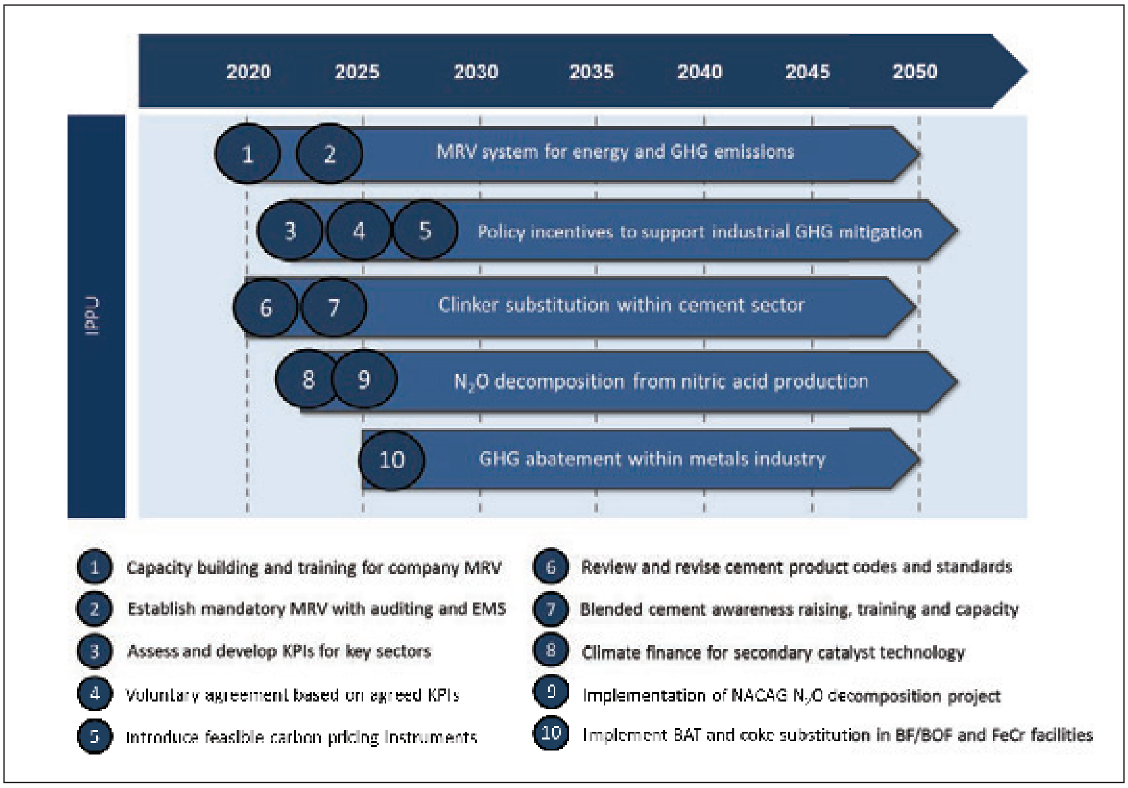


Figure 4.6: Timeline of mitigation actions to support NDC implementation within IPPU

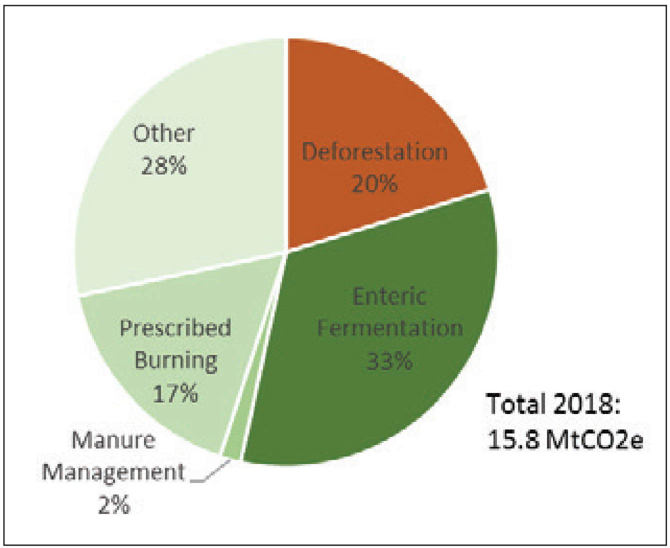
Note: MRV = Monitoring, Reporting and Verification; EnMS = Energy Management System

5. Agriculture, Forestry and Other Land Use

5.1 Business-as-usual Emissions

The total annual GHG emissions for the country sum up to 22.0 $MtCO_2e$, which constitutes 0.045% of the global emissions (GoZ, 2015). The TNC reported the total carbon stock, not the stock change. In the TNC enteric fermentation contributed the second highest GHG emissions (19.5%) after the energy industries (24.8%). In the LEDS development, forest loss data obtained from the Global Forest Change (GFW, 2019), as proxy data to estimate emissions from deforestation which employs an efficient algorithm for tiling cloud free Landsat images to produce up to date estimates of conversion from forest to non-forest was used. It is important to note, that GFW does not distinguish between anthropogenic and natural conversion from forest to non-forest.

In 2018, GHG emissions from AFOLU amounted to 15.8 $MtCO_2e$.The emissions from conversion of forest to non-forest land amounted to 3.20 $MtCO_2e$, while the agricultural sector contributed 12.59 $MtCO_2e$ (80%) (Figure 5.1).



Emissions from Deforestation

Zimbabwe has not yet taken a final decision on its forest definition, inter alia considering crown cover. The preliminary agreement is to use a crown cover of 10%, which was used for the further analysis.

The emissions from forest degradation are not quantified. While the emissions may be significant, it has proven to be difficult to appropriately quantify the related activity data. For the determination of historic emissions (e.g. reference period of 10 years), very high-resolution imagery is not available. Attempts to quantify the emissions from degradation using Landsat imagery have proven to be inaccurate. Therefore, the emissions from forest degradation are not quantified. GoZ may develop capacities for the monitoring of forest degradation, once higher resolution imagery is available also for the historic reference period.

For the BAU scenario, following the Forest Carbon Partnership Fund (FCPF) methodological Framework, a historic reference period of ten years (i.e. 01/2009 to 12/2018) was applied. The changes shown in Figure 5.2 were attributed to emissions from deforestation, as well as the effects of the improvement in accuracy of the GFW algorithm. As a result, the shifting average approach was used to calculate the ten-year averages the GFW algorithm underwent updates resulting in significant increments in the accuracy. The updates are only applied for new images. This leads to reporting of deforestation, which was not detected before, which may partly explain the jumps in Figure 5.2. Hence, the LEDS development process considers the 10-year average as BAU scenario was considered.

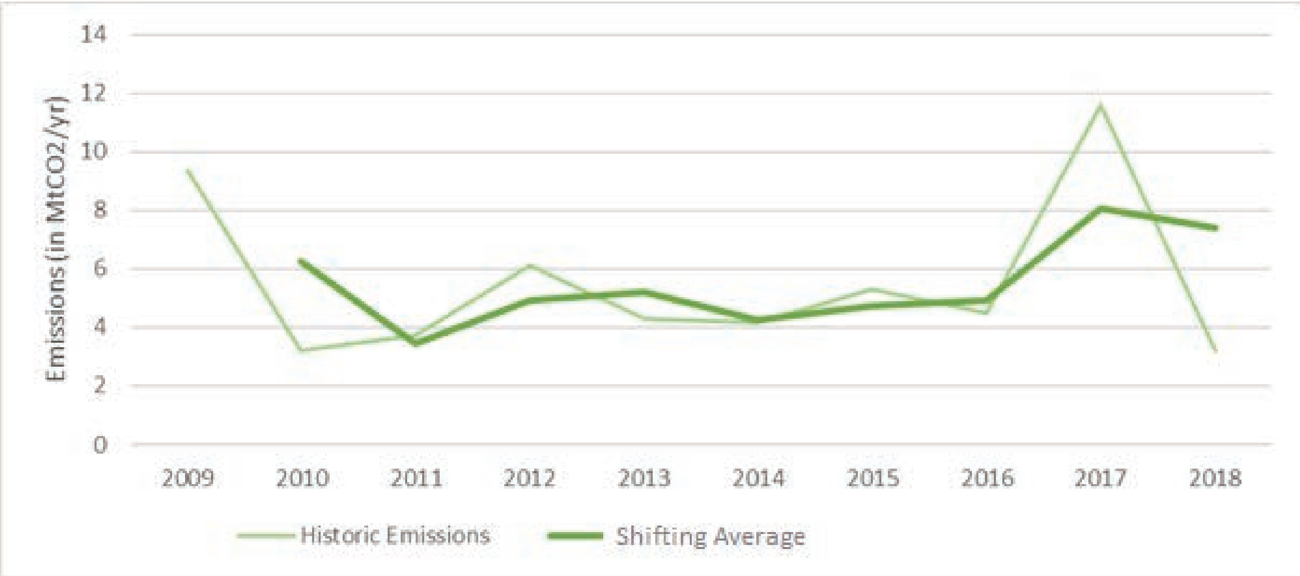


Figure 5.2: Zimbabwe Annual Emissions from Deforestation for the period 2009-2018[1] (cp. Harris et al. 2018)

The approach taken to developing a BAU projection for each contributing sub-sector is summarized in Table 5.1.

1 *This data does not distinguish between anthropogenic and natural deforestation (cp. Harris et al. 2018) and hence is used as proxy in the absence of a Forest Reference Emission Level.*

Table 5.1: Summary of the approach to BAU AFOLU projections per IPCC Category

Sector	Sub-sector	Category	Methodology.	Assumptions
3. Agriculture, Forestry and Other Land Use	3.A Livestock	3A1 Enteric fermentation	Provided a forecast of the GDP for the agricultural sector. The relation GDP agriculture (based on constant prices) and GHG emissions of livestock based on historic data for the period 1990 – 2018 was assessed Considering the correlation co-efficient and the GDP forecast up to 2050, livestock populations and GHG emissions from 2020 to 2050 were projected.	Increase in agricultural GDP expected for the period 2020-2050
		3A2 Manure Management		Significant correlation exists between agricultural GDP and livestock population up to 2050. No significant change is expected in CH_4 to livestock population relationships between the 1990-2018 and the 2020-2050 period.
	3.B Land	Forest Land converted to other land use	Considering a forest definition with a minimum threshold of crown cover of 10%, historic data for the period 2009 to 2018 was used to derive an average GHG emission estimate per annum.	Future emissions correspond to the historic ten-year average.
	3C Aggregate sources	3C1 biomass burning	Based on historic data for the period 1990 – 2018.	It is assumed that the emissions of agricultural soils depend to a large extent on the intensification of agricultural productivity linked to fertilizer application. Consequently, the development of the emissions of aggregate sources are modelled using ZIMRA's GDP forecast for the agricultural sector.
		3C2 Liming		
		3C3 Urea application		
		3C4-5 direct and indirect emissions from managed soils		
		3C7 Rice cultivation		

Figure 5.3 shows the GHG emissions for deforestation and agriculture from 2000 projected to 2050 under the BAU scenario.[1] Based on forecasts provided by ZimStat, GDP growth projections indicate period of strong growth of agricultural productivity up to 2034. From 2034, the agricultural GDP is projected to slightly decrease to 2050, as the economy's other sectors become more developed.

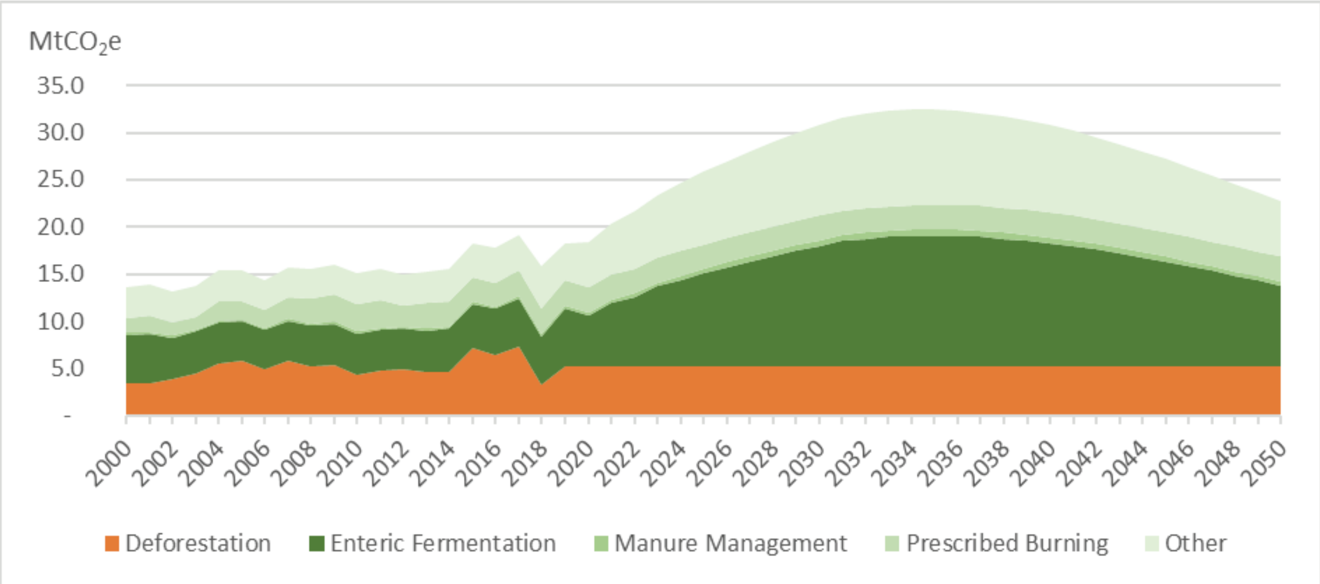


Figure 5.3: Historic and projected BAU GHG emissions for AFOLU

5.2 Mitigation Measures

Deforestation is one of the most severe environmental problems in Zimbabwe (GoZ, 2017) Annual forest area loss was estimated at 32,000 ha per annum for the period 2009-2018 (based on crown cover of 10%). Furthermore, forest degradation that is largely driven by the same factors causes many environmental problems such as increased soil erosion, depletion of water resources, and changes in microclimates.

Table 5.2 summarizes the mitigation measures identified by stakeholders for the forestry and agriculture sector.

1 The BAU assumes a constant deforestation rate from 2018- 2050 assuming Sustainable Management of all Forest Resources in the country.

Table 5.2: List of mitigation measures for Zimbabwe LEDS in the AFOLU Sector

Sector	Category	Mitigation measure	Principal mitigation
	3.A Livestock	Feedstock improvement	Improved feedstock reduces CH_4 emissions from enteric fermentation.
3. Agriculture, Forestry and Other Land Use	3.B Land	Climate Smart Agriculture Reduction of deforestation.	Increases SOC stock (provided by International Maize and Wheat Improvement Centre (CIMMYT)). Reduced GHG emissions from machinery provided CIMMYT Economic impact of maize mucuna intercropping, provided by International Crops Research Institute for the Semi-arid tropics (ICRISAT). A set of policies and initiatives to reduce net deforestation to 0.5% by 2035: National tree planting programme. Tobacco regulations requiring the use of dedicated energy plantations for tobacco drying. Sustainable tobacco initiatives, implemented by tobacco companies. Tobacco Wood Energy Programme, proposed by the Forestry Commission. Reduction of prescribed burning assisting natural Improved enforcement of national forest legislation. Sustainable Woodland Management Program (SWMP)
		Fruit Tree planting	Improvement of AGB+BGB carbon stocks in fruit tree plantation and provision of alternative income streams to reduce pressure on existing forests.
		Commercial Forestry	Establishment of commercial forests increases the ABG and BGB carbon stocks; The storage in long term harvested wood products may result in additional GHG
Sector	Category	Mitigation measure	Principal mitigation
			emission reductions not quantified.
	3C Aggregate sources	Reduction of prescribed burning	Reduces CH_4 and N_2O emissions from burning biomass in savannah, shrub land and grassland.

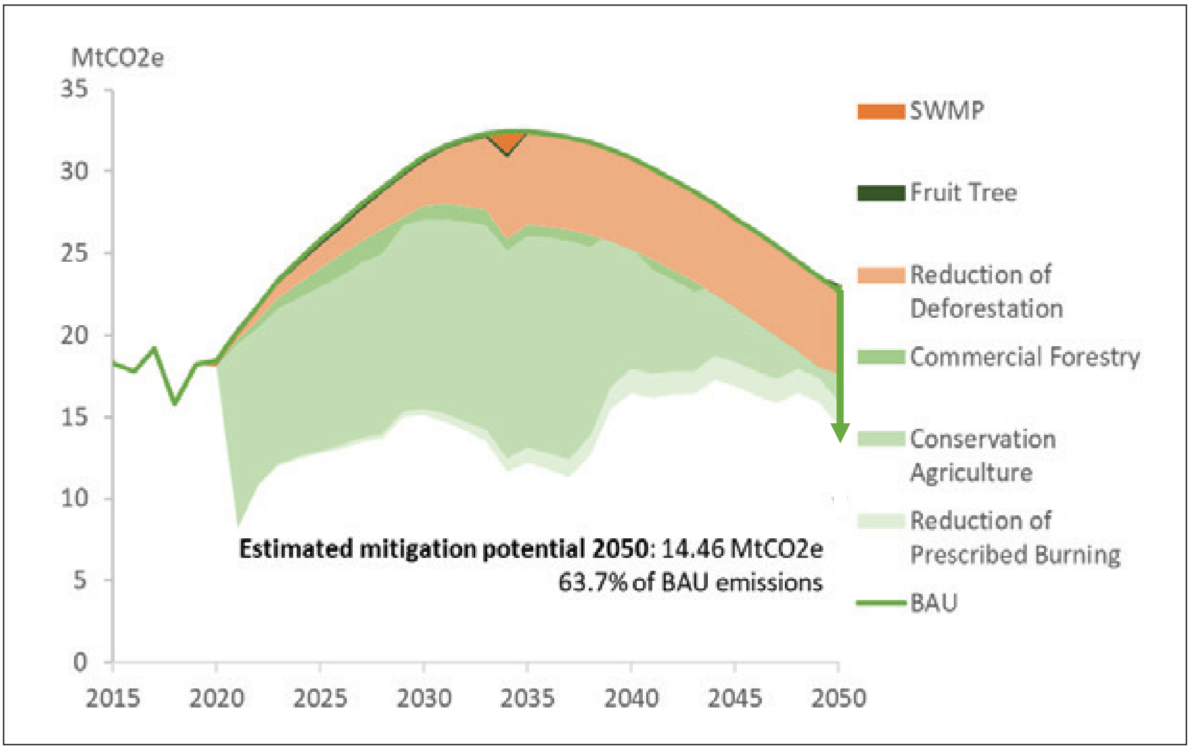


Figure 5.4: Estimated mitigation potential from AFOLU

Figure 5.4 summarizes the estimated GHG abatement potential by 2050 for all identified mitigation options. The results indicate that conservation agriculture may provide an important contribution to reducing the Zimbabwe's overall emissions. CA is a practice, which has implications on different GHG sources /carbon sinks. It increases SOC stocks, reduces fuel consumption by machinery, through the improvement of animal feed, reduces the emissions from enteric fermentation and may also reduce direct and indirect emissions from fertilizer application.

While conservation agriculture is a well proven solution in Zimbabwe, there could be further benefits in the future in transitioning from Conservation Agriculture practices into increasingly regenerative agriculture practices. It is expected that farmers that have already taken up some or the full package of Conservation Agriculture measures will be ready to convert to more effective practices for restoring degraded land. Where relevant, this may include agro-forestry, tree-intercropping, silvo-pasture and improved grazing management strategies for land regeneration and associated increase in SOC stocks along with agro-forestry based carbon sequestration.

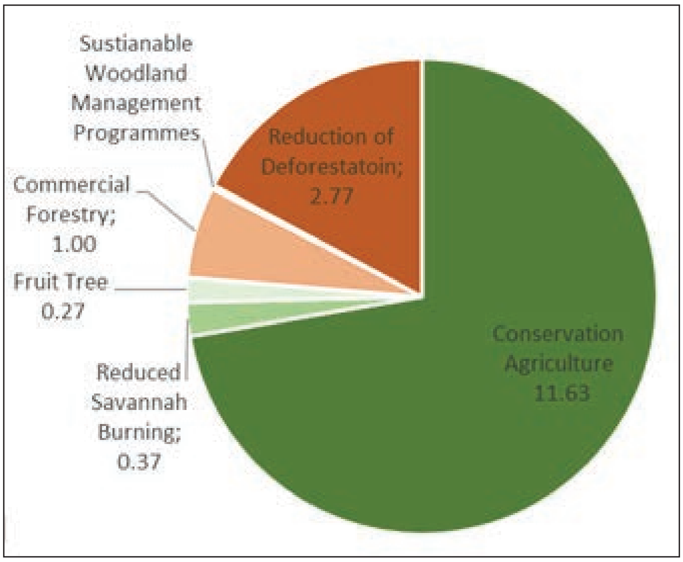


Figure 5.5: AFOLU GHG Abatement by Mitigation Measure

It is important to note that, commercial forestry may easily accommodate biomass energy demand of cement and ferrochromium mitigation measures specified under Chapter 4. The cement sector specifies an average annual energy demand from alternative fuels in the amount of 227.8 TJ, which could be met by 1,142 ha of short-term rotation plantations.

5.3 Economic Analysis

Figure 5.6 illustrates the marginal abatement cost curve of the AFOLU sector in which all abatement options are sorted in ascending order of marginal abatement cost. As discussed in Chapter 2, MACCs are based on an economic analysis. Specifically, for forestry operations, applying an economic discount rate is a decisive factor.

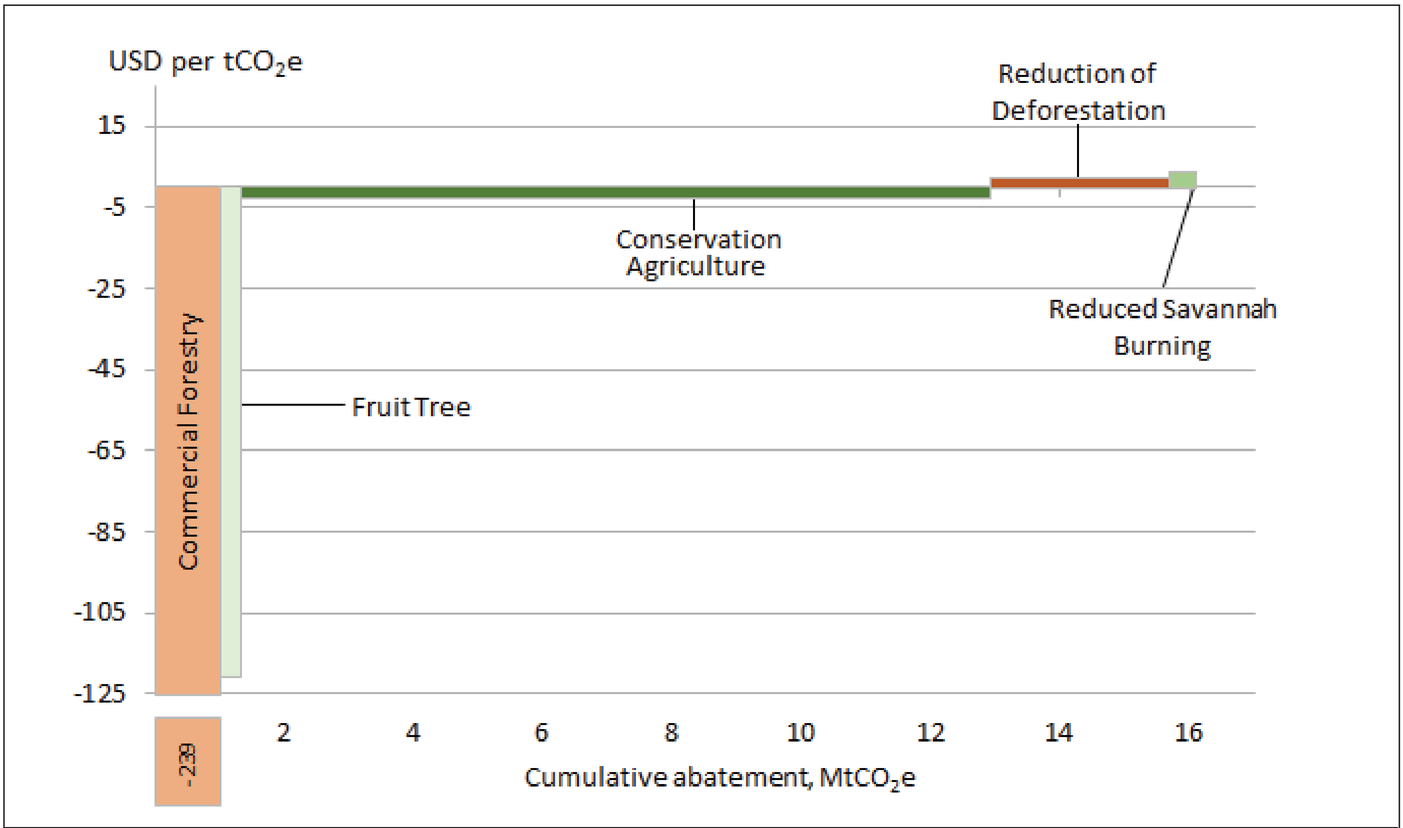


Figure 5.6: Marginal abatement cost curve for AFOLU, 2030

Interestingly, 80.22% of the mapped abatement potential allows reducing GHG emissions while increasing economic wellbeing at a discount rate of 6% per annum. However, it is important to note, that not even the most attractive activity (commercial forestry, with MAC of -239.35 USD) is financially viable with the current lending rate.

5.4 Roadmap of Actions

Figure 5.7 shows a summary timeline for the development and implementation of each of the actions proposed to implement the LEDS in the AFOLU sector.

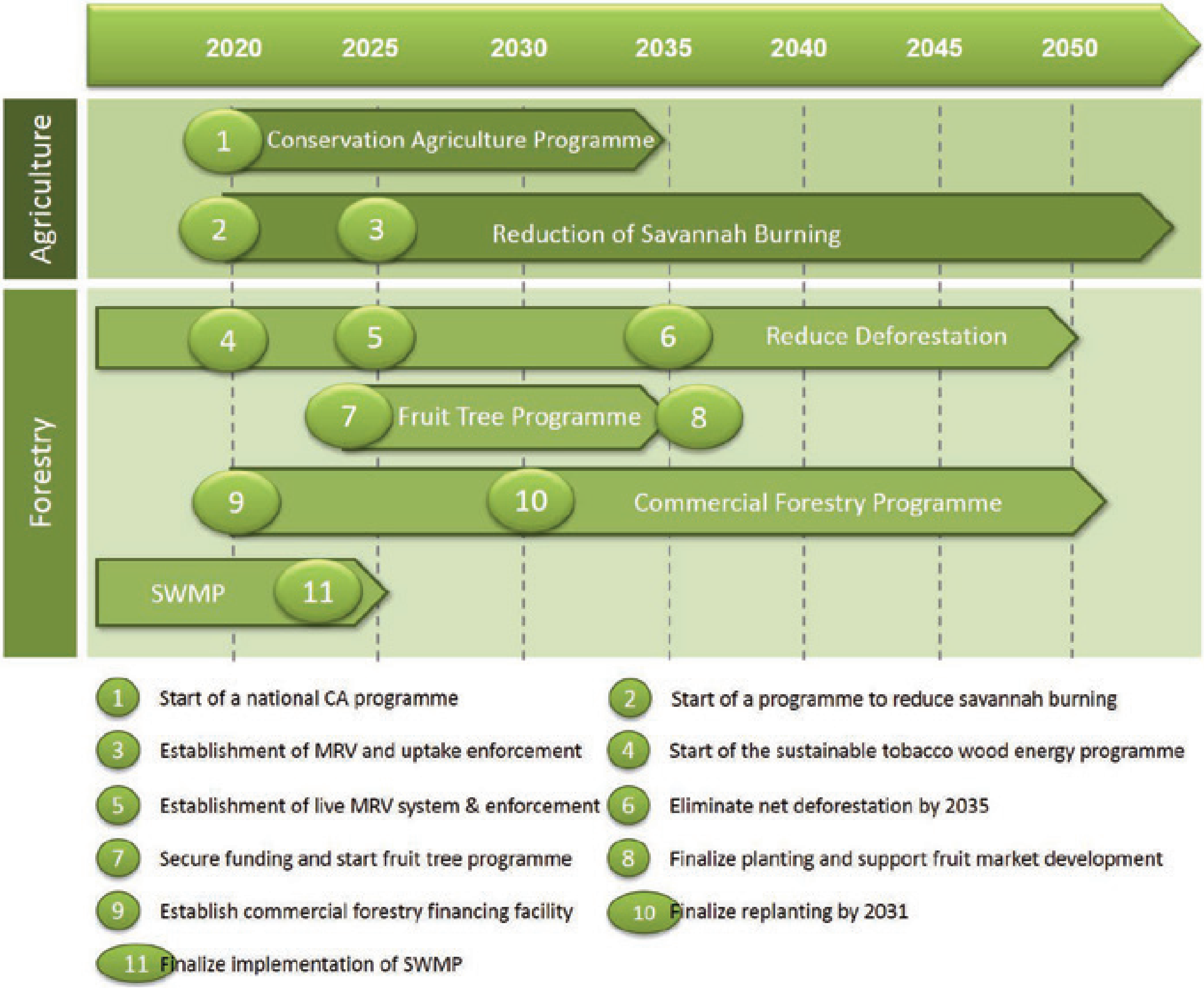


Figure 5.7: Timeline of mitigation actions to support LEDS implementation within AFOLU

6. Waste

6.1 Business-as-usual Emissions

In 2006, the Waste sector contributed 0.75MtCO_2e, (3.42%) of the national GHG emissions (22.0MtCO_2e). GHG emissions in Zimbabwe from the Waste sector mainly arise from solid waste disposal sites (SWDS) and wastewater treatment in urban areas. Biological treatment of solid waste, waste incineration and open burning of waste do not contribute much to the GHGs in Zimbabwe, and data on these waste management practices is scanty. The main gases produced from waste handling are CH_4, CO_2 (fossil origin), N_2O, NO_x and non-methane volatile organic compounds (NMVOCs) (IPCC, 2006). The TNC only covered CH_4 from the Waste sector due to lack of activity data. Solid waste management was a key category (excluding LULUCF) in 2006 and contributed 2.91% while emissions from wastewater were 0.53% of the national total (GoZ, 2016). Greenhouse gas emissions from waste incineration and open burning of waste were not estimated in the TNC due to lack of activity data. The main climate change mitigation action cited in the TNC was integrated waste management, and to a lesser extent, waste to energy (GoZ, 2016).

The main policies and strategies that relate to waste management in Zimbabwe include; the National Climate Policy (see Section 3.4), National Climate Change Response Strategy (see Section 3.3.4), National Environmental Policy and Strategies and Integrated Solid Waste Management Plan.

The main activity drivers for waste in Zimbabwe are population growth, urbanization, GDP, unsustainable consumption and poor waste management practices. Waste projections were based on population growth because. The mitigation options proposed in the LEDS focus on Landfill gas (LFG) capturing and composting. A waste collection rate of 80% was assumed to be achieved in 2020 and later increasing progressively to 100% by 2050. The involvement of corporates, small and medium enterprises remains critical in all aspects of solid waste management.

Under BAU, GHG emissions from solid waste and wastewater are projected to grow from around 1Mt/yr in 2020 to around 2.5Mt/yr in 2050 (Figure 6.1). The emissions from wastewater are minimal and contribute approximately 0.56% to the total BAU emissions by 2050.

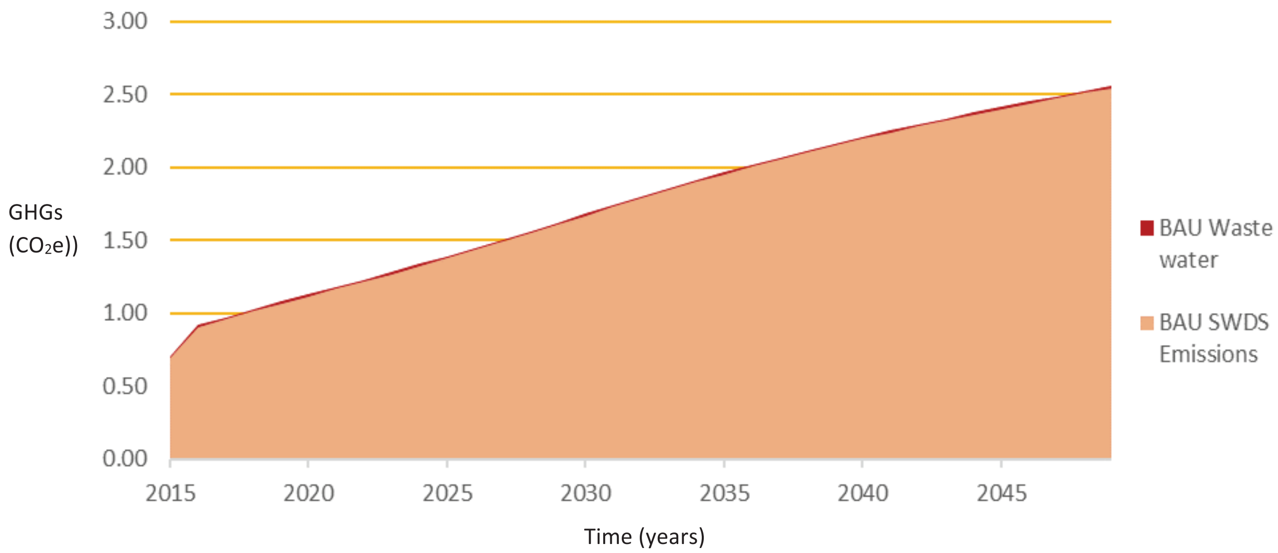


Figure 6.1: GHG emissions from Waste, historic and BAU projection to 2050 by source

6.2 Mitigation Measures

Mitigation measures identified include LFG capturing and composting of solid waste. Centralized composting facilities employing accelerated composting technologies were recommended taking into account the associated public health benefits. Although solid waste recycling was recommended in the Zimbabwe's Integrated Solid Waste Management Plan of 2014, the option was not considered in the LEDS. This climate change mitigation option has limited effect in reducing GHG emissions from the Waste sector. Methane flaring from wastewater was not considered due to its limited application and unavailability of related data in Zimbabwe. Waste to energy was recommended for the cement industry as an off taker. The related mitigation measures are included in the Energy section, Chapter 3.

The Waste sector CDM tool, Version 02.0.0, was used for climate change mitigation modelling for the Waste sector. The tool provides procedures for calculating CH_4 emissions from SWDS or prevented from SWDS.[1] The tool was developed for methane emissions mitigation from existing SWDS. The tool can be applied for mitigation of emissions from LFG flaring or avoided emissions from composting (UNFCCC, 2013). The existing SWDS from Harare, Bulawayo, Mutare and Gweru were considered.

Methane gas flaring

LFG flaring is achieved through the combustion of gases produced from waste decomposition. Over 98% destruction of organic compounds from LFG can be achieved through the use of open or closed flares. Open flame flaring is cheaper and easier to operate, although it presents challenges in the control of the process. Enclosed flares, though expensive, provide better combustion efficiencies and control of LFG flaring.

The Waste sector LEDS mitigation action assumes that LFG flaring will be conducted in the SWDS. It was assumed that 72.6% of the methane generated would be collected and flared. The LEDS envisages that methane flaring projects are implemented one city after the other, starting with Harare in 2020, followed by Bulawayo in 2021, Mutare in 2022 and Gweru in 2023, based on stakeholder consultations. A positive marginal abatement cost of $0.74/ tCO_2e was obtained from the economic analysis conducted. The positive marginal abatement cost showed that LFG flaring could be justified based on climate change mitigation and not on return on investment.

Composting

The residual emissions from the 72.6% abated through LFG flaring were targeted to be removed through composting. Composting reduces the generation of CH_4 at SWDS from new waste generated.

Figure 6.2 presents the BAU emissions and mitigation option from flaring and composting. The marginal abatement cost analysis on an internal rate of return (IRR) of 12.75% revealed that composting is financially viable (Figure 6.3).

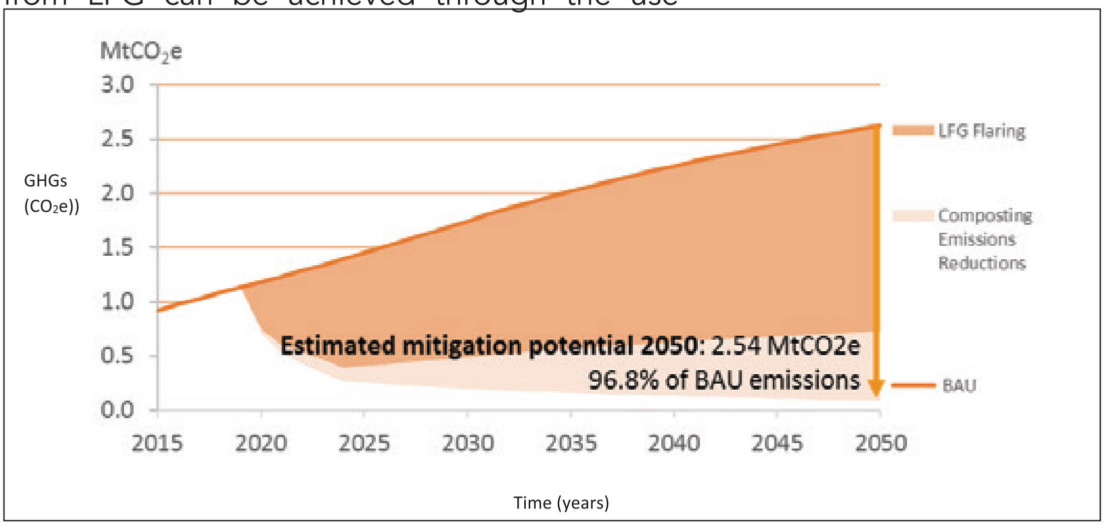


Figure 6.2: GHG emissions projections from waste under BAU and with mitigation

Solid waste recycling

The integrated Solid Waste Management Strategy (ISWMS) (2014) for Zimbabwe includes the option of recycling. Recycling assists in removing any contaminants from waste so as to render such waste reusable or returned to the economic mainstream in the form of raw materials. The environmental concerns on recycling include the need to reduce waste at dumpsites. Financial, economic and social motivation factors for recycling border on reduction in waste handling cost and revenue generation. Since recycling addresses waste management activities upstream, this option was however not considered in the mitigation analysis within the LEDS

6.3 Economic Analysis

The Waste sector MACC (Figure 6.3) indicates that significant CH_4 emissions can be abated through composting thus giving financial gains. Further mitigation can be achieved with flaring, which gives better mitigation option, but with no financial benefits. Flaring can therefore, be justified entirely on climate change mitigation reasons.

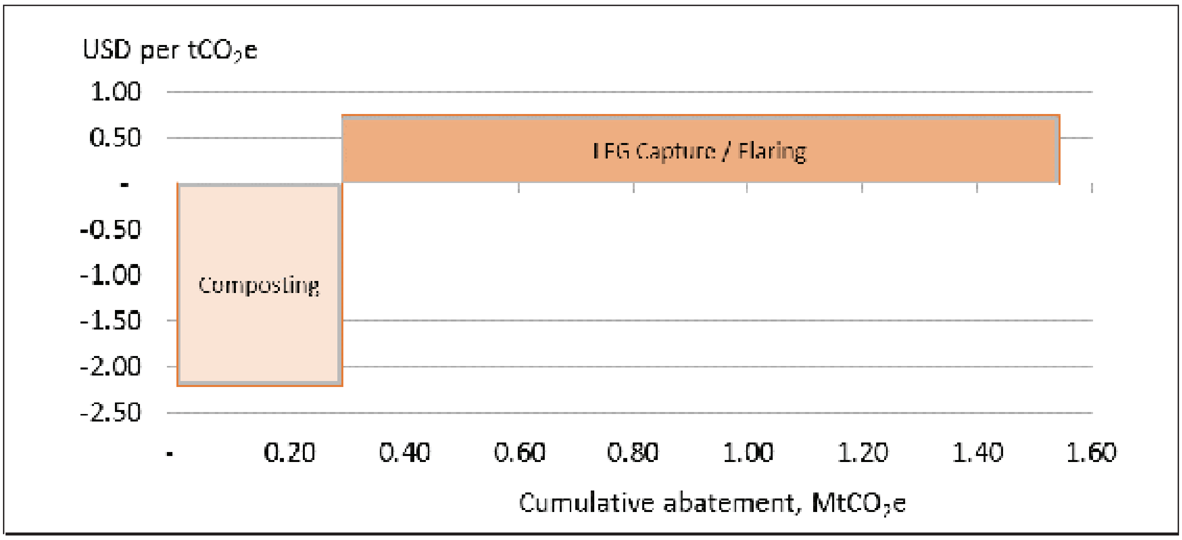


Figure 6.3: Marginal abatement cost curve for Waste

6.4 Roadmap of Actions

Figure 6.4 shows a summary timeline for the development and implementation of each of the actions proposed to implement the LEDS in the waste sector.

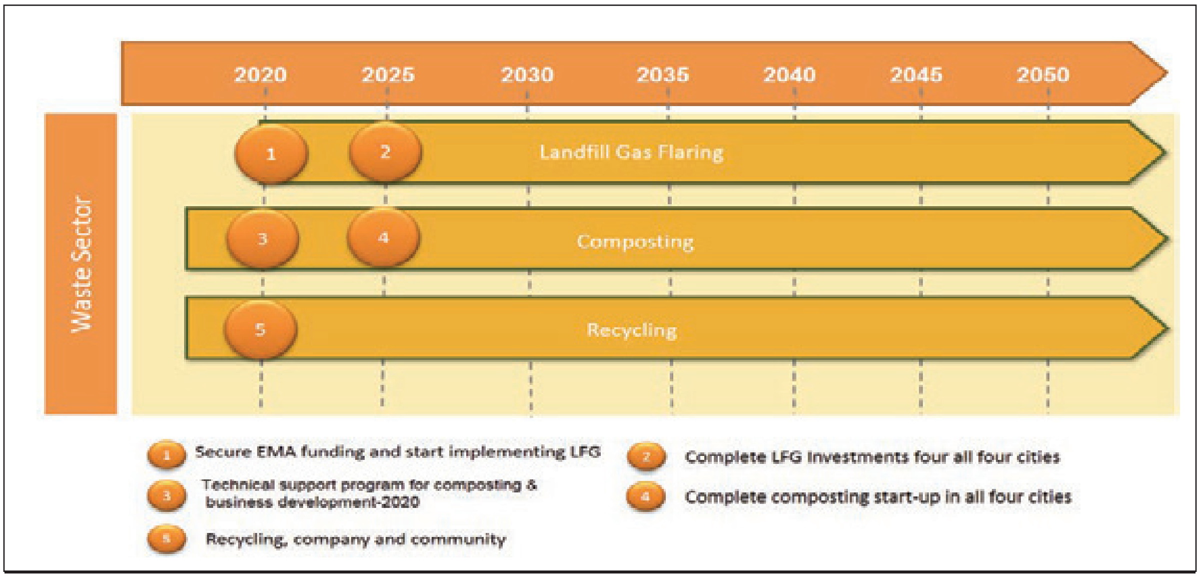


Figure 6.4: Roadmap for the Waste Sector

7. Summary of BAU and MIT Scenarios

Zimbabwe, as a developing country, is projected to experience decades of economic growth with its GDP increasing from USD 19,600 million in 2020 to USD 119,100 million by 2050, based on constant prices (ZIMRA, 2019). This corresponds to an increase of 508% over three decades. Economic development is driving Zimbabwe's BAU emission increment.

Since the beginning of its GHG emission inventory reporting in 1998 (Initial National Communication), the GHG intensity of Zimbabwe's economy has been decreasing. This is also reflected in Zimbabwe's BAU emission scenario. Figure 7.1 illustrates the aggregated BAU scenario up to 2050. The GHG emissions are projected to increase from 36.58 $MtCO_2e$ in 2020 to 65.28 $MtCO_2e$ in 2050. This corresponds to an increase of 78% over three decades.

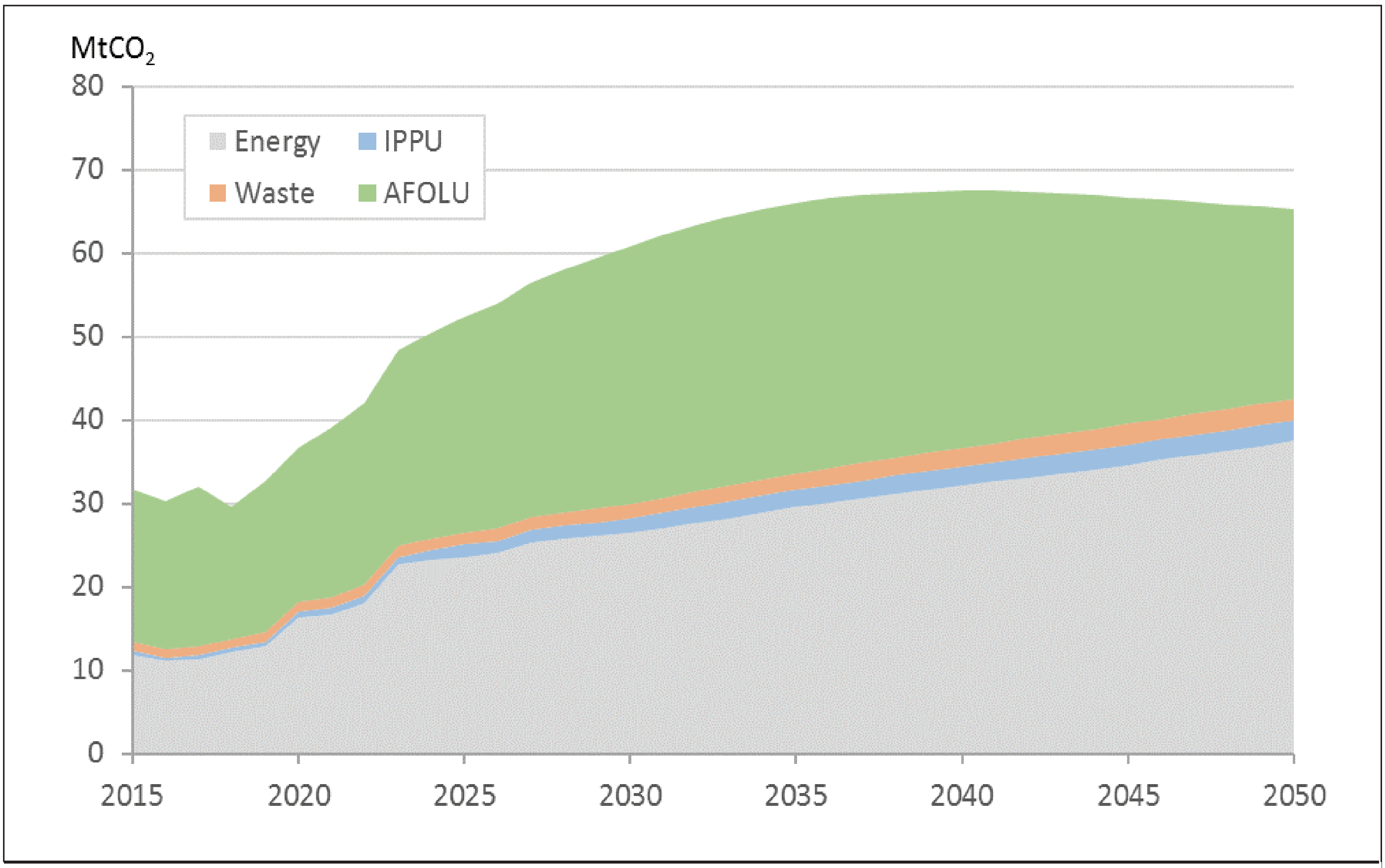


Figure 7.1: Economy wide BAU Scenario

Chapters 3 to 6 describe the mitigation potential from the 38 different mitigation measures identified in the strategy. These mitigation measures have the potential to significantly reduce Zimbabwe's GHG emissions below the BAU scenario despite strong forecast economic growth.

Figure 7.2 illustrates Zimbabwe's mitigation potential, aggregated according to the IPCC sector classification. The abatement potential is estimated to be up to 33.2 $MtCO_2e$ by 2050, which corresponds to around 50% of BAU GHG emissions in that year. The largest abatement potential is expected from the AFOLU sector (46.9% of the total abatement potential), followed by the energy sector (44.4%), waste (6.1%), and the IPPU (2.7%).

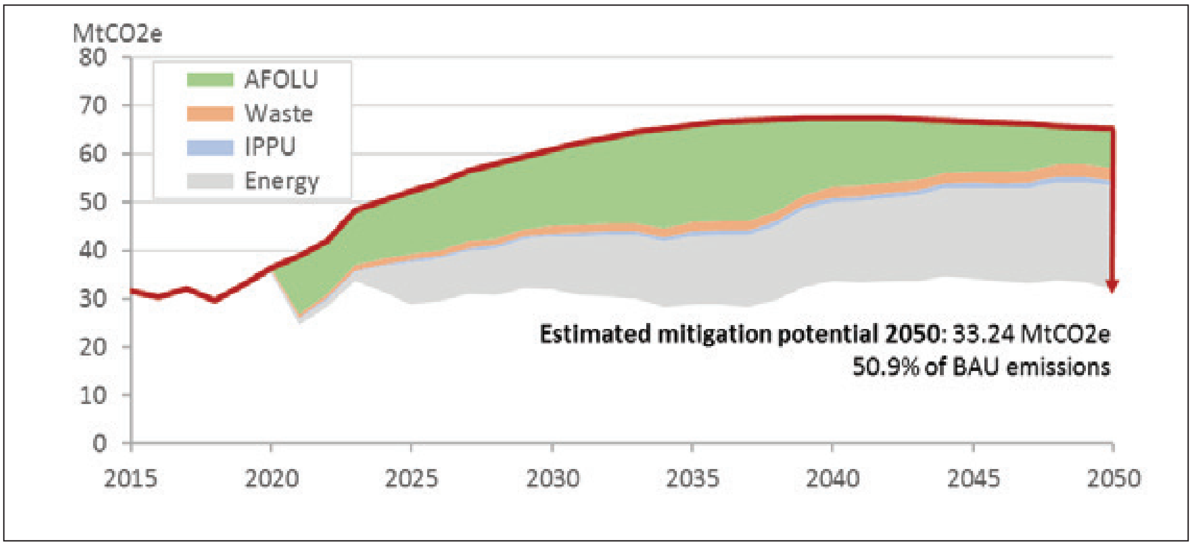


Figure 7.2: Economy wide MIT Scenario

Figure 7.3 shows the mitigation potentials of the top ten mitigation measures. Conservation agriculture[1] is expected to contribute the largest share with 28%, followed by the Batoka hydro power plant (20%). Other renewable energy projects (Devil's gorge, further RE measures) may contribute another 8% and 6% respectively. It is equally important to consider the trends of the mitigation contributions by sector over time.

The AFOLU abatement potential is driven by Conservation Agriculture, which leads to a substantial Soil Organic Carbon (SOC) increment, reduction of emissions from enteric fermentation and emissions from fuel combustion in agriculture in the years following the change of management regime. However, as SOC reaches a new dynamic equilibrium state, the annual sequestration rates diminish.

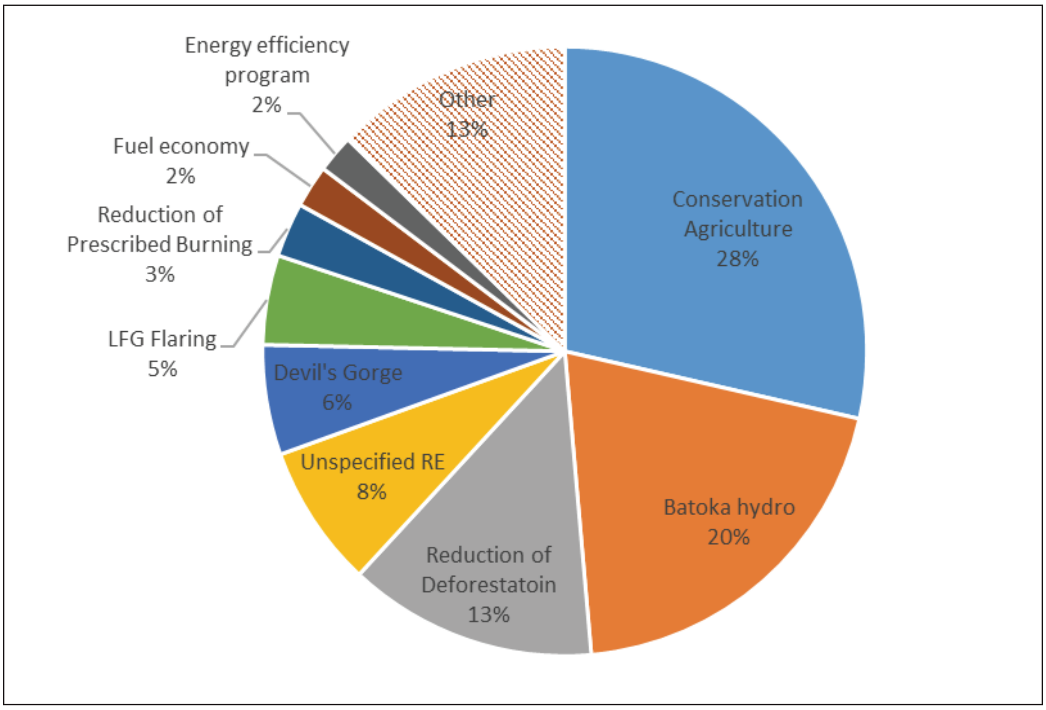
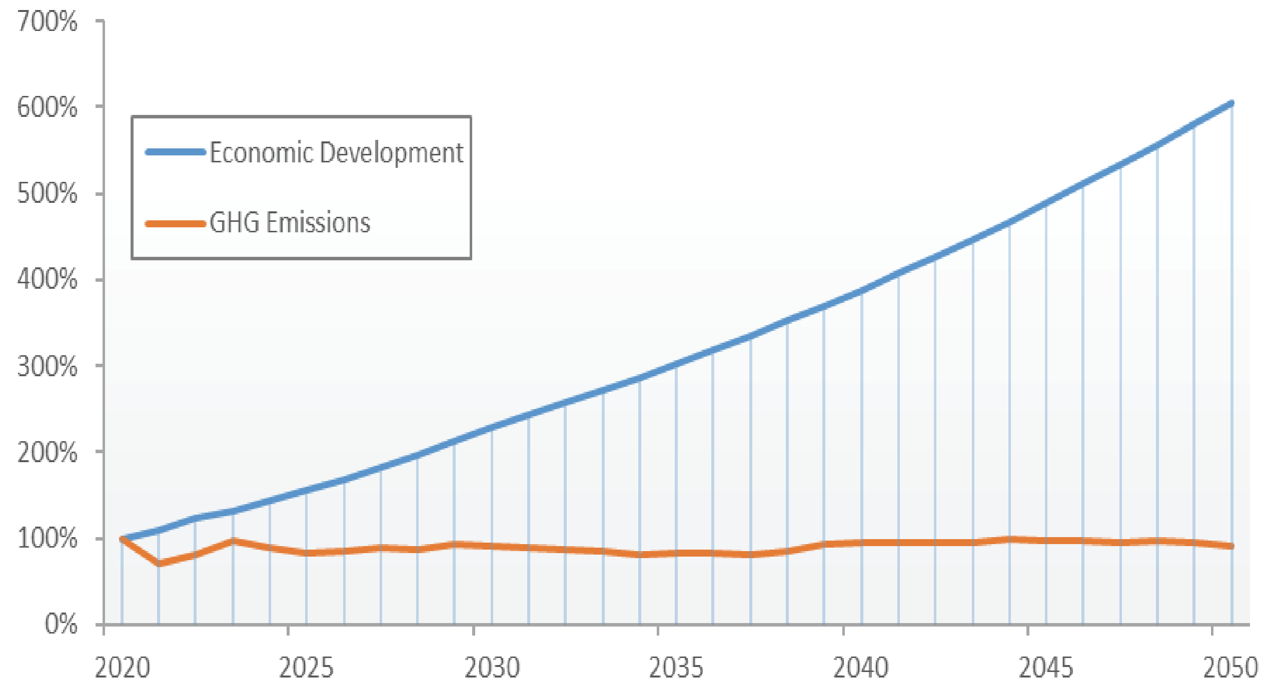


Figure 7.3: Contribution of top ten mitigation options

1 *Conservation Agriculture in this case includes emission reduction from fuel combustion, enteric fermentation and enhancement of soil organic carbon.*

The Energy sector, on the other hand, is dominated by slow turnover rates related to long equipment lifetimes. Mitigation measures such as introducing fuel economy standards for the transport fleet or promoting renewable energy projects face comparably small penetration rates, although their abatement potential increases over time. These policies and mitigation technologies play a central role and may contribute substantially towards decarbonisation in the long-term.

The aggregated mitigation scenario shows the potential to decouple Zimbabwe's GHG emissions from economic development. Zimbabwe has very low GHG emission levels. Per capita emissions are around 1.82 tCO_2e/person compared to the world average of 6.27 tCO_2e/person. Figure 7.4 illustrates how Zimbabwe's mitigation scenario manages to cater for needed economic development while maintaining the country's total GHG emissions at current levels.



Note: Economic development reflects forecast growth in real GDP

Figure 7.4: Decoupling Economic Development from GHG Emissions under the MIT Scenario

8. Financing Strategy

This section describes the climate financing strategy framework that will support the ambitious mitigation measures outlined in this strategy. A robust financing strategy is needed in order to achieve low carbon development in Zimbabwe. Zimbabwe's financial challenges (2015-2019) led to a very high cost of capital (e.g. the prime lending rate amounted to 18% per annum for 2018). The high costs of capital resulted in investments in cheaper but GHG intensive technologies. These include inefficient vehicles, investments in diesel and coal power plants and use of energy intensive and inefficient equipment. Such decisions are guided by high discount rates, which lead to investment decisions with low CAPEX while the high OPEX over the equipment lifetime is discounted by high compound interest.

In such an environment, a climate financing framework offering concessional lending for low carbon investments can have significant impacts, including:

- Improving national economic development;
- Improving economic competitiveness in the mid to long-term;
- Reducing energy use and import dependency; and
- Reducing GHG emissions.

Against this background, Zimbabwe's LEDS reflected by the mitigation scenarios described in Chapters 3 to 6 is closely linked to the development of a Low Emission Development Financing Facility, which offers concessional lending reflecting the SDR. The SDR of 6%, suggested by the World Bank for infrastructure and energy projects in Southern Africa (WB, 2016b), was applied consistently in the analysis.

Zimbabwe's financing strategy is based on the following key elements: also se Figure 7.5):

- **GHG Mitigation Potential.** Abatement options which are predominantly economically viable, in which benefits (e.g. fuel savings, employment benefits) outweigh costs (e.g. costs of equipment, clean technology and infrastructure) were identified. The sectoral MACCs do not therefore represent all technically possible options but focus more on economically viable abatement options. The sectoral analyses were undertaken from a socio-economic perspective considering a SDR of 6% and the economic cost of fuel and electricity, among other factors.
- **Amendment of Policies.** It is envisaged that appropriate policies will guide the investment in mitigation measures. For example, MEPS will prescribe minimum standards for Air Conditioners (ACs) and lighting devices, among others. There will be need to purchase only equipment, which is compliant with these standards.
- **Financing Instruments.** To facilitate the implementation of the LEDS, it is essential that a suite of suitable financing instruments is available. These must be designed to reduce the gap between the SDR and the commercial lending rate. According to the analysis, most projects will become financially attractive if the lending rate is reduced to below 10%, most projects will become financially attractive.
- **Private Sector Investment.** Combining policy amendments with suitable financing instruments will enable crowding in of the private sector to invest in mitigation measures instead of continuing with BAU practices. It is therefore envisaged that the bulk of the investment required under the LEDS will be covered by the private sector avoiding further burden on Zimbabwe's national budget.

The implementation of this strategy will create a win-win scenario where investments in mitigation measures will result in reduction of GHG emissions by around 50% against the BAU scenario. In the long term the expected increased competitiveness will result in the overall improvement in economic performance, and environmental and social well-being.

Low Emission Development Financing Facility

The vision for funding the implementation of Zimbabwe's LEDS is based on the establishment of the National Climate Fund. The facility will comprise funds provided by Bi-lateral, Multilateral, Private funds and Official Development Assistance (ODA). Zimbabwe should prioritise accessing climate finances such as the Green Climate Fund among others to support implementation of the identified mitigation options. Activities to be funded include developing bankable project proposals, and implementation of high priority, high impact mitigation measures, which are not financially viable.

As shown in **Table 8.1**, the mitigation analysis indicates an accumulated investment need of USD 6.3 billion by 2030 to support the implementation of economically viable abatement activities.

Table 8.1: Summary of Investment Needs

	No	Mitigation Measure	NPV (in M USD)	MACC (in USD/ tCO_2e)	Accumulated Investment Need up to 2030 (in M USD)
Energy	1	On-farm biogas	175.01	-28.98	82.95
	2	Solar pumping for irrigation	517.32	-94.44	378.98
	3	Off-grid solar electrification	88.81	- 138.46	250.89
	4	Energy Efficient lighting	106.68	-224.34	4.00
	5	Rooftop solar (commercial)	128.43	-216.02	40.00
	6	Minimum Energy Performance Standard	39.31	-98.54	18.64
	7	Solar LED street lighting	25.12	-86.69	20.76
	8	Solar water heaters	489.69	-144.45	90.08
	9	Reactive Power Correction	123.96	-28.76	36.06
	10	City of Harare-Mbare biogas plant	0.15	-26.55	0.26
	11	City of Bulawayo biogas plant	2.91	-24.83	3.30
	12	City of Harare-Firle biogas plant	11.62	-24.79	13.20
	13	Devil's Gorge hydropower	238.36	-3.95	2,250.00
	14	Batoka hydro	1,123.65	-6.20	2,600.00
	15	Solar IPPs	- 1.91	4.74	13.28
	16	Rural Electrification Fund micro-grids	-0.14	10.85	2.66
	17	Zimbabwe Power Company solar plants	-96.61	11.02	354.00
	18	Unspecified Renewable Energy projects	N.A.	-1.91	-
	19	Energy efficiency programme	1,779.48	18.24	341.17
	20	Electric motors (mining)	0.83	-8.01	0.32
	21	National Railways of Zimbabwe Rail electrification	-349.47	102.20	801.00
	22	Electric Vehicles	-193.81	17.71	367.37
Energy	23	Public transport	N.A.	12.00	N.A.
	24	Fuel economy	2,051.67	-100.83	510.87
	25	Biodiesel programme	2.94	-0.92	299.70
IPPU	26	Clinker substitution: fly ash	12.42	-16.98	0.64
	27	Clinker substitution: Blast Furnace	2.86	- 3.91	9.22

	No	Mitigation Measure	NPV (in M USD)	MACC (in USD/ tCO_2e)	Accumulated Investment Need up to 2030 (in M USD)
		Slag			
	28	N_2O decomposition	- 2.23	0.70	2.84
	29	Coke substitution: Steel	- 226.21	25.86	-
	30	Coke substitution: FeCr	-81.96	27.86	-
Waste	31	Landfill Gas Flaring	- 31.79	0.74	14.36
	32	Composting Emissions Reductions	25.91	- 2.20	104.51
	33	Solid Waste Management Programme	- 2.85	1.37	7.33
AFOLU	34	Reduction of Deforestation	N.A.	0.78	42.48
	35	Fruit Tree planting	437.17	-119.77	- 661.34
	36	Commercial Forestry	183.21	- 239.35	- 123.77
	37	Conservation Agriculture	549.83	- 2.13	3.14
	38	Reduction of Prescribed Burning	N.A.	3.50	1.31
		Total - All Projects	7,130		7,880
		Total – Projects with positive NPV	8,116		6,273

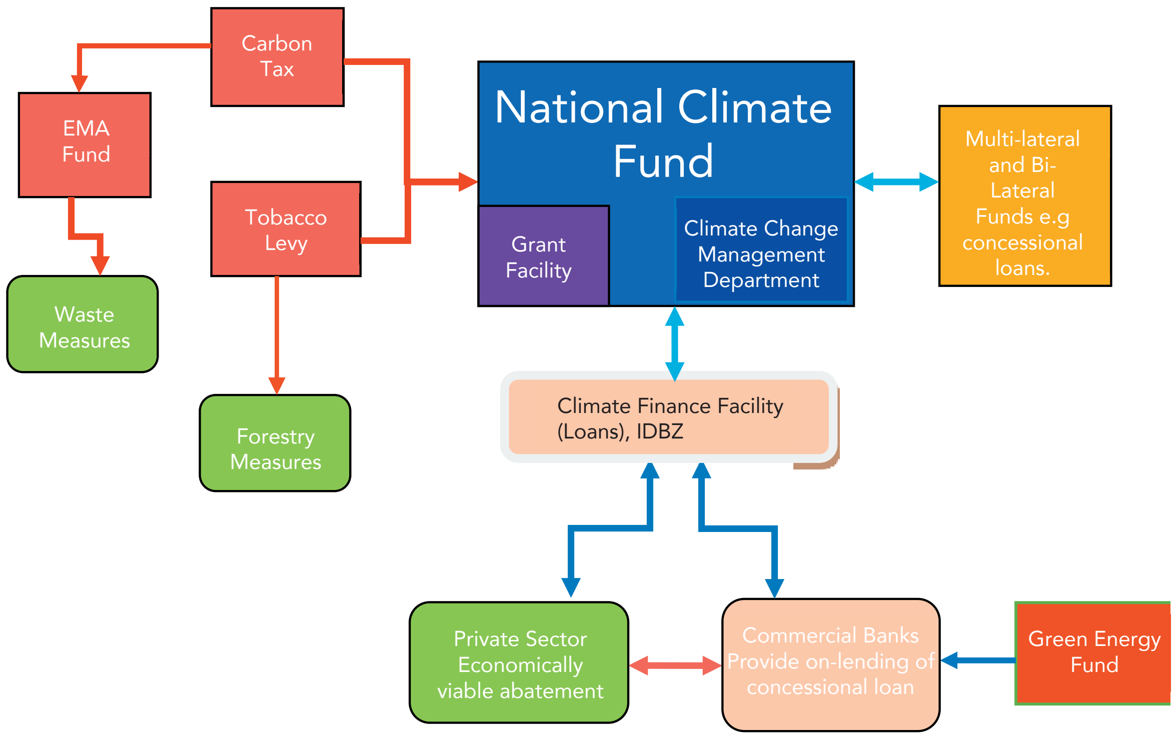
The following institutional setup is envisaged:

- The national climate fund will comprise loans provided Development Financial Institutions, Bilateral, Multi-lateral and Official Development Assistance.

- The national climate fund will be co-funded by the GoZ, which provides the proceeds of the carbon tax and the tobacco levy. Currently (2019) the government is collecting a carbon tax of 3USDc/l on gasoline and diesel. This is equivalent to a weighted average carbon tax of 12.24 USD/tCO_2e. The GoZ may increase the carbon tax in the medium to long term. The accumulated tax revenue by 2030 is estimated at USD 1,282 million. This will be complemented by the proceeds of Zimbabwe's tobacco levy, which is expected to contribute USD 42,480 million by 2030. The proposed National Climate Fund will also be used for co-funding by GoZ.

- If mitigation measures fall under IDBZ's core mandate (agricultural investment, energy projects), stakeholders may borrow directly from IDBZ. If mitigation measures do not fall under IDBZ core mandate, borrowing will be arranged through the operations of commercial banks (loans for energy efficient equipment, electric vehicles, etc.). Both pathways will result in long-term tenure.

Figure 8.1 shows Zimbabwe's Low Emission Development Financing Facility Framework



Key

	Recipients		Domestic sources		External sources		Funds host		Facility management

Figure 9.1 Zimbabwe's Low Emission Development Financing Framework

9. Monitoring Framework

Guide to this chapter

Section 9.1 focuses on MRV of the mitigation component of Zimbabwe's LEDS/NDC. It covers the key elements of an MRV framework through which progress can be tracked within the covered sectors. The section is structured as follows:

- **Reporting requirements under the UNFCCC**. This section briefly describes Zimbabwe's reporting obligations as a Party to the UNFCCC.

- **Reporting requirements under the Paris Agreement.** This section provides an overview of international reporting requirements for Zimbabwe under the PA.

- **Tracking progress towards the NDC.** This section considers the form of Zimbabwe's NDC target and what this means in terms of the specific information required to track progress, and to be reported internationally in the context of the NDC cycle.

- **Monitoring International support.** This section briefly reviews the information required to track climate finance flows for LEDS/NDC implementation.

Section 9.2 provides a brief gap analysis, taking stock of the current policies, institutional arrangements and technical capacities, as well as identifying gaps and room for improvement for an effective and meaningful MRV system.

Section 9.3 proposes a set of sectoral indicators for monitoring progress towards meeting the LEDS/NDC targets and implementing the mitigation actions described in this document. The indicators, which can be used for international reporting as well as for domestic tracking of LEDS/NDC implementation, are presented for each of the key emitting sectors as well as for Zimbabwe's energy sector as a whole.

9.1 The need to track progress

The successful implementation of Zimbabwe's long-term low Greenhouse Gas Emission Development Strategy (LEDS) and Nationally Determined Contribution (NDC) requires an effective measurement, reporting and verification (MRV) system. The implementation of a national MRV system enables the country to monitor the effectiveness of its mitigation actions, facilitate access to sources of climate finance, and allows tracking of progress in decoupling economic growth from greenhouse gas (GHG) emissions (Table 8.1). Zimbabwe has an obligation, under the Paris Agreement (PA), to implement and report on its climate actions. Internationally, the implementation of an MRV system is the basis for understanding the current GHG emission levels, the ambition of the existing efforts, and the progress made in contributing towards the global temperature reduction goal of the Paris Agreement (PA) (Desgain and Sharma, 2016).

An effective MRV system is not only limited to the monitoring of GHG emissions and removals, but also offers a wider range of functions, as summarised in Figure 9.1. These broader set of standards for MRV are also now included in the United Nation Framework Convention on Climate Change (UNFCCC) process by way of new requirements set out in the 'Paris Rulebook'[1] which governs implementation of the PA.

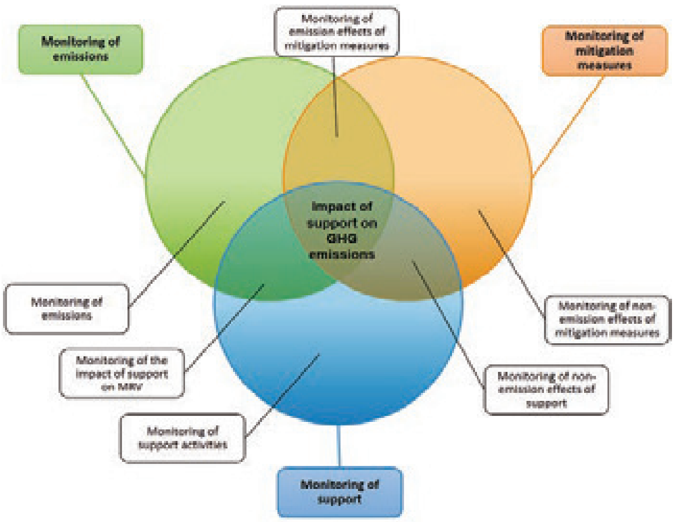


Figure 9.1 Mapping of Monitoring Functions

1 *As contained in Decisions 1 to 20 of the first Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA), held at the Katowice Climate Change Conference in December 2018.*

Table 9.1, drawing from the Paris Rulebook, lists some of the key aspects of an MRV system that are needed to track progress consistent with NDC and LEDS implementation

Table 9.1: MRV systems needed to track NDC implementation

MRV system	Relevance to implementation
GHG emissions & reductions	• Assess current GHG emissions for all Intergovernmental Panel on Climate Change (IPCC) sectors and sub-sectors; • Assess busines-as usual (BAU) GHGs, where dynamic baselines are considered for LEDS modeling (e.g. considering the BAU emission factor of the production of 1 tonne of cement) and the actual production level (in tonnes of cement); • Assess current progress in reducing greenhouse gas emissions towards the overall target (by updating the greenhouse gas inventory and Biennial Update Report (BUR), and expected future emissions (by reviewing greenhouse gas projections), at national and sectoral levels, to understand the aggregate impact of mitigation actions now and in the future.
Mitigation measures	• Monitor the implementation of the mitigation measures (e.g. implementation of low carbon cement measures, low carbon transport measures); • Assess whether the mitigation measures deliver the required impact on GHG emissions; • Assess whether the mitigation measures deliver the expected low emission development impact (e.g. reduction of lifecycle costs of the households);
Finance of mitigation measures	• Track climate finance flows for LEDS and NDC implementation, including international public finance, national domestic budgets and private climate finance, to improve the overall transparency of climate finance flows, and • Assess whether the scale/type of financing requirements for LEDS and NDC implementation are being addressed.

The remainder of this section describes the key steps needed for Zimbabwe to undertake MRV consistent with the features summarised in Table 9.1: MRV systems needed to track NDC implementation.

9.1.1 Reporting requirements under UNFCCC

All Parties to the UNFCCC are required to make arrangements for a domestic MRV system that can annually quantify national GHG emissions by sources and removals by sinks, and report the specific actions each country has identified and implemented to achieve mitigation targets. This information is compiled by Zimbabwe and is submitted to the UNFCCC through two reporting channels:

- National Communications (NCs), to be submitted every four years covering measurements of GHG emissions by sources and removals by sinks compiled in accordance with IPCC reporting guidelines (i.e., a national GHG inventory). It shall also include a description of steps made and envisaged to implement mitigation actions in support of the UNFCCC goal, among other things (Decision 17/CP.8 and various other decisions on implementation details); and
- Biennial Update Report (BURs), to be submitted every two years. These shall include an updated GHG inventory report from that of the NC, measurement of mitigation actions and their effects, reporting on the domestic MRV system and a description of needs and support received. All non-Annex I countries should have submitted their first BUR by December 2014 and then every two years thereafter (Decision 2/CP.17; Decision 19/CP.18; Decision 9/CP.21).

Zimbabwe submitted its Third National Communication (TNC) in 2016, reporting on its national GHG inventory for the year 2006. The country is yet to submit a BUR as of 2019.

9.1.2 Reporting requirements under the Paris Agreement

The Paris Agreement contains several additional MRV requirements which, when taken together with the existing UNFCCC arrangements, will provide the basis for Zimbabwe's international reporting requirements in respect of its NDC. New MRV requirements are primarily defined by Article 13 of the PA, which established a new enhanced transparency framework (ETF) through which Parties must regularly account for their NDCs alongside other reporting requirements similar to those contained in NCs, BURs and the International Consultation and Analysis (ICA).[1]

The Paris Rulebook, largely agreed in 2018, included modalities, procedures and guidelines (MPGs) for the ETF, covering new MRV requirements for signatory Parties (widely referred to as the "MPGs"; Decision 18/CPA.1 and the Annex thereto). The MPGs require all Parties to submit a first Biennial Transparency Reports (BTRs) including a National Inventory Report (NIR) by the end of 2024, and every two years thereafter, covering a range of aspects which include, add to and enhance MRV requirements under the Convention, such as:

- Provision of information by which to track progress in implementing and achieving NDCs;
- Provision of information on adaptation;
- Enhanced rules around reporting of annual inventories of GHG emissions and removals;
- Information on financial, technology development and transfer and capacity-building support received and needed in the future.

In all cases, the MPGs allow for flexibility in implementing MRV for developing countries, cognisant of their national capacities. Such flexibility notwithstanding, all Parties are expected to:

- Report information in the BTR on each selected NDC indicator in each reporting year during the NDC implementation period;
- Report GHG emissions and removals data for a reporting year no older than three years before the date of submission of the BTR or NIR (i.e., the vintage of reporting data must not exceed 3 years).

Therefore, under the Paris Rulebook, Zimbabwe will be required to regularly and systematically monitor and report information on its mitigation actions in a way that provides clarity and allows regular review of the level of progress being made in achieving the mitigation targets specified in the LEDS/NDC.

Information submitted by countries in their BTR and NIR will be used to assess progress in NDC implementation by all Parties through global stocktake (GST) of efforts specified under Article 14 of the PA. The GST primarily informs Parties whether the world is on track to meet the PA's ultimate goals in respect of limiting mean global temperature increases to within 2°C of preindustrial times or, more ambitiously, 1.5°C.

9.1.3 National Functions of LEDS/NDC Monitoring

In addition to the international reporting requirements outlined, domestic reporting of Zimbabwe's GHG emissions and efforts taken to reduce emissions will be important to building national transparency and informing the stakeholders. It will also help inform good policy-making. The MRV system shall offer two key functions on a domestic level, which are discussed subsequently.

Function 1: Monitoring of effectiveness of policies/programs

The LEDS identified 38 mitigation measures, with an expected positive net present value of USD 7,130 million over the lifetime of underlying investments in 2030. A future, economy wide NDC may pick up these mitigation measures. A successful monitoring system will enable Government to not only monitor the GHG emissions and related emission reductions, but it will allow to monitor whether certain policies deliver the expected impacts on the economic development (e.g. does the fuel economy standard guide the private sector to take economically cost-effective car purchase decisions?, does the minimum energy performance standard guide households to purchase AC systems with minimal lifecycle costs?). Information on key indicator values to

1 *The ICA will inter alia allow for technical expert analysis of the BURs and facilitate sharing of views*

demonstrate progress in implementing those actions can be viewed as useful additional information. Reporting information on mitigation actions aggregated by sector is also useful, as the indicators used to monitor the impacts of the mitigation measures can then help in understanding the changes in sectoral GHG emissions.

To enable a transparent MRV and assessment of progress in implementing each NDC, the document will need to include information on (i) measures being implemented for achieving the mitigation target for the current accounting period at that time; (ii) measures planned for achieving the mitigation target for the next NDC accounting period; and (iii) key indicator values to report the impacts/outcomes of the measures being implemented for the current NDC accounting period at that time.

Function 2: Monitoring of GHG emissions and progress towards NDC target

The nature of Zimbabwe's target, including the coverage of sectors and GHG gases, will determine the specific information that needs to be monitored to track the progress of the NDC. Zimbabwe's target is defined on the basis of achieving a 33% reduction in per capita emissions in 2030 with respect to a BAU baseline reference case. The scope of the target applies to the IPCC "Energy" category sector and activities and covers emissions of CO_2, CH_4 and N_2O. The emissions reduction achieved in each year will, therefore, be determined by the relative difference between the emissions level achieved through implementation of the NDC mitigation actions in 2030 (actual emission) and a BAU emissions projection for the same year. This latter projection represents the case under which no actions additional to those already being implemented are taken to limit GHG emissions.

For NDC mitigation targets expressed as reductions of GHG emissions below BAU, reporting information on the description of the mitigation actions, and on the projections of national GHG emissions with mitigation measures, will provide sufficient information on tracking progress in implementing an NDC (Desgain and Sharma, 2016).

The use of progress indicators, grouped according to key emitting sectors, are therefore seen as a useful element of the MRV framework for tracking the progress of the NDC. The information required to track the NDC is similar to the information that developing countries are currently required to report. For example, the requirements for reporting under the BURs include;

- Name and description of each mitigation action, including information on the nature of the action, coverage, quantitative goals related to the action, if any, and progress indicators;
- Steps taken or planned to implement the mitigation action;
- Progress with implementing the mitigation actions and the results achieved; and
- Information on the domestic MRV system

Timelines for NDCs and MRV

Zimbabwe, which has submitted an NDC for the period 2021-2030, will communicate or update its NDC by 2020, and then every five years thereafter. Zimbabwe's second NDC will therefore need to be submitted in 2025 (for the accounting period 2031-2035). The first global stocktake' of NDCs will take place in 2023 and every five years thereafter as guided by the UNFCCC negotiations.

Figure 9.2 shows how the cycle related to NDC development and MRV will work under the Paris Agreement. Within this timeline, Zimbabwe will make an ongoing review of its NDC target and the ability to increase the level of ambition. This will be informed by the collection and preparation of national statistics, as well as tracking the progress of the mitigation actions described in this document. Importantly, with each successive NDC period, existing NDC actions (at that time) will become part of the BAU baseline thereby ensuring ongoing strengthening of ambition.

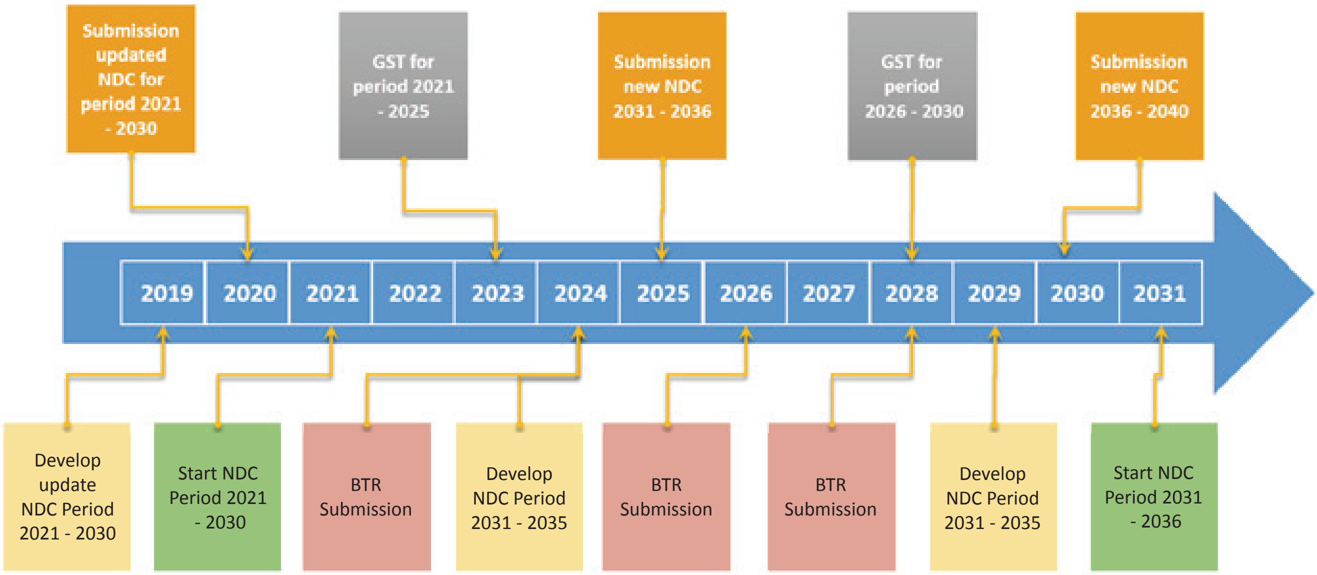


Figure 9.2: Timeline of NDC cycle for Zimbabwe

Source: Adapted from Desgain and Sharma, (2016)

In terms of the NDC submissions made by Zimbabwe, these should include information on the most recent BAU scenario projection, with a base year defined as the start year of the NDC accounting period ongoing at that time (i.e. five years prior to year of NDC submission). The BAU scenario will run until the end of the accounting period for which the NDC is being submitted (ibid.) i.e. 2030 for the first NDC. The NDC will also include information on the NDC mitigation scenario (as described in Section 4 of this document). For the base year, national GHG emissions will be represented by the estimated national GHG inventory for that year.

9.1.4 Monitoring international support

The Paris Rulebook requires Parties to report on financial, technology and capacity building needs, as well as indicating the support received to help meet these needs. Some of these elements are also reported in the BUR. Under Annex III of Decision 2/CP.17, the following items should be monitored and reported:

- Zimbabwe's national contribution to climate finance (million USD);
- International financial contribution received by Zimbabwe (million USD);
- Technology development and transfer (activities undertaken);
- Capacity building (activities undertaken).

In addition, some other elements must be monitored which are not at present fully covered in the BURs. These include the following:

- Other voluntary schemes: in accordance with Article 6.2 of the Paris Agreement, the progress of Nationally Appropriate Mitigation Actions (NAMAs) would need to be monitored, including those prepared to date.

- Internationally Transferred Mitigation Outcomes (ITMOs): in accordance with Article 6.4 and of the Paris Agreement, any emission reductions units generated in Zimbabwe but subsequently transferred to other Parties need to be monitored and recorded. These emission reductions should not be counted towards fulfilment of Zimbabwe's NDC, in order to avoid double counting.

These elements should therefore be included in a framework of indicators used to track Zimbabwe's NDC implementation, as described further below.

9.2 Gap Analysis

Zimbabwe has submitted three national communications reports (NCs) to the UNFCCC. The Initial National Communication was submitted in 1998 for the 1994 base year; the Second National Communication was submitted in 2013 for 2000 base year and the Third National Communication in 2017 for the base year of 2006.

The country is currently preparing its Fourth National Communication and First Biennial Update Report. The NCs submitted by Zimbabwe cover the chapters outlined in Decision 17/CP.8 on Non-Annex 1 NCs, namely: National circumstances; Greenhouse gas inventory; Vulnerability assessment and adaptation; Climate Change mitigation; Research, systematic observation and technology transfer; Climate Change education, training and awareness, as well as, Policy, constraints, gaps and related financial, technology and capacity building needs. The subsequent sections provide the discussion of the gap analysis for MRV aspects in Zimbabwe.

9.2.1 Institutional and procedural gaps

Zimbabwe established the Climate Change Management Department (CCMD) in 2013. The country then set up a high level inter-ministerial committee on Climate Change coordinated from the President's office. The members to the high-level committee are the permanent secretaries for all ministries. The committee is responsible for oversight on all Climate Change activities in the country. The country is working towards establishing procedural arrangements for Climate Change mitigation monitoring and reporting.

Zimbabwe also established NDC technical committees whose mandate is to offer technical guidance on LEDs and NDC implementation. The key institutions include the ministries responsible for energy, industry, transport, local government, gender, environment, finance and agriculture. However, serving in the technical committees is voluntary and no legal or contractual arrangements were put in place to guide functioning of these committees. The lack of binding terms of reference for the committees presents a gap in ensuring effective and committed service by the committee members.

The CCMD collaborates with other ministries and government departments and has identified contact persons in the respective institutions. However, the absence of clear formal procedures for data provision compromises the timeliness and quality of reported information and makes data gathering a tedious process. Zimbabwe does not currently have a clear timetable for domestic and international reporting of GHG and Climate Change mitigation information.

9.2.2 Policy gaps

Zimbabwe completed the development of its National Climate Policy in 2017. The Policy provides for a commitment to establish MRV systems for the purposes of international reporting (see Section 4.7) (GoZ, 2017). However, the policy is silent on domestic MRV arrangements. Section 4.7 does not cover the reporting requirements for Climate Change mitigation actions and their effects, both ex-ante and ex-post. The main law on environmental management in Zimbabwe is the Environmental Management Act (Chapter 20:27). The Act does not explicitly cover GHG emissions reporting, let alone reporting on climate change mitigations and their effects. As of 2019, the country had started the development of a Climate Change Bill which seeks, among other things, to address the data gaps. The Bill is expected to be promulgated into law by the end of 2021. Other related policies such as the National Energy Policy (GoZ, 2012), Electricity Act (Chapter 13:19), Zimbabwe Energy Regulatory Authority Act (, Chapter 13:23) covers reporting of energy data but:

- different data sets are kept with different institutions, and
- the data sets do not necessarily meet all requirements of GHG inventory (GHGI).

The inclusion of robust MRV requirements in the relevant laws/bylaws should significantly assist in closing the policy gaps. Urban local authorities, despite having established environmental departments, have not developed by-laws for tracking and reporting on climate change information, especially GHG emissions and mitigation actions, within their areas of jurisdiction. As a result of the policy gaps highlighted, the nature and periodicity of reporting of climate change mitigation indicators in Zimbabwe was not legally defined as of 2019.

9.2.3 Technical and capacity gaps

Zimbabwe reports, to the UNFCCC, GHG emissions in line with the IPCC Guidelines and relevant COP decisions. However, there are no guidelines for domestic reporting on GHGs and climate change mitigation information. Although the country has not yet defined the economy-wide progress and outcome indicators for climate change mitigation, the energy sector MRV system provided in the NDC implementation framework presents a solid basis for developing the economy-wide MRV system. While some Energy indicators were covered in the NDC implementation framework, there are no national or sectoral guidelines for reporting on the GHG and non-GHG effects of implemented climate change actions for the rest of the sectors. Further to that, the skills for reporting are very low in the country. The country does not yet have in place a climate change information management system. However, the NC4 work includes development of a database for both GHG and climate change mitigation information. Another limitation in the process of reporting is on the low capacity of key stakeholders in the reporting of information on GHG emissions as well as climate change mitigation efforts and their effects.

Despite the country having been working on NCs for over twenty years, GHG activity data gaps still exist in all the IPCC sectors, including key category subsectors such as Forestry and Transport. Moreover, the country still uses default emission factors for almost all sectors, thereby compromising the quality of GHG information reported. There is currently no mechanism for tracking financial flow and any technical support for climate change mitigation. Capturing the amount, nature, distribution, purpose as well as impact of climate finance is key in the tracking of LEDS and NDCs implementation progress. However, the country has since adopted the common tabular format for reporting mitigation actions in its BUR1 and this should form a good starting point for reporting climate change mitigation actions and their effects. The absence of a robust system for GHG inventory QA/QC to complement the stakeholder validation processes already conducted, also compromise the quality of inventory information.

9.3 Monitoring of GHG Emissions and Mitigation Measures

Capitalizing on the analysis of the international framework and the gap analysis, this chapter provides a discussion of framework indicators and draft MRV tables for the four IPCC sectors and the overall LEDS/NDC implementation.

9.3.1 Framework of indicators

The following sections set out a framework of high-level progress indicators for use in Zimbabwe to help track and report on implementation of the LEDS/NDC in support of the MRV requirements set in the Paris Rulebook.[2] Some important considerations for using indicators are discussed briefly below.

Considerations for using progress indicators

Monitoring progress requires a comparison of Zimbabwe's actual emissions per capita over time with the estimated BAU reference case, and to assess to what extent the country is on track to achieve the NDC i.e. whether emissions are falling below or above the required level. However, there are several reasons why, , this represents an overly simplistic approach to monitoring:

- Emissions can be driven by a large number

2 *It should be noted that developing detailed MRV frameworks for each of the specific mitigation actions identified in this document is also recommended. This would allow for robust and detailed tracking of each measure needed to achieve NDC implementation, and will also be required by project financers/supporters. This falls beyond the scope of this report. However, in parallel to the current document, a detailed MRV methodology has been developed for implementation of solar water pumping for irrigation within the agriculture sector.*

of factors. Many of these factors fall outside the control of policy-makers and mitigation actions undertaken. For example, mild winters can reduce energy demand for heating, resulting in lower emissions regardless of whether they have been achieved by mitigation actions. Failure to deliver planned electricity supply according to the SDP may result in continued reliance on imports, thereby reducing Zimbabwe's own emissions. Another key factor for Zimbabwe is the climatic conditions affecting the national hydrology and the availability of hydropower to supply clean baseload electricity to the grid. Falling or rising emissions levels can therefore give a misleading impression that the country is on course, or off course, to implementing the mitigation actions and meeting the NDC target.

- The nature of the NDC target - expressed as a per capita target (tCO_2 per capita) relative to a dynamic BAU - means that population growth and economic conditions will both have an impact upon the progress towards meeting the NDC from year to year. Variations in GDP growth and population from year to year could give a misleading impression that the country is on course, or off course, to implementing its mitigation actions and meeting the target – regardless of how successfully it is implementing the NDC.

- Long lead times for mitigation actions. Some of the actions described in this document will take several years before achieving significant emissions reductions. Therefore, focusing simply on emissions may not allow adequate monitoring of whether the implementation of these important longer-term measures is on course to deliver the required outcomes.

Progress indicators are proposed which monitor both the emissions and also non-GHG indicators of progress linked closely to each of the mitigation actions within each of the key emitting sectors. The choice of indicator has also been informed by existing indicator frameworks applied internationally in the context of climate change, which also support the metrics required under the Paris Rulebook.

The following section provides MRV tables / protocols, which allow monitoring GHG emissions as well as the effectiveness of mitigation measures. The protocols include the key quantitative indicators to track progress against the goals. The indicators include changes in emissions and emissions per capita since Zimbabwe set national goals for increased domestic renewable energy use. These are also proposed as key energy sector indicators. Separate tables of indicators were developed for each of the key sectors covered by the LEDS, providing a more detailed framework for tracking progress. This should address limitations arising from simply reporting on emissions and energy data.

Each of these sector tables is structured as follows:

- **Headline indicators:** The headline indicators include a breakdown by sector of emissions reductions against the BAU baseline. They also include other high-level indicators specific to each sector relating to emissions intensity.

- **Supporting indicators:** The headline indicators are complimented by a set of more detailed indicators which track progress in implementing the mitigation measures required to achieve sustainable emission reductions. A series of supporting indicators help quantify the progress in implementing the specific actions within each sector.

- **Other factors:** Various factors will act as drivers of emissions over the coming years, many of which are outside the country's control. No indicators are proposed for these, but they can be tracked as part of a monitoring framework in order to understand, and report on their influence upon LEDS/ NDC implementation. These cover aspects such as falling technology costs, energy market and infrastructure development as well as various economic factors.

The following sub-sections provide monitoring tables for the four IPCC sectors, i) Energy, ii) Industrial Processes and Product Use (IPPU), iii) Agriculture, Forestry and Other Land Use (AFOLU) and iv) Waste. The monitoring tables of the four IPCC sectors are aggregated into one overall NDC progress monitoring template, represented in Section 3.2.

9.4 Overall NDC Progress Indicators

Table 9.2: NDC progress indicators

GHG emissions		2015	2020	2021	2022	2023
Current GHG emissions ($MtCO_2e$)	Electricity Generation					
	Other Energy Use					
	IPPU					
	Forestry					
	Agriculture					
	Waste					
	TOTAL					
Reduction compared to BAU reference case without NDC mitigation measures (%)	Electricity Generation					
	Other Energy Use					
	IPPU					
	Forestry					
	Agriculture					
	Waste					
	TOTAL					
Population (Million)						
GDP (Million USD)						
GHG emissions per capita	tCO_2 per capita					
	% reduction to BAU					
Finance and mechanisms		**2015**	**2020**	**2021**	**2022**	**2023**
Domestic climate finance (in M USD)	Direct					
	Indirect					
International climate finance (in M USD)	Grants					
	Other					
Internationally Transferred Mitigation Outcomes ($MtCO_2e$)						
Technology development and transfer (activities undertaken)						
Capacity building and strengthening (activities undertaken)						
Other voluntary co-operation (activities undertaken)						

9.4.1 Energy Sector

Table 9.3: NDC progress indicators: Electricity generation

Headline indicators - GHG emissions		2015	2020	2021	2022	2023
Total BAU (tCO_2e)						
Total MIT Emissions (tCO_2e)						
Current GHG Emissions (tCO_2e)						
Headline indicators - Other		2015	2020	2021	2022	2023
BAU electricity demand (GWh/yr)						
Current electricity demand (GWh/yr)						
BAU Emissions intensity of grid electricity (tCO_2e per MWh)						
Current Emissions intensity of grid electricity (tCO_2e per MWh)						
Share of renewables in total grid electricity supply (%)						
Supporting indicators		2015	2020	2021	2022	2023
Generation (GWh)	Coal					
	Hydropower					
	Other (Specify)					
	TOTAL					
Fuel Consumption (t)	Coal					
Net Calorific Value (GJ/t)	Coal					
Mitigation Measures		2015	2020	2021	2022	2023
Generation (GWh)	Hydropower					
	Solar PV					
	Biogas					
	Wind					
	TOTAL					
Demand-side energy(GWh/yr)	MEPS					
	RPC					
	EE Industry					
	Other					
	TOTAL					
International finance & support		2015	2020	2021	2022	2023
International contribution to finance mitigation measures (indicate activities and amounts)						
Technology transfer and capacity building activities (indicate activities)						
Other factors						
Development and strengthening of grid infrastructure (indicate key developments)						
Developments relating to progress with Southern African Power Pool (SAPP) (indicate key developments)						
Hydropower availability and hydrological conditions (describe availability and load factor issues etc)						

Table 9.4: NDC progress indicators: Other energy use

Headline indicators - GHG emissions		2015	2020	2021	2022	2023
Total BAU (tCO_2e)						
Total MIT Emissions (tCO_2e)						
Current GHG Emissions (tCO_2e)						
Headline indicators - Other		**2015**	**2020**	**2021**	**2022**	**2023**
BAU fossil fuel use (% of total energy use)						
Current fossil fuel use (% of total energy use)						
BAU renewable energy use (% of total energy use)						
Current renewable energy use (% of total energy use)						
Supporting indicators		**2015**	**2020**	**2021**	**2022**	**2023**
Fossil fuel consumption (GJ)	Coal					
	Diesel					
	Gasoline					
	Kerosene					
	LPG					
Biofuels consumption (GJ)	Liquid biofuels					
	Solid biofuels					
Mitigation Measures		**2015**	**2020**	**2021**	**2022**	**2023**
Number of companies that have implemented on-site renewable energy supply projects						
Number of solar water heaters installed						
Number of solar off-grid installed						
Climate Smart Agriculture	Solar pumping for irrigation (kW)					
	On-farm biodigestors (kW)					
Share of total fuel use in transport from biofuels (%)						
Average GHG intensity for newly registered vehicles (gCO_2e per km)	Light duty vehicles (LDVs) - gasoline					
	Light duty vehicles (LDVs) - diesel					
	Buses					
	Heavy goods vehicles (HGVs)					
Total number of electric vehicle (EV) registrations						
Progress with achieving modal shift to lower carbon forms of transport (describe activities)						
Progress with rail electrification and rehabilitation programme (describe milestones achieved and activities)						
International finance & support		**2015**	**2020**	**2021**	**2022**	**2023**
International contribution to finance mitigation measures (indicate activities and amounts)						
Technology transfer and capacity building activities (indicate activities)						
Other factors						
Developments in transport infrastructure investment and management measures (indicate activities developed)						
Indicators of activity by mode of transport e.g. occupancy rates; average distances (indicate, once studies are available)						
Ongoing developments and trends within buildings practices and household and SME energy use (describe)						
Availability and cost of new and low carbon technologies and practices						

9.4.2 Industrial Processes and Product Use

Table 9.5: NDC progress indicators: IPPU

Headline indicators - GHG emissions		2015	2020	2021	2022	2023
Total BAU (tCO_2e)						
Total MIT Emissions (tCO_2e)						
Current GHG Emissions (tCO_2e)						
Headline indicators - Other		2015	2020	2021	2022	2023
BAU Emissions intensity of cement production (tCO_2e per tonne cement)						
Current Emissions intensity of cement production (tCO_2e per tonne cement)						
BAU Emissions intensity of nitric acid production (tCO_2e per tonne)						
Current Emissions intensity of nitric acid production (tCO_2e per tonne)						
BAU Emissions intensity of ferrochrome (FeCr) production (tCO_2e per tonne)						
Current Emissions intensity of FeCr production (tCO_2e per tonne)						
Supporting indicators		2015	2020	2021	2022	2023
Mitigation Measures		2015	2020	2021	2022	2023
Clinker substitution in cement production (%)	Fly ash					
	Blast Furnace Slag (BFS)					
	TOTAL					
N_2O decomposition in fertilizer production	Nitric acid production (tonnes)					
	Mitigation from N_2O decomposition (tCO_2e)					
Coke substitution in FeCr production (%)						
International finance & support		2015	2020	2021	2022	2023
International contribution to finance mitigation measures (indicate activities and amounts)						
Technology transfer and capacity building activities (indicate activities)						
Other factors						
Development relating to investment in/ refurbishment of domestic iron and steel production (e.g. ZISCO site)						
Progress with enabling continued and/or greater use of clinker substitute materials in cement production						
Status of viability of coke substitution materials for use in metals production (e.g. charcoal; biocoke)						
Progress with implementation of MRV system for GHG emissions in industry						

9.4.3 Agriculture, Forestry and Other Land Use

Table 9.6:NDC progress indicators: Forestry

Headline indicators - GHG emissions		2015	2020	2021	2022	2023
Total BAU (tCO_2e)						
Total MIT Emissions (tCO_2e)						
Current GHG Emissions (tCO_2e)						
Headline indicators - Other		2015	2020	2021	2022	2023
Net forest loss / gain - natural moist forest (in ha/yr)						
Net forest loss / gain - natural deciduous forest (in ha/yr)						
Net forest loss / gain - timber plantations (in ha/yr)						
Net forest loss / gain - wooded grassland (in ha/yr)						
Supporting indicators		2015	2020	2021	2022	2023
Emission Factors	Average biomass stock natural moist forest (in tC/ha)					
	Average biomass stock natural deciduous forest (in tC/ha)					
	Average biomass stock timber plantation (in tC/ha)					
	Average biomass stock natural wooded grassland (in tC/ha)					
	Average biomass stock of deforested areas (in tC/ha)					
Mitigation Measures		2015	2020	2021	2022	2023
Forestry Measures	Planted Area - Fruit Tree (in ha)					
	Planted Area - Timber Plantation (in ha)					
Finance & support		2015	2020	2021	2022	2023
International contribution to finance mitigation measures (indicate activities and amounts)						
National contribution to finance mitigation measures (indicate activities and amounts)						
Technology transfer and capacity building activities (indicate activities)						
Other factors						
Measures and policies to regulate the fuel consumption for tobacco drying						
Implementation of sustainable woodland management programs						
Implementation of tree planting activities						
Other measures and policies to fight deforestation						

Table 9.7: NDC progress indicators: Agriculture

Headline indicators - GHG emissions		2015	2020	2021	2022	2023
Total BAU (tCO_2e)						
Total MIT Emissions (tCO_2e)						
Current GHG Emissions (tCO_2e)						
Headline indicators - Other		**2015**	**2020**	**2021**	**2022**	**2023**
Current Emissions from Enteric Fermentation(in						
Current Emissions from Manure Management (in						
Current Emissions from Savannah-, Grassland- and Woodland-Burning (in tCO_2e/yr)						
Supporting indicators		**2015**	**2020**	**2021**	**2022**	**2023**
Activity Data	Dairy Cattle (no. heads)					
	Non-dairy cattle (humid)					
	Non-dairy cattle (semi-arid)					
	Goats					
	Burnt Savanna (in ha)					
Mitigation Measures		**2015**	**2020**	**2021**	**2022**	**2023**
Conservation Agri-culture	Area under CA Mgmt (in ha)					
	2-wheeled tractor dissemina-tion (no. devices)					
	Legume Fodder produced (in t/yr)					
International finance & support		**2015**	**2020**	**2021**	**2022**	**2023**
International contribution to finance mitigation measures (indicate activities and amounts)						
National contribution to finance mitigation measures (indicate activities and amounts)						
Technology transfer and capacity building activities (indicate activities)						
Other factors						
Dependence /reliance on the government to distribute fertilizer						
Government led command agriculture program						

Table 9.8: LEDS progress indicator: Waste

Headline indicators		2015	2020	2021	2022	2023
Organic waste disposed BAU (t/yr)						
Organic waste disposed MIT (in t/yr)						
Organic waste disposed current (in t/yr)		1402.4				
Supporting indicators-progress indicators		**2015**	**2020**	**2021**	**2022**	**2023**
Wood and wood product waste generated (in t/yr)		12.19				
Pulp, paper and cardboard waste generated (in t/yr)		90.29[15]				
Food, food waste, beverages and tobacco waste generated (in t/yr)		44.32				
Textiles waste generated (in t/yr)						
Garden, yard and park waste generated (in t/yr)		48.75				
Total organic waste handled and disposed at landfill / dump sites (in t/yr)		276.97				
Mitigation measures		**2015**	**2020**	**2021**	**2022**	**2023**
LFG Flaring	Number of sites with LFG capture	-				
	Share of total LFG flared (in %)	-				
Composting	Amount of compost produced (in t/yr)	-				
	Share of organic waste composted (in %)	-				
Recycling	Quantities of PET recycled (in t/yr)	-				
	Quantities of other plastics recycled (in t/yr)	-				
	Quantities of metals recycled (in t/yr)	-				
	Quantities of paper and cardboard recycled (in t/yr)	-				
Finance & Support		**2015**	**2020**	**2021**	**2022**	**2023**
International contribution to finance mitigation measures (indicate activities and amounts)		-				
National contribution to finance mitigation measures (indicate activities and amounts)		-				
Technology transfer and capacity building activities (indicate activities)		-				
Other factors						
Developments in waste infrastructure investment and management measures (indicate activi-						
Development of waste regulations and enforcement						
Availability and cost of new and low carbon technologies and practices						
Development of waste regulations and enforcement						
Availability and cost of new and low carbon technologies and practices						

9.5 Incorporation of a Monitoring Framework

The tables present sector-based indicators which track progress on implementation of Zimbabwe's LEDS/NDC. The proposed indicators provide only an initial framework for tracking progress. This is only the first step in incorporating an effective monitoring framework, which is well coordinated across all areas of government.

There is a need to develop a monitoring plan/ standard operating procedure according to the following step-wise actions:

1. Refine or agree on the choice of performance indicators: The proposed choice of indicators outlined in this section needs to be agreed with relevant stakeholders and government departments and further refined to closely reflect anticipated performance outcomes for each mitigation action and sector.

2. Develop specific metrics and interim target figures: This involves developing trajectories for each of the indicators through 2030 and agreeing specific interim target figures and milestones e.g. for 2020, 2025 and 2030. As shown in the indicator tables, some of these may be quantitative whereas others relate more to milestones.

3. Finalise monitoring framework and assign responsibilities: A methodological framework needs to be finalised and used to develop a full monitoring plan. This plan shall comprise:

    a. Roles and processes (e.g. data collection, aggregation) of all governmental agencies and the private sector;
    b. Specify timing of each process (e.g. cement companies shall report KPIs to MoI by end January, for the previous year etc.);
    c. Specify quality assurance and quality control (QA/QC) functions and responsibilities (e.g. compare data from a cement company with the data of that same company of the previous monitoring period for checking plausibility and completeness).

4. Formalize monitoring responsibilities: CCMD may consider formalizing such a monitoring plan by creating a legal act or statutory instrument, which requires the reporting to CCMD in prescribed intervals. This may increase the efficiencies and accuracy of reporting processes while reducing the required level of effort.

5. Specify updating procedures for monitoring Framework: The prescribed protocols and tables should be systematically reviewed and amended involving key actors for data collection, gathering, evaluation and QA/QC in three to five-year intervals. The protocols should also allow for revision and/or refinement of the specific monitoring procedures. To give an example: GHG emissions from enteric fermentation and manure depend inter alia on the average live weight of animals. This parameter is currently fixed. In 2025 it may be decided to monitor animal live weight on annual basis. Then this may be integrated in the monitoring procedures.

The implementation of the monitoring plan may enable the CCMD, other governmental agencies and private sector entities to incorporate a monitoring framework, which allows tracking of GHG emissions, the effectiveness of policies and measures while supporting Zimbabwe's overall low carbon development.

References

African Development Bank (AfDB), 2011. Infrastructure and Growth in Zimbabwe: An Action Plan for Sustained Strong Economic Growth. Tunis, Tunisia.

SAPP (nd). ASB0001, Grid emission factor for the Southern African Power Pool, UNFCCC, Bonn, Germany.

BLOOMBERG-PLATTS-CITIBANK, 2018. Coking coal price outlook.https://www.businessinsider.com.au/coal-price-outlook-supply-demand-balance-2018-2

CDM EB94, Annex 8, AMS-II.T.: Emission reduction through reactive power compensation in power distribution network, Version 1, UNFCCC, Bonn, Germany;

CDM EB87, Annex 9, Tool 07 - Tool to calculate the emission factor for an electricity system, Version 5, UNFCCC, Bonn, Germany.

RBZ. 2018.Interest Rates. https://rbz.co.zw/index.php/research/markets/interest-rates

EBRD, 2016. Low-Carbon Roadmap for the Egyptian Cement Industry. European Bank for Reconstruction and Development, October 2016.

Eijck, J. van, Smeets, E., and Faaij, A., 2012. The economic performance of jatropha, cassava and Eucalyptus production systems for energy in an East African smallholder setting. GCB Bioenergy 4, 828-845.

Energy Saving Trust, 2017. Guide to charge-point infrastructure for business users. Energy Saving Trust, August 2017.

FAO, 2003. On-farm Composting Methods. Land and Water Discussion Paper 2. Food and Agriculture Organization of the United Nations, Rome, Italy.

FCPF 2016, Methodological Framework, FCPF Carbon Fund, Revised Version, World Bank, Washington, USA;

Finealt Engineering , 2016. CDM Project Idea Note: Jatropha Cultivation and Biodiesel Production Project. Submitted by Finealt Engineering 24 February 2016.

GFEI, 2019. Prospects for Fuel Efficiency, Electrification and Fleet Decarbonisation. Working Paper 20. Global Fuel Economy Initiative (GFEI) May 2019.

Global Forest Watch (GFW), 2019. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend.850–53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

Government of Zimbabwe (GoZ), 2009. National Environmental Policy and Strategies. Ministry of Environment and Natural Resources, Harare

Government of Zimbabwe (GoZ), 2013. Zimbabwe Agenda for Sustainable Socio-Economic Transformation. Harare: Ministry of Finance and Economic Development, Harare

Government of Zimbabwe (GoZ), 2015a. Zimbabwe Intended Nationally Determined Contributions (INDCs) Submitted to the United Nations Framework Convention on Climate Change (UNFCCC), Ministry of Environment Water and Climate, Harare

Government of Zimbabwe (GoZ), 2015b. Zimbabwe's National Climate Change Response Strategy. Ministry of Environment Water and Climate, Harare

Government of Zimbabwe (GoZ), 2016. GoZ. Zimbabwe Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), Ministry of Environment Water and Climate, Harare

Government of Zimbabwe (GoZ), 2017b. Zimbabwe Climate Policy. Minister of Environment, Water and Climate, Harare

Government of Zimbabwe (GoZ), 2017b. Zimbabwe's NDC Implementation and MRV Framework. Presented at IETA Pavilion, Bonn Zone, 13 November 2017. International Emissions Trading Association, Geneva

Government of Zimbabwe (GoZ), 2002, Environmental Management Act Chapter 20:27, Harare, Zimbabwe

Government of Zimbabwe (GoZ), 2014, Solid Waste Management Plan, Harare, Zimbabwe

Government of Zimbabwe (GoZ), 2018a. Zimbabwe National Transport Master Plan, 2018.

Government of Zimbabwe (GoZ), 2018b. Climate Smart Agriculture Framework 2018 – 2028. Ministry of Lands, Agriculture, Water, Climate, and Rural Resettlement, Harare

Government of Zimbabwe (GoZ), 2018c. Towards an Upper - Middle Income Economy by 2030: New Dispensation Core Values. Government of Zimbabwe, Washington DC
Government of Zimbabwe (GoZ), 2018d. Transitional Stabilisation Programme Reforms Agenda. October 2018 – December 2020: Towards a Prosperous and Empowered Upper Middle Income Society by 2030. Government of Zimbabwe, Harare
Government of Zimbabwe (GoZ), 2019a. National Renewable Energy Policy. Ministry of Energy and Power Development, Republic of Zimbabwe, Harare
Government of Zimbabwe (GoZ), 2019b. National Biofuels Policy. Ministry of Energy and Power Development, Republic of Zimbabwe, Harare
Government of Zimbabwe (GoZ), 2017, Grid Code of Zimbabwe, Harare, Zimbabwe;
GoZ-CTCN, 2017. Climate-Smart Agriculture Manual for Zimbabwe, Joint Government of Zimbabwe and Climate Technology Centre and Network, Denmark

Harris, N., Davis., C.,Goldman.,E.D., Petersen., R and Gibbes., S 2018. "Comparing Global and National Approaches to Estimating Deforestation Rates in REDD+ Countries" Working Paper. Washington, DC: World Resources Institute. Available online at wri.org/publication
Hof, Andries, Michel den Elzen, AnnemiekAdmiraal, Mark Roelfsema, David Gernaat and Detlef van Vuuren. 2017. Global and regional abatement costs of Nationally Determined Contributions (NDCs) and of enhanced action to levels well below 2 °C and 1.5 °C, Environmental Science & Policy, no. 71, 30-40.
Wolfgang., H, Jürgen, S. and Wolfgang J. 2012. Reactive Power Compensation: A practical guide, Wiley, ISBN: 978-1-119-96778-1.
Homann-Kee, T. S, Valbuena, D., Masikati, P., Descheemaeker, K., Nyamangara, J., Claessens,L., Erenstein, O., Van Rooyen, A., Nkomboni, D., 2014, Economic trade-offs of biomass use in crop-livestock systems: Exploring more sustainable options in semi-arid Zimbabwe, Agricultural Systems, 134, 48-60.
ICCT, 2014. Costs and Benefits of China 5/V and 6/VI Standards in Guangdong Province. The International Council on Clean Transportation. Working paper 2014-6, June 2014.
IEA/CSI, 2009. Cement Technology Roadmap. International Energy Agency/WBCSD Cement Sustainability Initiative (CSI). Paris.
IPCC 2006., 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.
IPCC/TEAP. 2005. Bert Metz, Lambert Kuijpers, Susan Solomon, Stephen O. Andersen, Ogunlade Davidson, José Pons, David de Jager, Tahl Kestin, Martin Manning, and Leo Meyer (Eds). Cambridge University Press, UK. pp 478. Cambridge, England.
Masami,K.and Trimble, C. 2016. Political economy of power sector subsidies: A re-view with reference to Sub-Saharan Africa, African Renewable Energy Access Programme, World Bank, Washington, USA.
Masami, K., Bacon,R. and Trimble, C. 2014. Making Power Affordable for Africa and viable for its utilities, African Renewable Energy Access Programme. World Bank. Washington, USA.
McKinsey & Company. 2009. Pathways to a Low-Carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve. http://www.mckinsey.com/clientservice/ccsi/pathways_low_carbon_economy.asp.
Meltzer, J. 2018. Blending Climate Funds to Finance low carbon, climate resilient infra-structure, Working Paper 120, Global Economy and Development, Brooklings.
Michaelowa, A. 2012. Strengths and weaknesses of the CDM in comparison with new and emerging markets. CDM Policy Dialogue. University of Zurich, Switzerland.
Asami, M., and Merven, B. 2013. Southern African Power Pool: Planning and Prospects for Renewable Energy, IRENA Innovation and Technology Centre.
National Renewable Energy Laboratory (NREL), 2018. 2018 ATB Cost and Performance Summary. Accessed online July 2019.: https://atb.nrel.gov/electricity/2018/summary.html
Ndong,R., Montrejaud-Vignoles, M. Girons, O. S., Gabrielle, B. Pirot, R. Domergue, M. and Sablayrolles, C. 2009. Life cycle assessment of biofuels from Jatropha Curcas in West Africa: a field study. Plant Environment Interaction, 1,197-210.

Norgate, T. and Langberg, D. 2009. Environmental and Economic Aspects of Charcoal Use in Steelmaking. In ISIJ International 49(4), 587-595.

Powlson, D.S., Stirling, C.M., Thierfelder, C, Whited, R. P and Jate, M.L., 2016, Does conservation agriculture deliver climate change mitigation through soil carbon sequestration in tropical agro-ecosystems? In Agriculture, Ecosystems & Environment, 220, 164-174.

Rahman, S., Larson, D.F., and Dinar, A. 2015. Cost of Greenhouse Gas Emissions Abatement under the Clean Development Mechanism. Climate Change Economics, 6-1, World Scientific Publishing Company.

SAPP. 2017. Southern African Power Pool Plan 2017. Southern African Power Pool. Harare, Zimbabwe.

SITRA, 2019. Information on Bogota Bus Rapid Transit (BRT) project. The Finnish Innovation Fund (SITRA).: https://www.sitra.fi/en/cases/bus-rapid-transit/ .

Randall, S.F., Sentala, M., Yamba, F., SLukewsa, B.,Himunzowa,G.,Heaps, C.,Chapman, A.,Mahumane, G.,Tembog, B.,Nyambe, I. 2016. Electricity supply and demand scenarios for the Southern African Power Pool. Southern African Power Pool, Harare.

Martin; S., Castro, P., Michaelowa, A. 2011. Mobilizing private finance for low carbon development, Climate Strategies, Cambridge.

Prasad, T., Shkaratan, M., Izaguirre, A.K., Helleranta, J.,Rahman, S., Bergman, S. 2009. Monitoring Performance of Electric Utilities - Indicators and Benchmarking in Sub-Saharan Africa, Report Nr 69562, World Bank, Washington, USA.

Trimble, C., Masami K., Ines P.K., Farah M. 2016. Financial Viability of Electricity Sectors in Sub-Saharan Africa: Quasi-Fiscal Deficits and Hidden Costs. Policy Research Working Paper; No. 7788, World Bank, Washington, USA.

United Nations Environment Programme (UNEP), 2016. Motor Vehicle Inventory for LDVs in Zimbabwe: data provided under the Global Fuel Economy Initiative (GFEI).

UNFCCC, 2015. The Paris Agreement. United Nations Framework Convention on Climate Change. https://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf, Accessed date: 31 December 2019.

Van Dorp, M., 2013. Economic feasibility of Jatropha production and processing: A calculation model for business case development by small producer organizations (SPO). Supported by the Global Sustainable Biomass Fund, Netherlands.

Van Eijck, J., Smeets, E., and Faaij, A., 2012. The economic performance of jatropha, cassava and Eucalyptus production systems for energy in an East African smallholder setting. GCB Bioenergy 4, 828-845.

VDZ, 2019. Analysis of clinker production costs. Accessed July 2019.https://www.vdz-online.de/uploads/media/EU_ETS_Charts_EN.pdf

WBCSD CSI (2016) 'Getting the Numbers Right' (GNR) database. :https://www.wbcsdcement.org/index.html

World Bank, (WB) 2018, World Development Indicators - Electric power transmission and distribution losses, https://data.worldbank.org/products/wdi;

World Bank (WB). 2016. State and Trends of Carbon Pricing 2016 (October), by World Bank, Washington, DC.

World Bank (WB). 2016b. Discounting Costs and Benefits in Economic Analysis of World Bank Projects, World Bank, Washington, USA;

Zimbabwe Energy Regulatory Authority (ZERA), 2015, Notification on the Introduction of a Reactive Energy Charge (Draft), Harare, Zimbabwe;

Zimbabwe Revenue Authority, (ZIMRA) 2017, Value Added Tax Act, Harare, Zimbabwe.

Zimbabwe Electricity Transmission and Distribution Company (ZETDC), 2017. System Development Plan. June 2017. ZETDC, Harare, Zimbabwe.

Zimbabwe Electricity Transmission and Distribution Company (ZETDC), 2014, Electricity Tariff, effective since September 2014; Electricity Act, Section 53 (Chapter 13:19), Harare, Zimbabwe.

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