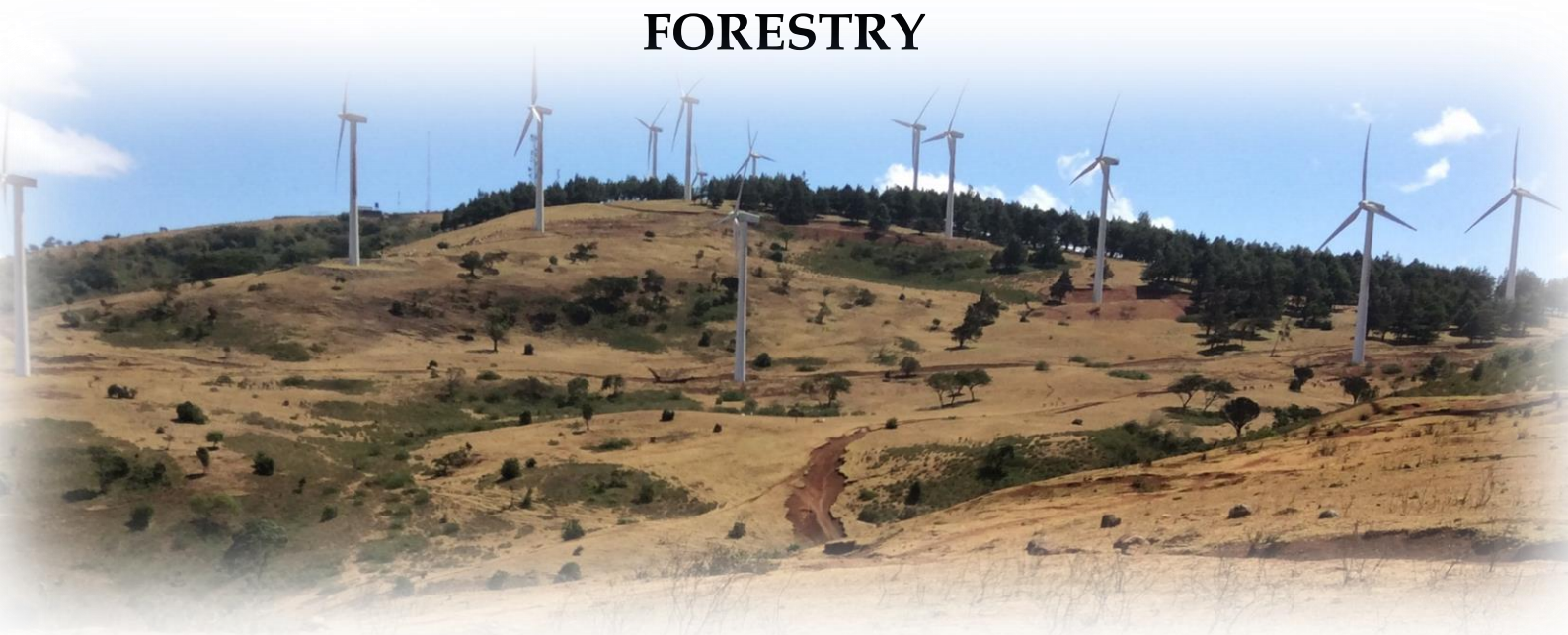
REPUBLIC OF KENYA

MINISTRY OF ENVIRONMENT AND FORESTRY



NATIONAL CLIMATE CHANGE ACTION PLAN 2018-2022

Volume 3:

Mitigation Technical Analysis Report

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List of Abbreviations

ABPP	African Biogas Partnership Program
AGB	Above-Ground Biomass
ASALs	Arid and Semi-Arid Lands
ATAR	Adaptation Technical Analysis Report
BAU	Business-As-Usual
BRT	Bus Rapid Transit
CCAP	Centre for Clean Air Policy
CDM	Clean Development Mechanism
CEEC	Centre for Energy Efficiency and Conservation
CFAs	Community Forestry Associations
CFLs	Compact Fluorescent Lights
CIDPs	County Integrated Development Plans
CoG	Council of Governors
COP	Conference of the Parties
CPAs	Charcoal Producer Associations
CSA	Climate Smart Agriculture
eBRT	Electric Bus Rapid Transit System
EOPS	Early Oil Pilot Scheme
ERC	Energy Regulatory Commission
FAO	Food and Agriculture Organization
FPP	Forest Preservation Programme
FRA	Forest Resources Assessment
GCF	Green Climate Fund
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GFEI	Global Fuel Economy Initiative
GHG	Greenhouse Gas
GoK	Government of Kenya
GW	Gigawatts
GWh	Gigawatts hours
HFC	Hydrofluorocarbon
IC-FRA	Improving Capacity in Forest Resources Assessment in Kenya
ICPS	Improved Charcoal Production Systems
ICT	Information Communication Technology
IFC	International Finance Corporation
ILRI	International Livestock Research Institute
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producers
IPPU	Industrial Process and Product Use
IUCN	International Union for Conservation of Nature
KAA	Kenya Airports Authority
KAM	Kenya Association of Manufacturers

KCAA	Kenya Civil Aviation Authority
KEBS	Kenya Bureau of Standards
KEFRI	Kenya Forestry Research Institute
KENFAP	Kenya National Federation of Agricultural Producers
KenGen	Kenya Electricity Generating Company
KENHA	Kenya National Highways Authority
KENSA	Kenya Private Sector Alliance
KES	Kenya Shillings
KETRACO	Kenya Electricity Transmission Company
KFS	Kenya Forest Service
KIRDI	Kenya Industrial Research and Development Institute
KMA	Kenya Maritime Authority
KPA	Kenya Ports Authority
KQ	Kenya Airways
KRA	Kenya Revenue Authority
KRC	Kenya Railways Corporation
KRRA	Kenya Rural Roads Authority
KURA	Kenya Urban Roads Authority
LAPSSET	Lamu Port and South Sudan Ethiopia Transport
LCPDP	Least Cost Power Development Plan
LDVs	Light Duty Vehicles
LPG	Liquefied Petroleum Gas
LRT	Light Rail Transit
LULUCF	Land Use, Land-Use Change and Forestry
MEF	Ministry of Environment and Forestry
MITC	Ministry of Industry, Trade and Cooperatives
MOE	Ministry of Energy
MOEP	Ministry of Energy and Petroleum
MPM	Ministry of Petroleum and Mining
MRT	Mass Rapid Transit
MRV	Monitoring, Reporting and Verification
MSW	Municipal Solid Waste
MTAR	Mitigation Technical Analysis Report
MTIHUD	Ministry of Transport, Infrastructure, Housing and Urban Development
MtCO2e	Million Tonnes of Carbon Dioxide equivalent
Mtoe	Million Tonnes of oil equivalent
MTP III	Third Medium-Term Plan
MW	Megawatts
NAMA	National Appropriate Mitigation Action
NAMATA	Nairobi Area Transport Metropolitan Authority
NCA	National Construction Authority
NCCAP	National Climate Change Action Plan
NDC	National Determined Contribution
NDMA	National Drought Management Authority

NEMA	National Environment Management Authority
NGOs	Non-Governmental Organizations
NTSA	National Transport and Safety Authority
OMCs	Oil Marketing Companies
PV	Photovoltaic
REA	Rural Electrification Authority
REDD+	Reducing Emissions from Deforestation and forest Degradation plus
REM	Rural Electrification Master plan
RERAC	Renewable Energy Resources Authority Committee
RERC	Rural Electrification and Renewable Energy Corporation
SEZ	Special Economic Zone
SGR	Standard Gauge Railway
SLEEK	System for Land-Based Emissions Estimation in Kenya
TW	Terawatts
TWG	Thematic Working Group
ULCPD	Updated Least Cost Development Plan
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency International Development
USD	United States Dollar

Executive Summary

This Mitigation Technical Analysis Report (MTAR) provides the evidence base for the prioritised climate change mitigation actions in the five-year National Climate Change Action Plan (NCCAP) 2018-2022. It is to be annexed to the plan which it is an integral part of. The prioritised actions in the MTAR have been developed in a consultative and inclusive manner.

Climate change is the most serious global challenge of our time and it is important that countries do not only implement actions that enhance adaptation to the already changing climate but also act to mitigate further global temperature rise. The Paris Agreement adopted at Conference of the Parties (COP) 21 charts a new course in the global climate effort by building upon the United Nations Framework Convention on Climate Change (UNFCCC) and, for the first time, bringing nearly all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries.

Appropriate financial flows, a new technology framework and an enhanced capacity building framework are being put in place, thus supporting action by developing countries in line with their own national objectives. For enhanced transparency of action and support, and to facilitate implementation and promote compliance, the agreement establishes a new mechanism with a more robust enhanced transparency framework.

Since COP 21, countries were invited to confirm their intentions by ratifying the Paris Agreement and submitting Nationally Determined Contributions (NDCs) to the UNFCCC. In future, countries will be required to submit updated and more ambitious NDCs every five years.

Kenya submitted its NDC on 28th December 2016, when it deposited its instrument of ratification for the Paris Agreement under the UNFCCC. The NDC sets out an adaptation contribution of mainstreaming adaptation into Medium Term Plans and implementing adaptation actions. The mitigation contribution intends to abate greenhouse gas (GHG) emissions by 30% by 2030 relative to the business as usual (BAU) scenario (baseline) of 143 million tonnes of carbon dioxide equivalent ($MtCO_2e$). Achievement of the NDC contributions is subject to international support in the form of finance, investment, technology development and transfer, and capacity building.

Climate change action in Kenya is guided by the Climate Change Act, (Number 11 of 2016), which provides a framework for mainstreaming climate change across sectors. The Act obligates the Cabinet Secretary responsible for climate change affairs to formulate a five-year National Climate Change Action Plan (NCCAP) that addresses all sectors of the economy and provides mechanisms for mainstreaming climate change into all sectors and the County Integrated Development Plans (CIDPs). In accordance with the Climate Change Act (2016), the NCCAP represents the national mechanism through which climate change will be addressed in Kenya, including the implementation of the NDC. The NCCAP is to be approved by the National Climate Change Council that is chaired by His Excellency, the President of the Republic of Kenya.

The first NCCAP (2013-2017) was prepared in 2013 and is due for update for the period from 2018 to 2022. The updated NCCAP (2018-2022) is to guide Kenya on the priority adaptation and mitigation climate change actions that help define Kenya's low carbon climate resilient development pathway and lead to the achievement of Kenya's NDC targets. The NCCAP 2018-2022 will cover Kenya's climate actions over the 5-year period ending in 2022.

This Mitigation Technical Analysis Report (MTAR) sets out to identify the actions to get Kenya on the right path towards the realisation of the 2030 mitigation targets defined in Kenya's NDC and the broader Kenya Vision 2030. It aims to identify priority mitigation actions for the 5-year period (2018-2022) of the plan in each of the six mitigation sectors set out in Article 4.3 of the UNFCCC (agriculture, energy, forestry, industry, transport and waste). The focus of the analysis is to clarify how Kenya will achieve the greenhouse gas (GHG) emission reduction contribution

of 30% or a net emission reduction of 42.9 $MtCO_2e$ relative to the baseline. The information and analysis in this report identify and prioritise climate change mitigation actions and provides the evidence base for updating of mitigation actions for the NCCAP 2018-2022. The expected emission reductions as a result of the priority actions in each of the six mitigation sectors are then estimated and summarised.

This MTAR provides the evidence base for the priority mitigation actions in the NCCAP 2018-2022 and is to be annexed to the plan as an integral part of the plan. Only mitigation actions are analysed in this MTAR since adaptation, which is Kenya's priority and a critical part of the NDC, is covered in the Adaptation Technical Analysis Report (ATAR) which is also an annex to and part of the NCCAP 2018-2022.

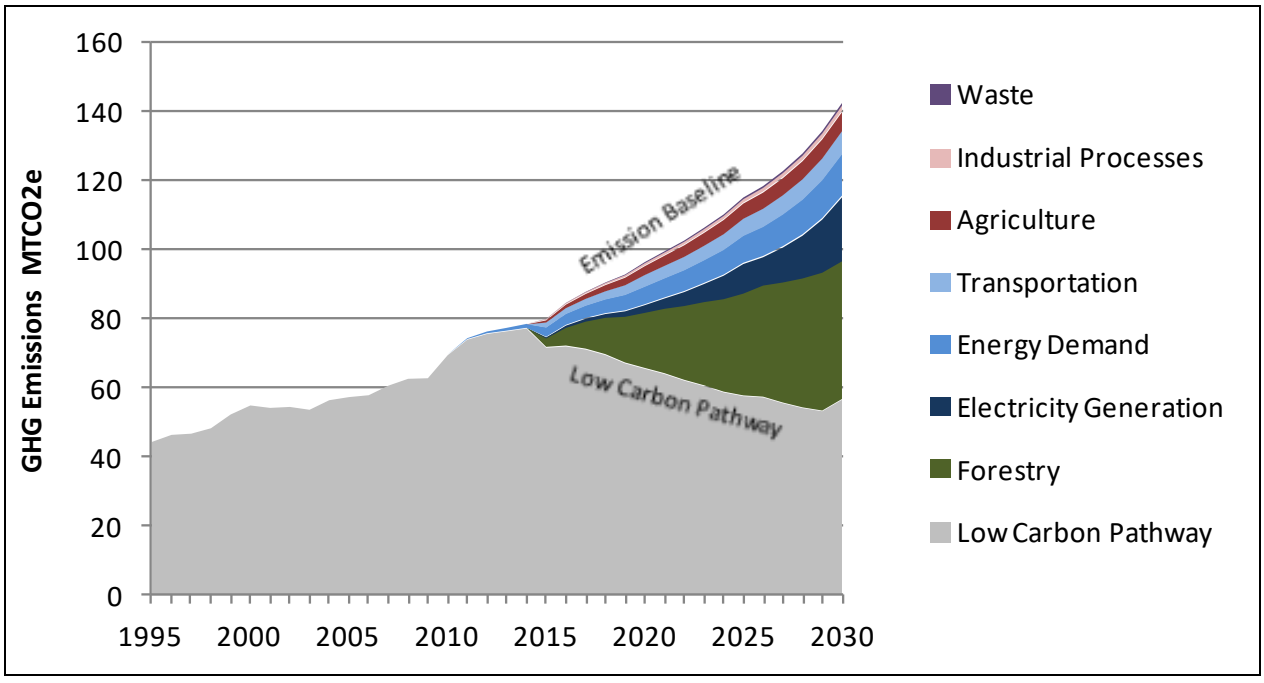
In addition, the Government of Kenya has set the Big 4 Agenda (2018), which establishes priority areas for 2018 to 2022 of ensuring food security, affordable housing, increased manufacturing and affordable healthcare. The prioritised mitigation actions are aligned to support the delivery of the Big Four priorities.

The analysis first clarifies the numbers underlying the baseline and NDC contribution as previously presented in the NCCAP 2013-2017 and the SNC. It then presents the previously proposed mitigation actions and the analyses of the NDC Sector Analysis. Finally, the proposed mitigation actions for the NCCAP 2018-2022 are presented, analysed and prioritised based on their mitigation potential.

Kenya's Baseline Greenhouse Gas Emission Projections and the NDC

This MTAR builds on the Kenya's NCCAP 2013-2017, Second National Communication (SNC) and the NDC Sector Analysis Report 2017. The NCCAP 2013-2018 established the baseline greenhouse gas (GHG) emissions projections to 2030 as 143 million tonnes of carbon dioxide equivalent (MtCO2e) and Kenya's mitigation potential for the 6 mitigation sectors as 60% or 85.8 $MtCO_2e$ by 2030 (Figure 1 and Table 1 below). The NDC sets to reduce Kenya's GHG emissions by 30% or 42.9 $MtCO_2e$ relative to this baseline, which is also the baseline that has been applied for the analysis in this MTAR.

Figure 1: Kenya's Baseline Emissions and Mitigation Potential for the Sectors ($MtCO_2e$ per year)



Source: GoK; NCCAP 2013-2017

Although the NDC target assumes that all sectors will work toward mitigation goals, this does not necessarily translate into a 30% emission reduction target for each of the 6 sectors as shown in Table 1. The actual mitigation potential of each of the six sectors depends on a number of factors ranging from policy, resources, priorities to the implementation practicality of the potential mitigation actions. The details of Kenya's baseline emissions projected to 2030 and the mitigation potential from previous analysis, including the NDC mitigation target, are provided in Chapter 2 of the MTAR.

Table 1: Kenya's Emission Reduction Potential and the NDC Targets by Sector ($MtCO_2e$ per year)

Sector	GHG Emission Reduction Potential ($MtCO_2e$)				NDC Target ($MtCO_2e$)
	2015	**2020**	**2025**	**2030**	**2030**
Forestry	2.71	16.24	29.76	40.2	20.10
Electricity Generation	0.28	2.24	8.61	18.63	9.32
Energy Demand	2.74	5.16	7.92	12.17	6.09
Transportation	1.54	3.52	5.13	6.92	3.46
Agriculture	0.63	2.57	4.41	5.53	2.77
Industrial Processes	0.26	0.69	1.03	1.56	0.78
Waste	0.05	0.33	0.5	0.78	0.39
Total Emission Reduction Potential				**85.79**	**42.90**
Total Emissions in 2030	**8.21**	**30.75**	**56.86**	**143.00**	**143.00**
% of Total Emissions in 2030				**60%**	**30%**

Source: derived from Government of Kenya (2015), Second National Communication, page 172

To achieve the mitigation NDC target, Kenya has to reduce its GHG emissions by not less than 42.9 $MtCO_2e$ relative to the BAU scenario by 2030. This in turn requires Kenya to introduce policies, programs and technologies that encourage emission reductions and drive the country to low carbon development pathway. In the NCCAP 2013-2018 and SNC, priority actions to reduce GHG emissions were identified and prioritised for implementation.

The NDC Sector Analysis Report 2017 examined what was realistically doable in each of the sectors, given a number of priorities, planned actions and assumptions; and identified the low and high range of potential emission reductions for each of the six sectors as shown in Table 2.

Table 2: Kenya's Emission Reduction Potential and the NDC Targets by Sector ($MtCO_2e$ per year)

Sector	Total Emissions ($MtCO_2e$)	Emission Reductions Relative to Baseline (MtCO2e)			
		High range*	Low range*	Technical Potential	NDC Target
	2030	2030	2030	2030	2030
Forestry	22	20.1	11.3	40.2	20.10
Electricity Generation	41	12.6	7.5	18.63	9.32
Energy Demand	10	-	-	12.17	6.09
Transportation	21	3.5	2.0	6.92	3.46
Agriculture	39	2.8	1.6	5.53	2.77
Industrial Processes	6	1.3	1.0	1.56	0.78
Waste	4	0.4	0.4	0.78	0.39
Total	**143**	**40.1**	**23.8**	**85.8**	**42.9**

Source: Government of Kenya (2015), Second National Communication, and NDC Sector Analysis Report 2017

**The low target is aligned with the proportional contribution that the sector would need to make in order for there to be a high level of certainty that the overall target will be achieved if all other sectors also meet their low target reduction.*

**The high target is intended to guide responsible ministries and agencies in terms of what they should objectively plan and prepare for should the sector require additional emission reductions.*

For the NCCAP 2018-2022, a number of actions have been proposed, analysed and prioritised. Table 3 shows a summary of the prioritised actions in the 6 sectors and their mitigation potential. The details of this analysis are discussed in Chapter 3 of this report.

Table 3: Emission Reduction Potential of the Prioritised Mitigation Actions ($MtCO_2e$)

Sector/Sub-sector	Agriculture Sector Prioritized Mitigation Action	Emission Reduction (tCO_2e)	
		Action up to 2022	Action up to 2030
Agriculture	Increase agroforestry area by 200,000 acres by 2022	1.66	3.71
Agriculture	Increase farm area under sustainable land management by 250,000 acres by 2022	0.55	0.77
Livestock	Implementation of Kenya's Dairy NAMA-267 HH by 2030	0.40	0.69
Total Sector Emission Reduction Potential of the Prioritized Actions		**2.61**	**5.17**
Sector/Sub-sector	**Energy Sector Prioritised Mitigation Action**	**Emission Reduction (tCO_2e)**	
		Action up to 2022	**Action up to 2030**
Energy Supply/Electricity Generation	Developing new 2,405 MW of grid-connected renewable electricity generation and retirement of three thermal plants by 2022	9.2	9.2
Energy demand side	Develop and distribute 4 million improved biomass (charcoal and biomass) stoves by 2022	6.3	6.3
	Develop and distribute 1 million clean energy (LPG, biogas, and ethanol) stoves by 2022	0.8	0.8
Total Sector Emission Reduction Potential of the Prioritized Actions		**16.3**	**16.3**
Sector/Sub-sector	**Forestry Sector Prioritized Mitigation Action**	**Emission Reduction (tCO_2e)**	
		Action up to 2022	**Action up to 2030**
Forestry	Reduce deforestation and forest degradation by rehabilitation and protection of additional 100,000 Ha of natural forests (including mangroves) by 2022	2.0	2.0
	Afforestation/reforestation/agroforestry of additional 100,000 Ha of land by 2022	2.0	4.8
	Restoration of 200,000 ha of forest on degraded landscapes (ASALs, rangelands) by 2022	5.4	13
	Increase area under private sector-based commercial and industrial plantations from 71,000 Ha to at least 121,000 Ha	1.0	1.0
Total Sector Emission Reduction Potential of the Prioritized Actions		**10.4**	**20.8**
Sector/Sub-sector	**Industry Sector Prioritized Mitigation Action**	**Emission Reduction (tCO_2e)**	
		Action up to 2022	**Action up to 2030**
Industry	Implementing the NAMA on charcoal	0.45	1.08
Total Sector Emission Reduction Potential of the Prioritized Actions		**0.45**	**1.08**
Sector/Sub-sector	**Transport Sector Prioritized Mitigation Action**	**Emission Reduction (tCO_2e)**	
		Action up to 2022	**Action up to 2030**
Road	Implementation of the Mass Rapid Transport System (Bus Rapid Transit System with Light Rail) for Greater Nairobi	0.44	2.3
Road/Rail	Transfer of Freight from Road to Rail Between Nairobi and Mombasa	0.82	4.8
Road	Improvement of the Heavy-Duty Truck Efficiency	0.32	0.97
Rail	Electrification of the SGR Line Between Nairobi To Mombasa by 2022	0.24	0.32

Total Sector Emission Reduction Potential of the Prioritized Actions		1.8	4.7
Sector/Sub-sector	Waste Sector Prioritized Mitigation Action	Emission Reduction (tCO_2e)	
		Action up to 2022	Action up to 2030
Solid waste	Implementation of the Solid Waste NAMA		
	With composting	0.10	0.13
	With land fill gas capture and electricity generation	0.62	0.79
	Incineration with electricity generation	0.36	0.46
Total Emission Reduction Potential (NAMA)		**0.72**	**0.82**
Total Emission Reduction Potential (Incineration with electricity generation)		**0.36**	**0.46**

The above mitigation potentials of the prioritized actions are summarised sectorial in Table 4 below.

Table 4: Kenya's Emission Reduction Potential (NCCAP 2018-2022) and the NDC Targets by Sector ($MtCO_2e$ per year)

Sector	Total Emissions ($MtCO_2e$)	Emission Reductions Relative to Baseline (MtCO2e)				
		High range*	Low range*	Technical Potential		NDC Target
	2030	2030	2030	2022	2030	2030
Forestry	22	20.1	11.3	10.4	20.8	20.10
Electricity Generation	41	12.6	7.5	9.2	9.2	9.32
Energy Demand	10	-	-	7.1	7.1	6.09
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Agriculture	39	2.8	1.6	2.61	5.17	2.77
Industrial Processes	6	1.3	1.0	0.45	1.08	0.78
Waste	4	0.4	0.4	0.72	0.82	0.39
Total	**143**	**40.1**	**23.8**	**32.28**	**48.87**	**42.9**

From Table 4, it is evident that through the prioritised actions, Kenya can achieve the NDC mitigation target by 2030. The largest contributions to the realisation of the target will have to come from the forestry and energy sectors.

Chapter 1: Introduction and Methodology

1.1: Introduction

Climate change is the most serious global challenge of our time and it is important that countries do not only implement actions that enhance adaptation to the already changing climate but also act to mitigate further global temperature rise. The Paris Agreement adopted at Conference of the Parties (COP) 21 charts a new course in the global climate effort by building upon the United Nations Framework Convention on Climate Change (UNFCCC) and, for the first time, bringing nearly all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries.

The Paris Agreement aims to:

- Strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 20^0C above pre-industrial levels.
- Strengthen the ability of countries to deal with the impacts of climate change.
- Pursue efforts to limit the temperature increase further to 1.5^0C.

To reach these ambitious goals, and besides provision of a universal platform for all countries to act towards the commonly agreed goal for responding to climate change, the international agreement provides the mechanisms to pursue these goals and binding obligations for all Parties related to transparency and reporting, including commitments by developing countries, such as Kenya, to:

- Prepare, communicate and maintain successive Nationally Determined Contributions (NDCs),[1] with the expectation that each party's successive NDC will represent a progression beyond its previous one and reflect its highest possible ambition
- Pursue domestic mitigation measures aimed at achieving their NDCs.
- Report regularly on their emissions inventories, progress in implementing and achieving their NDCs, the support required and any support received.

Appropriate financial flows, a new technology framework and an enhanced capacity building framework are being put in place, thus supporting action by developing countries in line with their own national objectives. For enhanced transparency of action and support, and to facilitate implementation and promote compliance, the agreement establishes a new mechanism with a more robust enhanced transparency framework.

Since COP 21, countries were invited to confirm their intentions by ratifying the Paris Agreement and submitting NDCs to the UNFCCC. In future, countries will be required to submit updated and more ambitious NDCs every five years.

Kenya submitted its NDC[2,3] on 28th December 2016, when it deposited its instrument of ratification for the Paris Agreement under the UNFCCC.[4] The NDC sets out an adaptation contribution of mainstreaming adaptation into Medium Term Plans and implementing adaptation actions. The mitigation contribution intends to abate greenhouse gas (GHG) emissions by 30% by 2030 relative to the business as usual (BAU) scenario (baseline) of 143 million tonnes of carbon dioxide equivalent ($MtCO_2e$). Achievement of the NDC contributions is subject to international support in the form of finance, investment, technology development and transfer, and capacity building.

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represents the national mechanism through which climate change will be addressed in Kenya, including the implementation of the NDC. The NCCAP is to be approved by the National Climate Change Council that is chaired by His Excellency, the President of the Republic of Kenya.

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This Mitigation Technical Analysis Report (MTAR) sets out to identify the actions to get Kenya on the right path towards the realisation of the 2030 mitigation targets defined in Kenya's NDC and the broader Kenya Vision 2030.[5] It aims to identify priority mitigation actions for the 5-year period (2018-2022) of the plan in each of the six mitigation sectors set out in Article 4.3 of the UNFCCC (agriculture, energy, forestry, industry, transport and waste). The focus of the analysis is to clarify how Kenya will achieve the greenhouse gas (GHG) emission reduction contribution of 30% below the 2030 BAU specified in Kenya's NDC, a net emission reduction of 43 MtCO2e relative to the baseline. The information and analysis in this report identifies and prioritises climate change mitigation actions and provides the evidence base for updating of mitigation actions for the NCCAP 2018-2022. The expected emission reductions as a result of the priority actions in each of the six mitigation sectors are then estimated, together with the budgets before any existing gaps are identified.

Only mitigation actions are analysed since adaptation, which is Kenya's priority and a critical part of the NDC,[6] is covered in the Adaptation Technical Analysis Report (ATAR) which is also an annex to and part of the NCCAP. In addition, the GoK, has set the Big 4 Agenda (2018)[7] which establishes priority areas for 2018 to 2022 of ensuring food security, affordable housing, increased manufacturing and affordable healthcare. The mitigation actions are aligned to support the delivery of the Big Four priorities.

The analysis first clarifies the numbers underlying the baseline and NDC contribution as previously presented in the NCCAP 2013-2017 and the SNC. It then presents the previously proposed mitigation actions and the analyses of the NDC Sector Analysis.[8] Finally, the proposed mitigation actions for the NCCAP 2018-2022 are presented, analysed and prioritised based on their mitigation potential. The MTAR is organised in the following chapters:

- Chapter 1 – Introduction and Methodology
- Chapter 2 – Kenya's Baseline Emissions and the NDC
- Chapter 3 – Mitigation Actions and Impacts
- Section 3.1. – Agriculture
- Section 3.2 – Energy
- Section 3.3 – Forestry
- Section 3.4– Industry
- Section 3.5– Transportation
- Section 3.6– Waste
- Chapter 4 – Implementation Plan

This analysis is an annex to and a part of the NCCAP 2018-2022.

1.2 Methodology

This MTAR examined Kenya's options to realise the country's mitigation target as set out in the NDC in the 6 mitigation sectors. Only mitigation is analysed as adaptation, which is a critical part of Kenya's NDC and a priority area of focus, has been addressed in a separate Adaptation Technical Analysis Report (ATAR). The MTAR builds on previous work carried out during the NCCAP 2013-2017, Kenya's Second National Communication to the

UNFCCC (SNC) and NDC Sector Analysis Report 2017. Besides the actions that were presented and prioritised in prior week, some new mitigation actions have been proposed and analysed in the MTAR. The assessment of the mitigation potential of the proposed actions and related assumptions for NCCAP 2018-2022 has been built from the NCCA 2013-2017, the SNC and the NDC Sector Analysis Report 2017. Additional information is available in the fact sheets in the NCCAP low-carbon analysis in each of the six sectors, accessible at: http://www.kccap.info. The fact sheets for the six mitigation sectors have been compiled into one document that is available at: http://www.starckplus.com/index.php/starck-components/technical-assistance .

The MTAR first establishes the baseline emissions projections as determined in the NCCAP 2013-2017 and confirmed in the SNC as the basis for the NDC target and future emission reductions. It then examines the expected GHG emission reduction contributions for each sector drawing from the NDC Sector Analysis Report 2017, which examined options to deliver on Kenya's mitigation contributions in the six sectors and determined a high and low range of potential of emission reductions for each of the sectors.

With reference to the sector plans, policies, NCCAP 2013-2017, SNC and NDC Sector Analysis Report 2017, selected sector stakeholders, in various meetings, identified and proposed mitigation actions for their respective sectors for period 2018-2022. In addition, the county governments' inputs were also obtained through the county consultations. These were presented and discussed in the Mitigation Thematic Working Group (TWG) that provided clarifications and more detail on the proposed actions. This process also helped to identify gaps and update some of the information although mostly, existing information was used due to the stringent timelines for delivery of the NCCAP 2017-2022 and related documents. The final list of proposed actions for mitigation analysis was then agreed.

Using the list of the agreed actions, with further consultations, existing reports and standard Intergovernmental Panel on Climate Change (IPCC) and UNFCCC approved data, emission estimations were made for the proposed actions. The actions were later prioritised on the basis of their estimated mitigation potentials.

With reference to the preliminary findings, further consultations with various stakeholder groups were conducted and feedback received was incorporated into the final report.

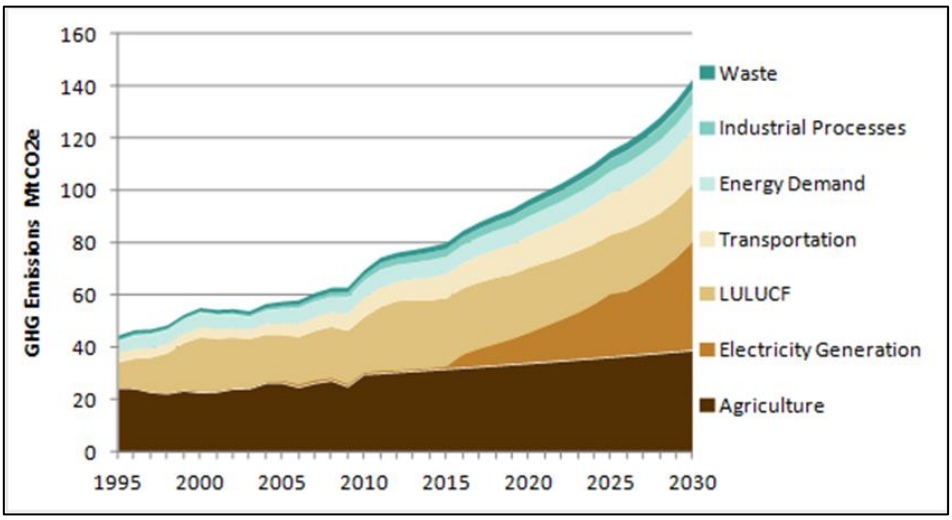
The Mitigation Technical Analysis Report was revised and expanded to incorporate the comments and input received at the various stakeholder meetings.

Chapter 2: Kenya's Greenhouse Gas Emissions Baseline and Mitigation Targets

2.1: Kenya's Baseline Greenhouse Gas Emission Projections

This MTAR builds on the NCCAP 2013-2017, the SNC and the NDC Sector Analysis Report 2017. The NCCAP 2013-2017 established the baseline GHG emissions projections to 2030 for the 6 mitigation sectors as shown in Figure 2.1.1 and summarised in Table 2.1.1 below. A key outcome of the analysis was that Kenya's total GHG emissions from all the six sectors combined would grow to about 100 and 143 million tonnes of carbon dioxide equivalent ($MtCO_2e$) by 2022 and 2030, respectively. In 2030, the highest amount of emissions would come from the energy sector (electricity generation), followed by agriculture and forestry (LULUCF).

Figure 2.1.1: Baseline Emission Projections for Kenya (MtCO2e per year)



Source: GoK; NCCAP 2013-2017

Table 2.1.1: Baseline Emission Projections for Kenya (MtCO2e per year)

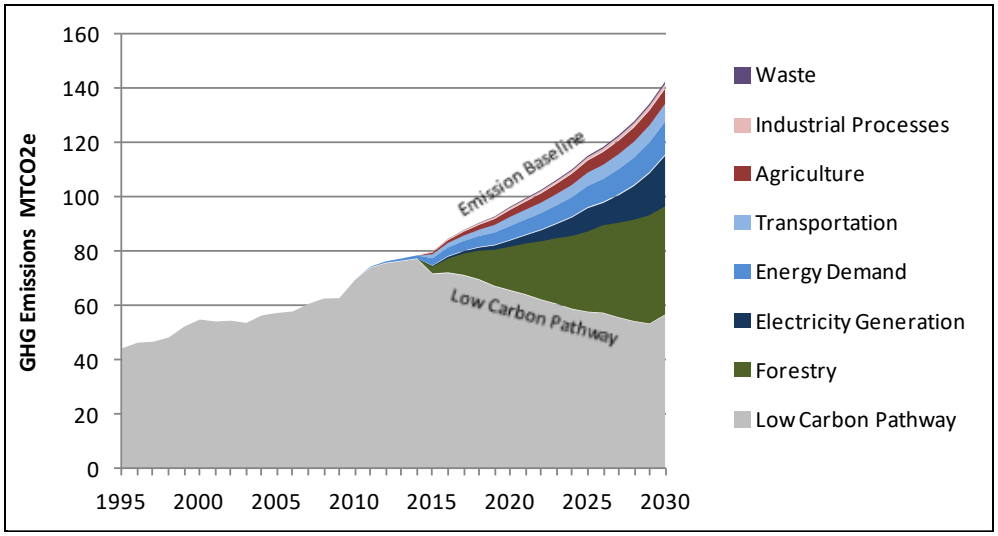
Sector	Baseline GHG Emission ($MtCO_2e$)							
	1995	2000	2005	2010	2015	2020	2025	2030
Forestry (LULUCF)	10	21	18	21	26	25	23	22
Electricity Generation	0	1	1	1	1	12	24	41
Energy Demand	4	5	5	6	7	8	9	10
Transportation	4	4	4	7	9	12	16	21
Agriculture	24	23	26	30	32	34	36	39
Industrial Processes	1	1	1	2	3	4	5	6
Waste	1	1	2	2	2	3	3	4
Total	**44**	**55**	**57**	**70**	**80**	**96**	**115**	**143**

Source: GoK (2015), SNC

The NCCAP 2013-2017 and the SNC then identified and examined various mitigation options in the 6 sectors to determine the priority actions and their technical mitigation potentials as summarised in Figure 2.1.2 and Table 2.1.2 below. This analysis showed that out of the total 143 $MtCO_2e$, Kenya had the technical potential to reduce 60% or 85.8 $MtCO_2e$ by 2030. The results of the analysis, which have been applied for the baseline emission projections in this MTAR, formed the basis of Kenya's NDC which was set at 50% of the technical emissions

reduction potential or 42.9 $MtCO_2e$ by 2030. This technical potential provided a basis for determining the overall 30% target for Kenya, but each sector had widely differentiated potential as well as costs.

Figure 2.1.2: Kenya's Mitigation Potential for the Sectors ($MtCO_2e$ per year)



Source: GoK; NCCAP 2013-2017

2.2: Kenya's Mitigation NDC and the Technical Mitigation Potential of the Sectors

Kenya's mitigation NDC, whose achievement is subject to international support (finance, investment, technology), is based on the NCCAP 2013-2017 and SNC analysis. The NDC seeks to abate the country's GHG emissions by 30% (42.9 $MtCO_2e$) by 2030 relative to the BAU scenario of 143 $MtCO_2e$. Table 2.1.2 summarises the potential emission reductions against proportionate NDC targets for each of the six sectors as determined in the SNC.

Table 2.1.2: Kenya's Emission Reduction Potential and the NDC Targets by Sector ($MtCO_2e$ per year)

Sector	GHG Emission Reduction Potential (MtCO2e)				NDC Target (MtCO2e)
	2015	**2020**	**2025**	**2030**	**2030**
Forestry	2.71	16.24	29.76	40.2	20.10
Electricity Generation	0.28	2.24	8.61	18.63	9.32
Energy Demand	2.74	5.16	7.92	12.17	6.09
Transportation	1.54	3.52	5.13	6.92	3.46
Agriculture	0.63	2.57	4.41	5.53	2.77
Industrial Processes	0.26	0.69	1.03	1.56	0.78
Waste	0.05	0.33	0.5	0.78	0.39
Total Emission Reduction Potential				85.79	42.90
Total Emissions in 2030	**8.21**	**30.75**	**57.36**	**143.00**	**143.00**
% of Total Emissions in 2030				**60%**	**30%**

Source: derived from Government of Kenya (2015), Second National Communication, page 172

Although the NDC target assumes that all sectors will work toward mitigation goals, this does not necessarily translate into a 30% emission reduction target for each of the sectors as shown in Table 2.1.2. The actual mitigation potential of each of the six sectors depends on a number of factors ranging from policy, resources, priorities to the implementation practicality of the potential mitigation actions.

To achieve the NDC target, Kenya has to introduce policies, programs and technologies that encourage emission reductions and drive the country to low carbon development pathway. In the NCCAP 2013-2018 and SNC, priority actions to reduce GHG emissions were identified and prioritised for implementation.

The NDC Sector Analysis Report 2017 examined what was realistically doable in each of the sectors, given a number of priorities, planned actions and assumptions; and identified the low and high range of potential emission reductions for each of the six sectors as shown in Table 2.1.3.

Since the NDC Sector Analysis Report of 2017, a few changes have taken place in the six sectors, with some priorities and government plans having shifted. Some of the changes have significant implications on climate change mitigation

To achieve the mitigation NDC target, Kenya has to reduce its GHG emissions by not less than 42.9 $MtCO_2e$ relative to the BAU scenario by 2030 as established in the NCCAP 2013-2017. For the NCCAP 2018-2022, a number of actions have been proposed. Chapters 3 of this MTAR analyses the proposed mitigation actions by sector and estimate their mitigation potential. The actions are then prioritised based on their mitigation potential with a focus on low carbon climate-resilient development towards the NDC realisation.

Table 2.1.3: Kenya's Emission Reduction Potential and the NDC Targets by Sector ($MtCO_2e$ per year)

Sector	Total Emissions ($MtCO_2e$)	Emission Reductions Relative to Baseline (MtCO2e)			
		High range*	Low range*	Technical Potential	NDC Target
	2030	2030	2030	2030	2030
Forestry	22	20.1	11.3	40.2	20.10
Electricity Generation	41	12.6	7.5	18.63	9.32
Energy Demand	10	-	-	12.17	6.09
Transportation	21	3.5	2.0	6.92	3.46
Agriculture	39	2.8	1.6	5.53	2.77
Industrial Processes	6	1.3	1.0	1.56	0.78
Waste	4	0.4	0.4	0.78	0.39
Total	**143**	**40.1**	**23.8**	**85.8**	**42.9**

Source: Government of Kenya (2015), Second National Communication, and NDC Sector Analysis Report 2017

**The low target is aligned with the proportional contribution that the sector would need to make in order for there to be a high level of certainty that the overall target will be achieved if all other sectors also meet their low target reduction.*

**The high target is intended to guide responsible ministries and agencies in terms of what they should objectively plan and prepare for should the sector require additional emission reductions.*

Chapter 3: Proposed Mitigation Actions for 2018-2022

3.1. Agriculture Sector

3.1.1 Overview

The agriculture sector, including crop cultivation, livestock and fisheries, is the means of livelihood for the majority of the rural population in Kenya and provides over 70% of employment in rural areas.[9] Agriculture is key to Kenya's economy, contributing 26% of the Gross Domestic Product (GDP) and another 27% of GDP indirectly through linkages with other sectors.[10] The agriculture sector continues to play a vital role in the rural economy and according to the *Agricultural Sector Development Strategy 2010-2020,* growth in the national economy has historically been highly correlated with growth in the agricultural sector[11] .

The sector was one of the first to fully devolve the function of service provision to the county governments underscoring the importance of County Governments' role in ensuring food security. The sector employs more than 40% of the total population and more than 70% of Kenya's rural people. Agriculture in Kenya is large and complex, with a multitude of public, parastatal, non-governmental and private sectors.[12]

Agriculture is a priority of the Government and people of Kenya because of the sector's importance to food security (one of the Big 4 priority sectors), rural livelihoods and poverty alleviation. Agriculture is a key economic sector and is considered the backbone of Kenya's economy for its direct contribution to the GDP and linkages with other sectors such as manufacturing and trade. The agricultural sector contributes about 25% of Kenya's GDP and about 27% indirectly through linkages to agro-based industries and the service sector.[13]

In 2015, the agriculture sector was the leading source of GHG emissions in Kenya, with the livestock sub-sector contributing about one half of the emissions. With a large number of livestock,[14] the livestock sub-sector is dominated by pastoralism, which is the most important economic and livelihood activity in the Arid and Semi-Arid Lands (ASALs) that comprise over 80% of the country's land area. The sub-sector supports 20% of the Kenyan population (over 10 million people), most of whom who live in the ASALs.[4] The dairy industry is a growing sub-sector, with milk production having increased from 495.2 million litres in 2012 to 650.3 million litres in 2016, an increase of about 30%.[15]

The combination of deforestation to open up croplands, the extension of agriculture onto land with low potential, and the use of more basic farming techniques and technologies due to cost and capacity barriers make the current agricultural system unsustainable in the long term.

Kenya recently released its Kenya Climate Smart Agriculture Strategy 2017-2026, which among other objectives, aims to minimise GHG emissions from the sector. Climate Smart Agriculture (CSA) is defined as agriculture that "sustainably increases productivity, enhances resilience, reduces/removes greenhouse gas emissions, and enhances the achievement of national food security and development goals".[16]

The CSA strategy has been used as a source of input for the development of NCCAP 2018-2022 and is likely to be used as a tool that supports its implementation.

Because of the importance of food security in Kenya, adaptation to climate change is the priority of the Government of Kenya for the agricultural sector, with mitigation pursued as an additional benefit when possible. The Government's position, as stated in the NCCAP 2013-2017, is that Kenya will not adopt measures to reduce GHG emissions if they threaten the country's ability to feed its growing population or reduce export earnings. The NCCAP 2013-2017 states that the approach to addressing climate change is "to implement adaptation projects or activities in as a low carbon pathway as practically and economically feasible" and that food security takes precedence over

mitigation of GHG emissions.[17] This approach has been continued in the Mitigation Technical Analysis for the agriculture sector.

3.1.2 Mitigation Actions in the Agriculture Sector

Between 2995 and 2025, the agricultural sector is estimated to be the largest source of GHG emissions of all sectors in Kenya. About 40% of total national emissions in 2015 were from this sector alone. Despite its important contribution to overall emissions, data required to calculate GHG emissions is lacking and there is significant uncertainty associated with the emission estimates when compared to energy demand, electricity generation and transportation sectors.

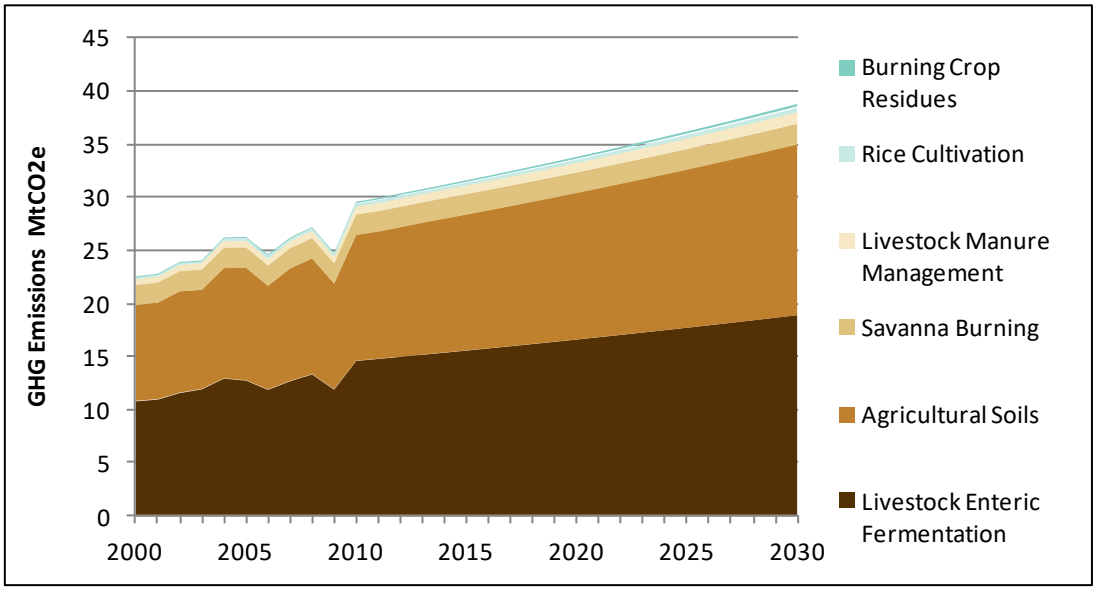
Besides the enteric Methane emissions from the livestock sector, which is nearly one half of the total sector's emissions, the emissions associated with the management of soils on agricultural lands, such as cultivation and tillage, are the second largest in the sector with a contribution of about 42% of the sectors total emissions.

The sector emissions also include those through such activities as conventional tilling, burning of savannah and crop residues, and rice cultivation.

Baseline

According to Kenya's SNC, agriculture emissions (the largest source of GHG emissions in Kenya) are likely to increase from 30 $MtCO_2e$ in 2010 to 39 $MtCO_2e$ in 2030 (Figure 3.1.1 and Table 3.1.1), largely driven by livestock Methane emissions (18.8 MtCO2e in 2030) and in agricultural soils (16.2 $MtCO_2e$ by 2030). The sector also contributes Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) emissions through activities such as conventional tillage, burning of the savannah and crop residues, and rice cultivation.

Figure 3.1.1: Agriculture Sector Baseline Emission Projection for Kenya (MtCO2e)



Source: Government of Kenya (2015), Second National Communication

Table 3.1.1: Agriculture Sector Baseline Emission Projection for Kenya ($MtCO_2e$)

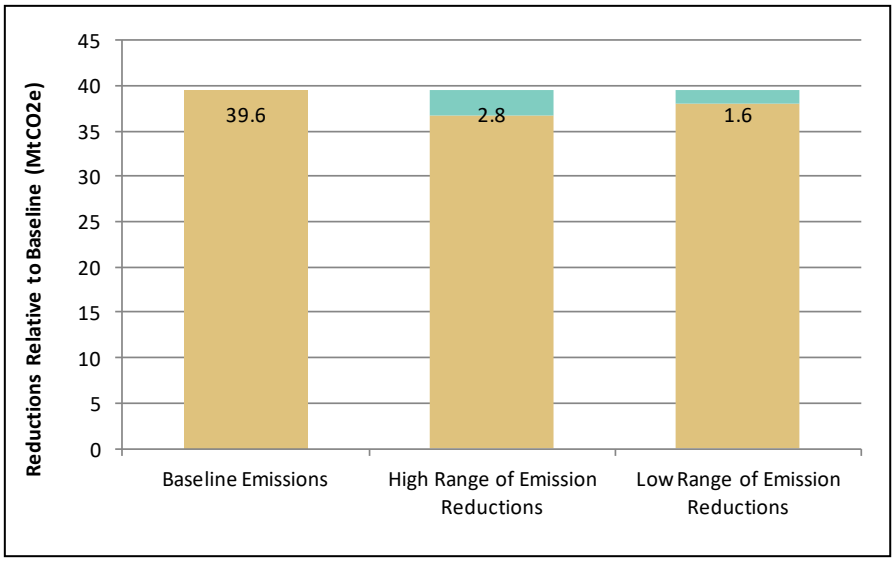
Agriculture Source	Agriculture Baseline GHG Emissions ($MtCO_2e$)						
	2000	2005	2010	2015	2020	2025	2030
Livestock Enteric Fermentation	10.8	12.7	14.5	15.5	16.5	17.7	18.8
Agricultural Soils	9.0	10.6	11.9	12.8	13.9	15.0	16.2
Savanna Burning	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Livestock Manure Management	0.6	0.7	0.8	0.8	0.9	1.0	1.1
Rice Cultivation	0.2	0.2	0.3	0.3	0.3	0.4	0.4
Burning Crop Residues	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Total	**22.6**	**26.3**	**29.6**	**31.4**	**33.6**	**35.9**	**38.5**

Source: Government of Kenya (2015), Second National Communication,

NDC Target for the Agriculture Sector

From the NDC Sector Analysis 2017, the indicative proportionate emission reduction target contribution for the agriculture sector by 2030 is 2.77 $MtCO_2e$ with a high and low range of 2.8 and 1.6 $MtCO_2e$, respectively (Table 2.1.3 and Figure 3.1.2).[18] These do not have to be necessarily delivered by the sector though, since the actual sector GHG emissions reduction will be based on the realistic opportunities available for emission reductions in the sector together with the sector plans and budget provisions.

Figure 3.1.2: Comparison of 2030 Baseline Emissions and NDC Target Emission Reductions (MtCO2e)



Source: Government of Kenya (2017), National Determined Contribution Sector Analysis Report

The agriculture sector should strive to meet the low range of emission reductions (1.6 $MtCO_2e$ by 2030), requiring that other sectors implement actions to achieve the high range of emission reductions. In the five-year period of the NCCAP 2018-2022 and NDC implementation plan, the sector should focus climate change efforts on adaptation, while building expertise and improving data for mitigation action.

It is on the basis of the above discussed baseline emissions that the mitigation actions proposed for the NCCAP 2018-2022 have been analysed in this report.

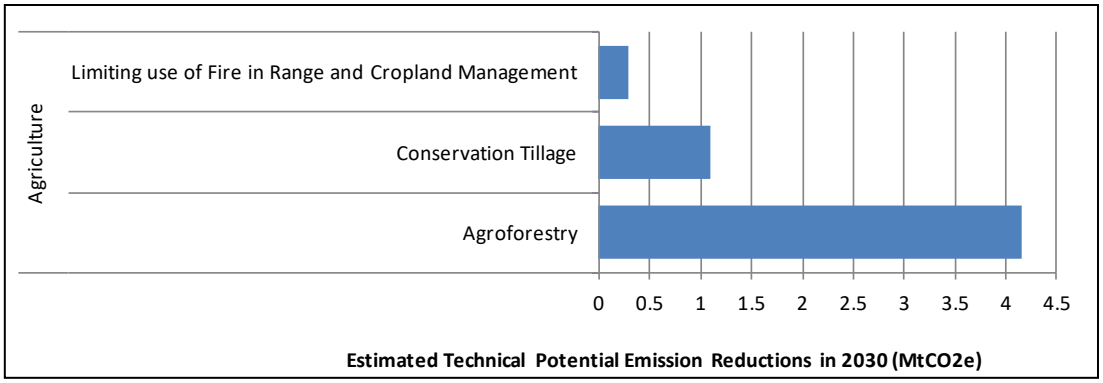
Mitigation Actions Identified in Kenya's Second National Communication

In the NCCAP 2013-2017 and the SNC, the following three mitigation action were prioritised for the agriculture sector as shown in Figure 3.1.3:

- Limiting the use of fire in range and cropland management (mitigation potential of 0.29 MtCO2e by 2030)
- Conservation tillage (mitigation potential of 1.09 $MtCO_2e$ by 2030)
- Agroforestry (mitigation potential of 4.16 $MtCO_2e$ by 2030)

Despite being a major contributor to GHG emissions in the sector, livestock was not included in the prioritised mitigation actions because of the signification implementation barriers the actions would face. However, a mitigation action is considered important in this sub-sector which is the largest emissions source in the agriculture sector. Significant work has been undertaken to measure GHG emissions in the dairy sub-sector and Nationally Appropriate Mitigation Action (NAMA) has been proposed for the dairy sector. While the emission reduction potential is not significant at a national scale, initiatives in the dairy sub-sector are important mitigation actions.

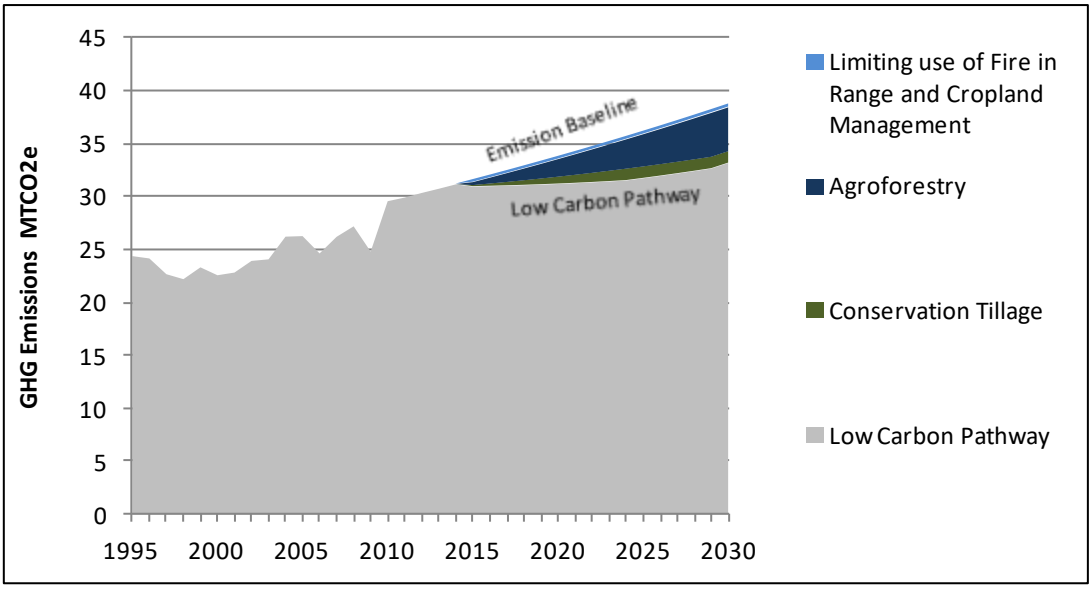
Figure 3.1.3: Technical Potential Emissions Reductions in 2030 for Agriculture Mitigation Options (MtCO2e)



Source: Government of Kenya (2017), National Determined Contribution Sector Analysis Report

The overall impact of the three actions on the sector's total emissions is best depicted in Figure 3.1.4 below (Table 3.1.2 shows the mitigation potential options in figures). From the depiction, it is evident that the opportunities for mitigation are limited in the agriculture sector and the practical strategy is to aim for the low range emission reduction target in the sector while looking for larger mitigation actions in the other sectors.

Figure 3.1.4: Technical Potential Emissions Reductions in 2030 for Agriculture Mitigation Options (MtCO2e)



Source: Government of Kenya (2015), Second National Communication Report

Table 3.1.2: Agriculture Priority Actions Emission Reduction Projection ($MtCO_2e$)

Agriculture Source	Agriculture Emission Reduction Potential-2015 to 2030 ($MtCO_2e$)			
	2015	2020	2025	2030
Conservation Tillage	0.11	0.65	1.09	1.09
Agroforestry	0.28	1.66	3.05	4.16
Limiting use of Fire in Range and Cropland Management	0.24	0.26	0.27	0.29
Total	**0.63**	**2.57**	**4.41**	**5.54**

Source: Government of Kenya (2015), Second National Communication Report

Proposed Mitigation Actions for the NCCAP 2018-2022 in the Agriculture Sector

The mitigation actions proposed in the agriculture sector for analysis and prioritisation in the NCCAP 2018-2022 are shown in Table 3.1.3 below. These actions were proposed by agriculture sector stakeholders led by the Ministry of Agriculture and Irrigation.

The following two actions have already been included in the energy sector and have therefore not been included for mitigation analysis under the agriculture sector:

- Increase adoption of biogas technology use by 80,000 households leading to abatement of 1.2 million tCO2e by 2022 or an average of 3 tCO_2e per household per year (Linked to biogas cooking in the energy sector).
- Increase adoption of biogas technology use by at least 200 abattoirs leading to abatement of 0.8 million tCO_2e by 2022 (Linked to increased renewable fuel use for industries and agro-processing under the energy sector mitigation actions).

For the following actions, it is not only the emission reduction potential that is not significant at a national scale, but also the data required to make a reasonable estimate of their mitigation potential is not available:

- Increase deep/offshore fishing fleet from 9 to 68 by 2022.
- Increase the number of farmers using low-carbon (recirculating) aquaculture systems from 20 to 180 by 2022

The following low-carbon development options were considered for mitigation analysis and prioritisation in the NCCAP 2018-202022:

- Increasing the total area under agroforestry at farm level by 200,000 acres (81,000 Ha) by 2022
- Increasing farm area under sustainable land management by 250,000 acres (101,000 Ha) by 2022.
- Implementing the Dairy Nationally Appropriate Mitigation Action (NAMA)
- Putting 50% of 30,000 hectares under rice production into efficient production technologies by 2022.
- Increasing the area under rain fed rice production from 400 hectares to 600 hectares by 2022

These options are analysed in detail below.

Table 3.1.3: Proposed Mitigation Actions in the Agriculture Sector for the Period 2018-2022

Strategic Objective 3.1.2: Reducing GHG emissions from agricultural systems without compromising productivity				
Issue/Problem: Climate change is negatively impacting agricultural productivity and resilience of value chain actors, including households (farmers, pastoralists and fisher folks)				
Opportunity	**Actions**	**Sector**	**Mitigation/ Adaptation/**	**SDG Target**
Agroforestry	Increase the total area, under agroforestry at farm level by 200,000 acres (81,000 Ha) by 2022.	Ministry of Agriculture and Irrigation (MoAI), KFS, County Governments	Adaptation and mitigation	1, 2, 13, 15
Sustainable Land Management	Increase farm area under sustainable land management by 250,000 acres (101,000 Ha) by 2022.	Ministry of Agriculture and Irrigation (MoAI), County Governments	Adaptation and Mitigation	1, 2, 13, 15
Efficient livestock management systems that enhance productivity.	Implement the Dairy Nationally Appropriate Mitigation Action (NAMA) 267,000 households involved in the programme leading to Greenhouse Gas emissions reductions.	Ministry of Agriculture and Irrigation (MoAI), County Governments	Adaptation and mitigation	2, 1,15
Manure management	Increase adoption of biogas technology use by 80,000 households leading to abatement of 1.2 million tCO_2e by 2022 (Linked to biogas cooking in the energy sector) Increase adoption of biogas technology use by at least 200 abattoirs leading to abatement of 0.8 million tCO_2e by 2022	Ministry of Agriculture and Irrigation (MoAI), County Governments	Adaptation and mitigation	2, 1,15
Overcapacity of artisanal fishing vessels	Increase deep/offshore fishing fleet from 9 to 68 by 2022	Ministry of Agriculture and Irrigation (MoAI),	Adaptation/ mitigation	1,2,14 and 15
Aquaculture production	Increase the number of farmers using low-carbon (Recirculating) aquaculture systems from 20 to 180 by 2022	Ministry of Agriculture and Irrigation (MoAI),	Mitigation and Adaptation	1,2, 14 and 15
Increased rice production	Put 50% of 30,000 hectares under rice production into efficient production technologies by 2022. Increase area under rain fed rice production from 400 hectares to 600 hectares by 2022	Ministry of Agriculture and Irrigation (MoAI), County Governments	Adaptation and mitigation	1,2, 3,12, 13, 15

Increase the total area, under agroforestry at farm level by 200,000 acres (81,000 Ha) by 2022.

According to all the previous three analyses, agroforestry is the mitigation option with the greatest emission reduction potential. Agroforestry is the interface between agriculture and forestry and encompasses mixed land-use practices. The term typically refers to land-use practices in which trees and other woody perennials are spatially or temporally integrated with crops and livestock on a given unit of land. It is distinct from forestry options, discussed in Chapter 5, because it targets lands that are currently in use for agriculture. The mitigation option encourages compliance with the Agricultural Farm Forestry Rules that require every land holder to maintain a compulsory farm tree cover of at least 10% on any agricultural land holding.[19]

The agroforestry mitigation option targets existing arable cropland and grazing lands that have high or medium agricultural potential. The total area of arable cropland and grazing land is estimated in the Agricultural Sector Development Strategy 2010-2020 to be approximately 5,620,000 hectares. The current extent of tree cover on this agricultural land is not known, but at least, 10 percent tree cover on farms is targeted by the Agricultural (Farm Forestry) Rules 2009. Without additional information on the total area of land under agroforestry at the farm level, the proposed action aims to increase the total area under agroforestry at farm level by 200,000 acres by 2022. It is assumed that achieving 5% of additional tree cover on these lands using agroforestry practices is possible and a reasonable mitigation scenario. Therefore, the low carbon scenario assumes that an additional 200,000 acres (81,000) Ha is converted to agroforestry between the years 2018 and 2022. This is equivalent to an average afforestation rate of 16,200 Ha per year over the 5 years. In the NCCAP, SNC and the NDC Sector Analysis, was assumed that an addition 281,000 Ha of land would be converted to agroforestry between 2015 and 2030. This is equivalent to an annual average conversion rate of 18,000 Ha. While the proposed action is slightly less ambitious than the previous studies, the difference would not be significant in terms of GHG emission reductions. Therefore, the earlier rate of 18,000 Ha per year leading to establishment of agroforestry in 90,000 Ha by 2022 has been assumed for emission reductions. Implementation of the agroforestry option should include data collection to determine the extent of existing tree cover on arable cropland and grazing land.

This action would therefore lead to similar emission reduction pattern as previously estimated but it would start from 2018 through to 2022. As a result of this action, increasing amounts of emission would be expected beyond 2022 as shown in Table 3.1.4 below.

Table 3.1.4: Emission Reduction Projection from Agroforestry ($MtCO_2e$)

Agriculture Source	Emission Reduction Potential-2018 to 2030 ($MtCO_2e$)			
	2018	2022	2027	2030
Agroforestry	0.28	1.66	3.05	3.71

Source: Adapted from Government of Kenya (2015), Second National Communication Report

To avoid double counting, the agroforestry-related emissions are not accounted for in the forestry sector.

Increase farm area under sustainable land management by 250,000 acres (101,000 Ha) by 2022

During the NDC Sector Analysis process, the conservation tillage option was revised to conservation agriculture/ sustainable land management, recognising that a broad set of land management actions are required to reduce GHG emissions associated soil carbon. The key issue is that this action is based on minimum soil disturbance, adequate surface cover, and complex crop rotations, including other practices that contribute to improving soil fertility and structure, adding biomass and nutrients to the soil, causing minimal soil disturbance as well as conserving soil and water. Three main elements typically contribute to conservation agriculture tillage, legumes

and crop residues. The details of the action were covered in the NCCAP and the NDC Sector Analysis Report 2017.

Robust data regarding the mitigation potential of organic farming systems is scarce, and no data could be found for Kenya. Organic farming is not a priority for Kenya and is not promoted by the government.[20] The Government of Kenya has programs to increase fertilizer usage, recognising that low rates of fertilizer application because of access, affordability or lack of information contribute to low yields for many farmers. Increasing and optimising fertilizer application would increase cropland productivity, but there is no available data to determine if this would result in a reduction of land clearing (i.e., converting grasslands or forested land to cropland). Additionally, there is no data around the GHG emissions associated with that land clearing or the increased use of nitrogen fertilizer. More research is needed on the relationships between crop production, fertilizer and GHG emissions to determine if this could be a mitigation option.[21]

Due to non-availability of reliable data on the prevalence of different land management practices, it was assumed in the NDC Sector Analysis that at least 25 percent of the 9,500,000 hectares of rain-fed agricultural cropland in Kenya apply full tillage.[22] With a further assumption of a 20% adoption rate for sustainable land management, converting 20% of rain-fed agricultural croplands from full tillage to conservation tillage would mean converting 475,000 hectares over ten years giving an annual average of 47,500 Ha. The agriculture sector stakeholders have set a target of increasing farm area under conservation agriculture by 250,000 acres (101,000 Ha) by 2022.). This is equivalent to an annual average of 20,200 Ha, which is slightly less than one half of 47,500 Ha per year that was applied in the mitigation analysis of the SNC and the NDC Sector Analysis of 2017.

Limiting the use of fire in range and cropland management is considered as an aspect of sustainable land management. Therefore, the mitigation contribution of this action as determined in the SNC has been included under this action.

Going by the SNC estimations and applying proportionate adjustments the emission estimations for this action are as shown in Table 3.1.5.

Table 3.1.5: Emission Reduction Projection from Increased Sustainable Land Management ($MtCO_2e$)

	Emission Reduction Potential-2018 to 2030 ($MtCO_2e$)			
	2018	2022	2027	2030
Increase farm area under sustainable land management	0.29	0.55	0.75	0.77

Source: Adapted from Government of Kenya (2015), Second National Communication Report

Implement the Dairy Nationally Appropriate Mitigation Action (NAMA): 267,000 households involved in the programme leading to Greenhouse Gas emissions reduction

Reducing enteric methane in the livestock sector is another proposed mitigation action, consistent with the Kenya Climate Smart Agriculture Strategy, 2016-2025, that prioritizes the reduction of emissions from livestock.[23] A short-term action is to reduce emissions in the dairy sector. A Food and Agriculture Organisation (FAO) study identified improving animal and herd productivity as one of the key pathways to reduce enteric methane emissions per unit of production. A combination of intervention packages aimed at improving feed availability and quality, improving herd health and improved genetics can potentially result in reduction potential of 21-36% in emission intensity relative to the baseline emission intensity.[24] A mitigation action in this sub-sector is considered a priority because

of the large amount of GHG emissions from this sector. Significant work has been undertaken to measure GHG emissions in the dairy sector. While the emission reduction potential is not significant at a national scale, initiatives in this sector are priority mitigation actions and a Dairy Sector Nationally Appropriate Mitigation Action (NAMA) has been proposed[25].

The Ministry of Agriculture and Irrigation has developed a Nationally Appropriate Mitigation Action on Low-emission and Climate Resilient Dairy Development in Kenya. The main objective of this NAMA is to trigger low-carbon development in the dairy sector through the introduction of climate-smart livestock practices and to bring the dairy production sector of Kenya onto a low carbon and more resilient path. More specifically, it will aim at transforming the Kenyan dairy sector and reduce greenhouse gas (GHG) emissions while also achieving other important social, economic and environmental benefits. The NAMA aims to provide effective support to 267,000 dairy farmers, double milk output, increase household dairy enterprise net income by at least 50% and provide additional benefits in the form of reduced labor and health burden of fuel wood collection especially for women. It is estimated that the NAMA will reduce GHG emissions by 8.8 $MtCO_2e$ over a 10-year period through the following 3 components initiatives:

- Increased dairy productivity (152,700 households): 4.14 MtCO2e
- Energy efficiency in processing (151 facilities): 2.96 MtCO2e
- Household biogas adoption (20,000 households): 0.98 MtCO2e

Because energy efficiency and biogas emission reductions have been included under energy emissions, only the emission reductions due to increased dairy productivity have been counted under the Dairy NAMA with the overall mitigation potential as shown in Table 3.1.6 below:

Table 3.1.6: Emission Reduction Projection from Implementation of the Dairy NAMA ($MtCO_2e$)

	Emission Reduction Potential-2018 to 2030 ($MtCO_2e$)			
	2018	2022	2027	2030
Implementation of Kenya's Dairy NAMA	0.03	0.40	0.69	0.69

Source: Adapted from Government of Kenya (2017), Kenya's Dairy NAMA Concept

Put 50% of 30,000 hectares under rice production into efficient production technologies and increase area under rain fed rice production from 400 hectares to 600 hectares by 2022

Two actions targeting rice production have been proposed by the agriculture sector players. Emissions from rice production systems can be reduced through the promotion of rain-fed rice, and the development and promotion of programmes and technologies for efficient rice production. Both actions are therefore important and should be implemented. However, their mitigation potentials have not been assessed because emissions from the flooding of rice are relatively low in Kenya, and the potential reductions from mitigation actions would not be substantial enough at the national level to form a wedge in the low-carbon analysis (See Table 3.1.1).

From the analysis in this section, the prioritised mitigation actions are summarised in Table 3.1.7.

Table 3.1.7: Emission Reduction Projection from Agriculture Sector Actions ($MtCO_2e$)

Agriculture Source	Emission Reduction Potential-2018 to 2030 ($MtCO_2e$)			
	2018	2022	2027	2030
Agroforestry	0.28	1.66	3.05	3.71
Increase farm area under sustainable land management	0.29	0.55	0.75	0.77
Implementation of Kenya's Dairy NAMA	0.03	0.40	0.69	0.69
Total	**0.6**	**2.61**	**4.49**	**5.17**

In order to achieve the minimum 1.6 $MtCO_2e$ recommended NDC target for emission reduction in 2030 for the agriculture sector, there is flexibility and implementation of all the three priority actions is not necessary. The technical mitigation potential of the three priority actions by 2030 is 5.17 $MtCO_2e$.

Conservatively therefore and focusing on food security mainly during the NCCAP 2017-2022 period, the sector priority actions can comfortably deliver the low range of emission reductions (1.6 $MtCO_2e$) by 2022 and the high range of emission reductions (2.8 $MtCO_2e$) by 2030.

3.1.2 Enablers

Technology

A summary of the key technologies associated with the three priority mitigation options is provided in Table 3.1.8. The enabling actions are required for monitoring, reporting and verification.

Table 3.1.8: Key Technologies in the Agriculture Sector

Mitigation Option	Key Technologies Required
Agroforestry	Nurseries, improved market access for small farms, extension service support, capacity building, research and pilot projects
Sustainable Land Management	Agriculture extension services, low cost tillage systems and equipment Extension services to educate pastoralists and farmers on the risks associated with using burning to manage range and croplands, and on the benefits of alternative practices
Kenya's Dairy NAMA	Formulation of improved feeds and feed additives to reduce enteric fermentation, development of breeding schemes, and improved herd health
Enabling actions	MRV capacity building, including data collection and inventory development

Source: Adapted from Government of Kenya (2017), NDC Sector Analysis

Capacity Building

Data required to calculate GHG emissions is lacking and considerable uncertainty remains in the calculation of agriculture emissions (compared to energy, transport and industrial sectors) and the impact of mitigation options, although significant work on livestock emissions has been undertaken at the Mazingira Centre at the International Livestock Research Institute (ILRI) in Nairobi. In the five-year period of the NCCAP 2018-2022 and NDC implementation plan, the sector should focus climate change efforts on adaptation, while building expertise and improving data for mitigation action. Agriculture experts notes that there are strong barriers to actions to reduce emissions from livestock in the pastoral areas including the cultural and economic importance of cattle and resistance to change in rural communities. Awareness raising and education actions in this sector are important to lay the groundwork for future mitigation and adaptation actions. This is particularly important because of the potential positive benefits for pastoralists in the ASALs and the large emissions generated by the sector.

There is great need for more extension services to support agroforestry, tree nursery development and related services.

Finance and Budgets

Table 3.1.8 is a summary of the budgets for implementation of the priority actions

Table 3.1.8: Key Technologies in the Agriculture Sector

Mitigation Option	Budgets (US $)	Remarks
Agroforestry	-	Included in the Smart Agriculture Programme
Sustainable Land Management	279.70 million	This is the budget for implementing the Smart Agriculture Programme. It includes agroforestry.[26]
Kenya's Dairy NAMA	222.6 million (149.73 million as private sector co-financing)	USD 56.06 million is requested from the GCF (application)[27] • $ 9.77 million as non-returnable grant • $ 10 million as credit guarantees • $36.19 million as concessional credit.
Enabling actions	0.25 million	About a quarter of this is included in the CBIT project

Source: Adapted from various sources

3.2: Energy Sector

3.2.1 Overview

In Kenya, energy is mainly consumed in the manufacturing, commercial, transport, residential, power generation, and some street lighting sectors. This chapter covers energy consumed in all the sectors except for the transport sector, which is the largest consumer of petroleum products and is discussed in Section 3.5 of this report.

The energy sector in Kenya is largely dominated by biomass (68% of the national energy consumption), electricity (9%) and imported petroleum (21%)[28], with biomass (wood fuel, charcoal, and agricultural waste) providing the basic cooking and heating energy needs of the rural communities, urban poor and the informal sector. Indigenous energy production in Kenya is limited to biomass (wood and agricultural waste), and electricity produced from hydropower, geothermal and other renewables (wind, biomass and solar). This is complemented by imported electricity, coal, oil and oil products.

Clean and sustainable energy is essential for the realization of Vision 2030[29] and the Big Four and is considered as one of the infrastructure enablers of the socio-economic pillar of the Vision. The draft 2015 Energy and Petroleum Policy indicates that rapid growth in Kenya's economy over the past decade is partly attributed to increased investment in the energy sector, particularly in the electricity sub-sector. The government's four key pillars of economic growth and the Big Four manufacturing priority are energy-driven. Further, the development of renewable energy technologies represents a major opportunity for "Growth of green industry in manufacturing" in Kenya. This can be a major sector of industrial growth in Kenya if it can position itself to be a regional technology hub, whilst in the same regard, it can also be a significant missed opportunity, if not pursued.

In 2017, Kenya's primary energy consumption was 23.8 million tonnes of oil equivalent (Mtoe), with the residential sector consuming by far the most energy, at 77% of final consumption, followed by transport with 14% and industry at 7%. The commercial and public sectors consume 1% with agriculture and forestry at less than 1%. Transport and commercial and public are the fastest growing sectors.[30] The draft Energy and Petroleum Policy 2015 aims "to ensure an affordable, competitive, sustainable and reliable supply of energy to meet national and county needs at least cost, while protecting and conserving the environment."[31] The Energy Bill, 2015, that aims to consolidate the laws relating to energy and provide for National and County Government functions in relation to energy, was passed by the National Assembly in November 2016 and forwarded to the Senate for consideration.[32] The Bill sets out institutions in the energy sector, promotes renewable energy, provides a framework for the exploration, recovery and commercial utilization of geothermal energy, regulates petroleum and coal activities and regulates electricity supply and use.[33]

Climate change mitigation analysis in the energy sector considers both energy supply (electricity generation) and energy demand at the household, industrial and commercial levels.

The three main electricity generation sources in Kenya are hydro, geothermal and thermal, together making up 98% of electricity sent to the national grid under normal hydrological conditions. In 2017, the total electricity generation was 8,272 Gigawatt hours (GWh) constituting of 3,341 GWh (33%) of hydro, 4,451 GWh (44%) of geothermal and 2,165 GWh (21%) of thermal.[34] The balance of 2% was generated from bagasse, wind and solar.

Recently discovered coal resources are expected to play an important part in Kenya's long-term electricity sector planning as set out in the Power Generation and Transmission Master Plan 2015-2035. The plan ranks coal as the fourth largest contributor to the generation capacity after geothermal, hydro, and imports in that order, from 2020 onwards. However, it now appears that the first coal powered plant will be commissioned after 2022. Coal-fired power plants in Lamu and Kitui are included in the baseline projection. Nuclear is also expected to play a role in

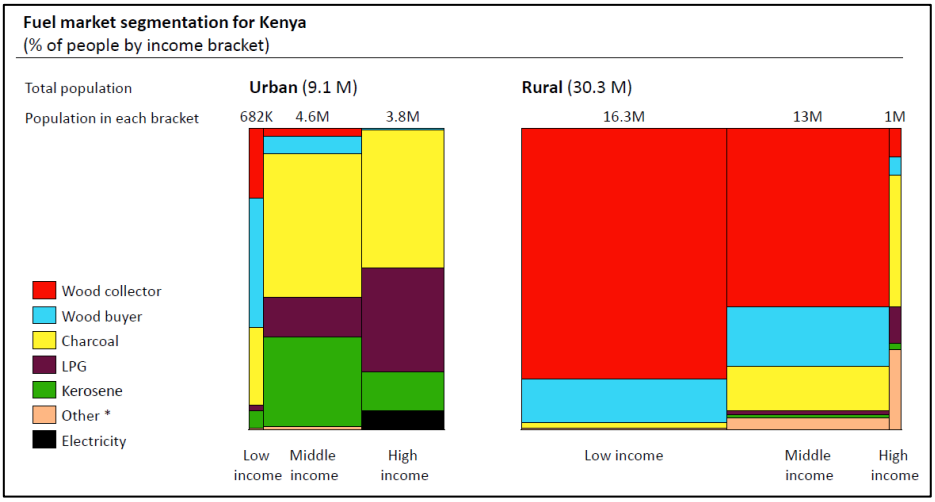
electricity generation in 2030.[35] An updated Least Cost Power Development Plan (LCPDP) 2017-2037, which is currently being developed is expected to reflect the adjusted generation technologies and timelines.

Along with an increase in generation capacity, the Government of Kenya has prioritized action to increase grid connectivity, with universal access by 2020.[36] The national connectivity access rate increased from 47% in March 2013 to 70.3% in June 2017.[37] For the off-grip communities and with significant private sector involvement, stand-alone solar photovoltaic (PV) systems are the most widely used technology in Kenya, with well over 200,000 systems installed and sales estimated at 20,000 systems per year.[38]

Kenya is expected to develop its domestic coal, oil and gas reserves over the next few years. The baseline includes only a small amount of crude oil production (about 2,000 barrels per day) starting in 2017 and rising modestly to 6,000 barrels per day by 2030. With the Early Oil Pilot Scheme having started in in the first half of 2018 at about 2,000 barrels per day, it is now expected that Kenya could be producing 60,0000 barrels per day by 2030. The emissions associated with fossil fuel production are not expected to be significant of the plan period but could pick up towards 2030 with increasing fossil fuel production.

On the demand side, fossil fuels and biomass are used to produce heat for productive purposes in the commercial and industrial sectors, and for cooking and heating purposes in the household sector. Since Kenyans rely on the traditional use of biomass as the primary energy source for heating and cooking, energy consumption in the residential sector is dominated by biomass. Fuel use, however, varies considerably between rural and urban populations, and income levels as shown in Figure 3.2.1 below.

Figure 3.2.1: Domestic Users Fuel Market Segmentation



Source: Dalberg (2013)

About 87% of the rural population uses firewood for cooking and 82% of the urban population uses charcoal for cooking.[39] Considered holistically, the annual contribution of charcoal to the economy is estimated to be about KES 135 billion.[40] The charcoal industry faces several challenges, including unsustainable fuelwood resources and the informal nature of the sector's operations.

Energy efficiency measures help to reduce energy consumption in households and reduce the energy costs in commercial and industrial services and products. The government, in partnership with stakeholders, has taken several energy efficiency and conservation initiatives. The Ministry of Energy, working with the Kenya Association of Manufacturers (KAM) has establish a Centre for Energy Efficiency and Conservation (CEEC) that promotes energy efficiency in private sector companies and public institutions and Kenya Power has distributed compact

fluorescent lights (CFLs). MOEP has implemented improved cookstoves programmes and developed regulations that influence the update of climate-related technologies, such as for solar water heating, solar PV systems and cookstoves.

Additional information on the electricity sub-sector sector is annexed to this analysis (Annex 3.2.1).

This climate change mitigation analysis in the energy sector has been prepared against the energy sectors circumstances summarized in this section. The analysis covers the actions prioritized by the sector. Petroleum products use for transportation are covered under Transport Sector (Section 3.2.5).

3.2.2 Mitigation Actions in the Energy Sector

Energy supply emissions are generated from electricity generation and from domestic sources of primary fossil fuel energy. Energy demand emissions are those related to the combustion of fossil fuels by residential, commercial energy and industrial end-users. Energy emissions-related to the transport sector are not included in the energy sector but in the transport sector emissions in section 3.2.5.

Despite several challenges with developing a baseline projection for Kenya's electricity sector, a baseline projection was agreed through a consultative process involving industry experts during the development of the NCCAP 2013-2017. The baseline was re-validated during the preparation of Kenya's SNC.

Baseline

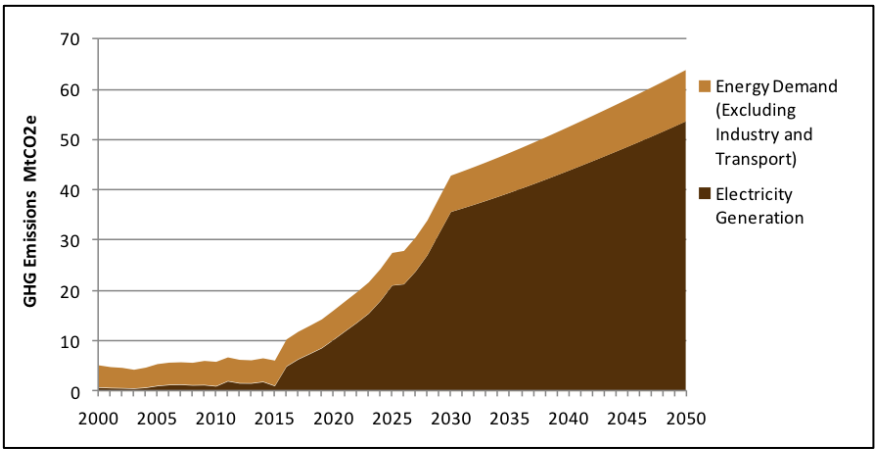
In the NCCAP 2013-2017 and the SNC, the baseline emissions were based on actual historical data to establish the trend which was then projected to 2030 putting into consideration the GoK's plans, programs and policies, including the Least Cost Power Development Plan (LCPDP) 2011-2031. Historic emissions for the supply side were based on actual dispatched electricity generation by generation type and not on installed capacity.

According to Kenya's CCAP 2013-2017 and SNC, the energy sector's contribution to GHG emissions was expected to increase sharply from 2015 to 2030. During the period, electricity generation emissions in the baseline scenario grow the most of all the sectors, increasing from 1 $MtCO_2e$ (1.3% of total national emissions) in 2015 to 41 $MtCO_2e$ (28.7% of total national emissions) in 2030. Much of this projected increase was attributed to considerable addition of coal and natural gas generation capacity over the next fifteen-year period to meet projected increasing energy demand in the then LCPDP 2011-2031. By 2016, Kenya had no significant GHG emissions related to the production of primary fossil fuels (coal, crude oil and natural gas). However, the projected baseline includes small amount of emissions that will result from the production of up to 6,000 barrels of crude oil per day by 2030. The baseline also includes a number of thermal plants, including 600 MW of coal generation (sub-critical technology) that was expected to come on stream from 2016.

During the same period, the GHG emissions from energy demand grow from 7 $MtCO_2e$ (8.8% of total national emissions) to 10 $MtCO_2e$ (7.0% of total national emissions).

As a result of the baseline projection trends of both the energy supply and demand sides explained above, the total GHG emissions from the energy sector (electricity generation and energy demand, excluding transport, was 8 $MtCO_2e$ (10% of the total national emissions) in 2015 and the sector's emissions were projected to grow to 51 $MtCO_2e$ (35.7% of the total national emissions) by 2030. (See Figure 3.2.2 and Table 2.1.1 in Chapter 2). The BAU projections show that by 2030, electricity generation will be the highest emitter of GHG emissions in Kenya.

Figure 3.2.2: Energy Sector Baseline Emission Projection for Kenya (MtCO2e)



Source: Government of Kenya (2015), Second National Communication

NDC Target for the Energy Sector

From the NDC Sector Analysis Report 2017 and the baseline emissions established in the NCCAP 2013-2017, the NDC target proportionate emission reduction required from the energy sector is 15.4 $MtCO_2e$ (9.32 $MtCO_2e$ from electricity generation and 6.09 $MtCO_2e$ from energy demand) as shown in Table 3.2.1.

The proportionate emission reduction contributions by the two energy sub-sectors to meet the NDC overall target are shown in Table 3.2.1 below. However, the actual sector GHG emissions reduction contribution towards the achievement of the NDC will be based on the realistic opportunities available for emission reduction in the sector together with the sector plans and budget provisions.

Further, the NDC Sector Analysis Report 2017 and the referenced companion report (Update of Kenya's Emission Baseline Projections and Impact on NDC Target[41]) show that relative to the baseline, there has been a significant shift in policy and planning that has impacted the actual emissions since the NCCAP 2013-2017 development in 2013 (See also Annex 3.2.2). While the GoK's new Master Long Term Plan forecast to 2035 is consistent with the 2011 Updated Least Cost Development Plan (ULCPD) that was used to project emissions for the NCCAP 2013-2017 and the SNC[42,43], there has been a general evolution in planning from 2011 to 2017.

Table 3.2.1: Technical Emission Reduction Potentials and NDC for the Energy Sector

Sector	GHG Emission Reduction Potential ($MtCO_2e$)				NDC Target ($MtCO_2e$)
	2015	2020	2025	2030	2030
Electricity Generation	0.28	2.24	8.61	18.63	9.32
Energy Demand	2.74	5.16	7.92	12.17	6.09
Total	**3.02**	**7.40**	**16.92**	**30.80**	**15.41**
% of Total Emissions in 2030				**60%**	**30%**

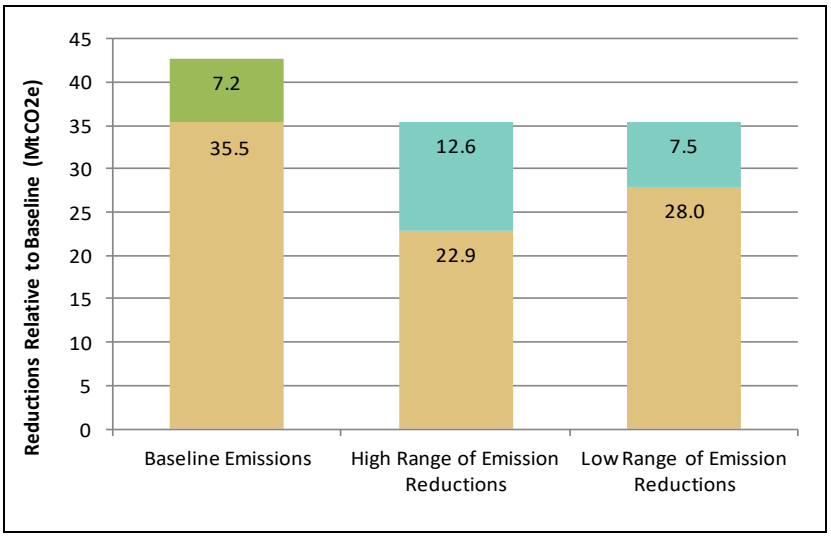
Source: Government of Kenya (2015), Second National Communication

The newer Master Long Term Plan forecast to 2035 in the electricity sector is dramatically lower than the forecast in the 2011 ULCPDP that was used to calculate the GHG emission baseline in the NCCAP 2013-2017 and SNC. In the newer Master Long Term Plan, the total supply drops by almost 40% by 2030 relative to the NCCAP 2013-2022 and SNC baseline, and because most of this was to be supplied with coal-fired electricity generation, a

dramatic drop in overall emissions of approximately 7.2 $MtCO_2e$ is projected (green bar in baseline emissions in Figure 3.2.3 below.

Based on the above described scenario, the NDC Sector Analysis Report 2017 identified a reasonable low and high range for a 2030 target for emission reductions in the energy sector as 12.6 $MtCO_2e$ and 7.5 $MtCO_2e$, respectively (Figure 3.2.3). The low target (7.5 $MtCO_2e$) is aligned with the proportional contribution that the sector would need to make in order for there to be a high level of certainty that the overall target will be achieved if all other sectors also met their low target of emission reduction. The high target (12.6 $MtCO_2e$) is intended to guide responsible ministries and agencies in terms of what they should objectively plan and prepare for should the sector require additional emission reductions. While total baseline emissions from the energy sector was 42.7 $MtCO_2e$, the low range and high range of emission reductions recognise that emission reductions of 7.2 $MtCO_2e$ per year relative to the baseline (47% of the proportionate NDC target reduction for the sector of 15.4 $MtCO_2e$) have already been realised in the energy sector due to the shift in policy, planning and actual generation discussed above.

Figure 3.2.3: Comparison of 2030 Baseline Emissions and INDC Target Emission Reductions (MtCO2e)



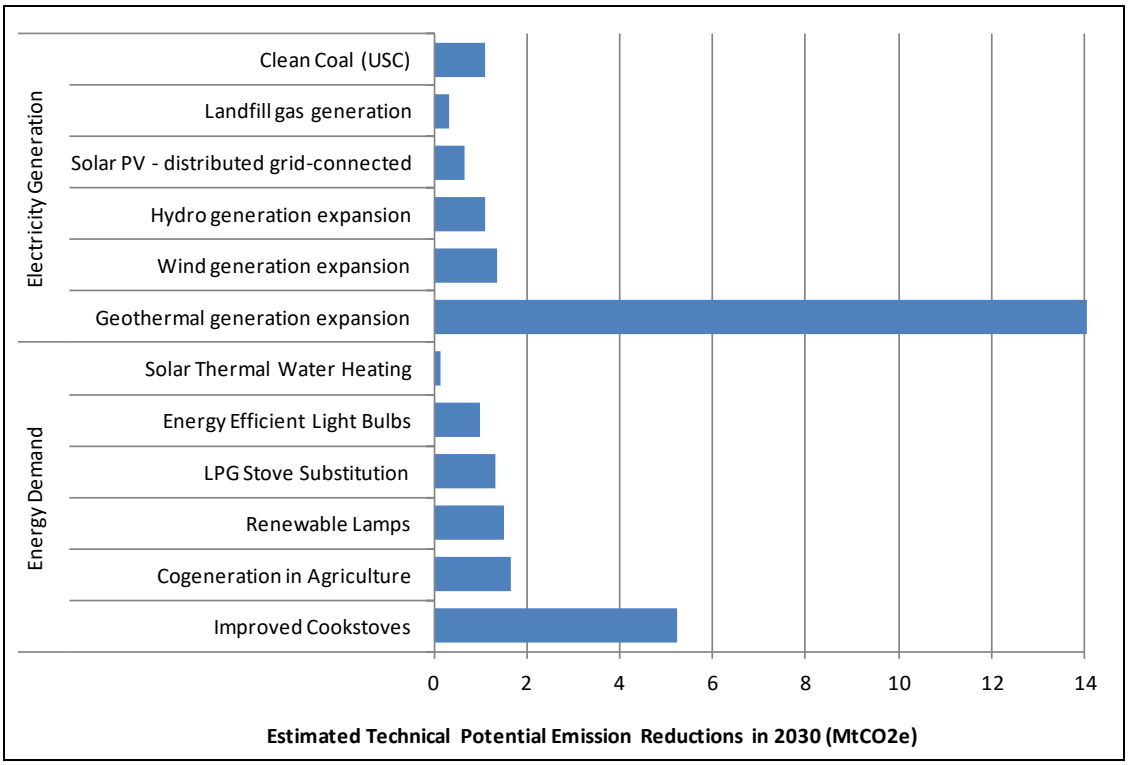
Source: Government of Kenya (2017), National Determined Contribution Sector Analysis Report

Mitigation Actions Identified in Kenya's Second National Communication

In the NCCAP 2013-2017 and the SNC, twelve mitigation actions were proposed for the energy sector (supply and demand sub-sectors) and a number of them have been implemented with varying degrees of success (Figure 3.2.4). Each of these options was assessed to determine its technical potential to contribute to emission reductions in the baseline in 2030.

In the NDC Sector Analysis Report 2017, it was established that in order to achieve the 7.5 $MtCO_2e$ recommended low range of emissions reduction target in 2030 (see Figure 3.2.3 above), there is flexibility and it is not necessary to fully implement all the twelve mitigation options. Figure 3.2.4 illustrates the estimated mitigation potential of the twelve options.

Figure 3.2.4: NCCAP 2013-2017 Mitigation Options and their Technical Potential Emission Reductions by 2030



Source: Government of Kenya (2017), NCCAP

A key observation in all the previous analysis is that, besides the flexibility in the options to achieve the GHG emission reduction target, the development of geothermal power and other renewables together with cookstoves had the highest mitigation potential.

The highest mitigation opportunity was in geothermal expansion, which envisaged the addition of 2,775 MW of geothermal by 2030. In 2013 the total electricity generation in Kenya was 8,087 GWh with geothermal comprising only 19.77% of the generation. By 2017, the generation had increased to 10,205 GWh, with geothermal contributing 43.62% of the generation. During the period, the installed geothermal capacity increased from 363 to 652 MW. The installed wind capacity remains low at 25 MW although the 300 MW Turkana wind is due for commissioning as soon as the transmission line is ready later in 2018.

The next biggest opportunity is clean cooking. Therefore, cookstoves would need to be addressed in a substantive way to achieve the recommended emission reduction target in the energy demand sector. At a minimum, biomass cooking needs to improve 10% from the 2010 baseline average efficiency (baseline efficiency is estimated to be approximately 18-20% accounting for the existing penetration of improved cookstoves) by 2030 to deliver emission reductions in line with the overall technical potential of energy demand mitigation options. Improvements greater than 10% from the baseline average efficiency substantially reduce the need to implement a wide range of other mitigation options such energy efficiency improvements in lighting or industry.

Because of the challenges with data capture and general monitoring, and while it is known that a number of energy efficient biomass stoves, together with clean fuel (ethanol and LPG) stoves have been distributed during this period, adequate data to determine the extent of these actions is yet to be captured. In addition, through the Ministry of Petroleum and Mining, the GoK has initiated a subsidised cooking gas program which has been piloted

in Machakos and Kajiado counties and further expansion is planned. The program targets poor households that cook with firewood, charcoal and kerosene. As part of the clean cooking drive, the GoK, through the Energy Regulatory Commission (ERC) has published new draft regulations allowing firms to apply for licences to operate reticulated systems that will transport LPG directly to households. However, biomass consumption is still growing, but more slowly than the other fuel sources (2.7% p.a. between 2000 and 2014 vs 6.2% for electricity and 3.6% for oil).[44]

Adoption of distributed and grid connected solar PV continues to grow, although there is no credible data on the actual number of distributed solar PV units currently in use. In 2014, Strathmore University commissioned the first 600 kW grid connected solar PV system in Kenya.

No coal, landfill gas, cogeneration plants were installed during the period.

Proposed Mitigation Actions for the NCCAP 2018-2022 in the Energy Sector

The following six mitigation options were proposed for consideration in the energy supply/electricity generation sub-sector for analysis and prioritisation in the NCCAP 2018-2022:

- Developing new 2,405 MW of grid-connected renewable electricity generation capacity and retirement of three thermal plants by 2022
- Increasing captive renewable energy generation capacity by 250 MW by 2022.
- Expansion, refurbishment, and modernization of electricity infrastructure with unspecified Kilometres of new lines and new or upgraded transformers by 2022.
- Increasing the use of green energy along agricultural value chains by 5 MW by 2022.
- Promotion of increased use of renewable energy resources (small hydros, solar, biogas, biomass, wind and hybrid systems) and conduct of research on possible application and extent of use of renewable energy resources by 2022.
- Improvement of operational efficiency in generation and reduction of transmission and distribution losses.

These actions, which are summarised in Table 3.2.2 below, were proposed by energy sector stakeholders led by the Ministry of Energy. Through the Mitigation Thematic Working Group and further consultations, a wider stakeholder group, including the private sector and aviation sub-sector players, were consulted and their feedback appropriately incorporated.

As a preliminary analysis, the following actions were disqualified from further mitigation analysis and prioritisation due to lack of adequate information and insufficient scale to make a significant mitigation impact relative to the low range NDC mitigation target:

- Expansion, refurbishment, and modernization of electricity infrastructure with unspecified Kilometres of new lines and new or upgraded transformers by 2022.
- Increasing the use of green energy along agricultural value chains by 5 MW by 2022.
- Promotion of increased use of renewable energy resources (small hydros, solar, biogas, biomass, wind and hybrid systems) and conduct of research on possible application and extent of use of renewable energy resources by 2022.

After consultations with the energy and private sector stakeholders, it was established that some of the proposed captive power generation using renewable energy, especially in the sugar sector, were also included in the grid-connected generation capacities. Therefore, to avoid double counting, the action to increase the generation of captive power has also been excluded from further mitigation analysis.

The following two actions have therefore been prioritised for mitigation analysis and prioritisation in the NCCAP 2013-2018.

- Developing new 2,405 MW of grid-connected renewable electricity generation and retirement of three thermal plants by 2022
- Improvement of operational efficiency in generation and reduction of transmission and distribution losses

These options are analysed in detail below.

Table 3.2.2: Proposed Priority Mitigation Actions in the Energy Supply Sub-Sector for the Period 2018-2022

Strategic Objective 3.2.1: Ensure an electricity supply mix based mainly on renewable energy that is resilient to climate change, and promote energy efficiency				
Issue/Problem: Renewable (and affordable) electricity supply with low GHG emissions needs to increase to meet the demands of a growing population and industrializing nation.				
Opportunity	**Actions**	**Sector**	**Mitigation**	**SDG Target**
Availability of renewable energy resources	Develop 2,405 MW of new renewables (Geothermal: 913 MW, Solar: 442 MW, Hydro: 93 MW, Wind: 800 MW, Biomass/Biogas: 157 MW and Distributed solar and mini-grids: 30 MW) and retire 300 MW of thermal plants (Kipevu: 120 MW, IberAfrica: 108.5 MM and Tsavo: 74 MW) by 2022	MoE, ERC, KenGen, KP, County Governments, Local NGOs, Private sector, GDC	Adaptation and Mitigation	1,7,8,9,11, 2, 13
Captive renewable generation potential	Increase captive renewable energy generation capacity by 250 MW by 2022 (at least 50 MW of solar, wind, hydro and 200 MW of cogeneration)	Industry, KAM, KIRDI, MoE, ERC	Adaptation and mitigation	7,9,12,13
Significant proportion of the population are either not connected to the grid or have unreliable electricity supply	Expand, refurbish, and modernize electricity infrastructure with Unspecified Kilometres of new lines and new or upgraded transformers by 2022.	MoE, KP, Ketraco, ERC	Mitigation and adaptation	1,2, 3,7,13,15
Available renewable energy resources	Increase the use of green energy along agricultural value chains by 5 MW by 2022	MoE, Ministry of Agriculture and Irrigation, Ministry of Industrialization and Enterprise Development, KIRDI, GDC, ERC	Mitigation and adaptation	1,2,7,9,13
Available renewable energy resources	Promote the increased use of renewable energy resources (small hydros, solar, biogas, biomass, wind and hybrid systems) Carry out research on possible application and extent of use of renewable energy resources	MoE, County Governments, ERC	Enabling	1,2,7,9,13

Table 3.2.2: Proposed Priority Mitigation Actions in the Energy Supply Sub-Sector for the Period 2018-2022 *(continued)*

Inefficiencies in electricity generation, supply and use	Improvement of operational efficiency in generation and reduction of transmission and distribution losses • Reduce the distribution and transmission losses from current 18% to 14% by 2020 • Improve electricity system utilization and efficiency through demand management • Optimize the operations of the Seven Forks Dams • Promote efficient lighting technologies such as LED and CFL bulbs (Distribution to households) • Building efficiencies through codes and standards • Energy efficiency programmes for users (industries, national and county governments, households) • Awareness, training, skills, incentives for energy efficiency programmes (Enabling activities) • Establish Standards and labelling for at least 5 additional products	MoE, ERC, KenGen, KP, KAM, KEPSA, Ministry of Transport, Infrastructure, Housing and Urban Development (MTIHUD), KIRDI	Mitigation and adaptation	
Biennial updates of the power development plans	Mainstreaming climate change in electricity planning process • Develop and apply of tools to integrate climate change considerations and broader development impacts into electricity sector master planning processes - Develop draft prototype of assessment tools, including methodology development workshops with relevant stakeholders, by fourth quarter 2018 - Development of concept and workshop series on how to integrate the tools into the LCPDP process, by fourth quarter 2018 - Regular reporting of climate change mitigation and adaptation implications in the electricity sector master planning documents.	MoE, ERC, KP	Enabling activity	
Primary Fossil Fuel Production (currently all plans are unconfirmed)	Mainstream climate change considerations in the planning of the primary fossil fuel (crude oil, gas and coal) production activities • Incorporate the climate change impacts, especially GHG emissions, of the production processes in the national GHG inventory estimation • Access the impact of proposed production activities on the realization of the NDC	Ministry of Petroleum and Mining, Ministry of Environment and Forestry, ERC	Enabling	

Developing new 2,405 MW of grid-connected renewable electricity generation and retirement of three thermal plants by 2022

Meeting future demand for electricity in Kenya and keeping the average emission intensity of the grid low enough to meet the NDC target will require substantial deployment of renewable energy technologies. A key strategy of the Government is to increase the proportion of renewable sources of electricity in the grid while reducing or minimising the development and use of fossil fuel generation plants. The proposed new additional generation capacity of 2,405 MW is comprised of the following generation technologies whose details are shown in Table 3.2.3 and are based on the 2018-2022 Third Medium-Term Plan (MTP III) planned generation between 2018 and 20122:

- Geothermal: 913 MW
- Solar: 442 MW
- Hydro: 93 MW
- Wind: 800 MW
- Biomass/Biogas: 157 MW
- Distributed solar and mini-grids: 30 MW

As part of the action to increase the proportion of renewable generation in the grid, the GoK also plans to retire the following three grid connected thermal plants, with a total capacity of about 300 MW, whose Power Purchase Agreements are expected to expire in the 2018-2022 period:

- Kipevu: 120 MW in 2019
- IberAfrica: 108.5 MM in 2019
- Tsavo: 74 MW in 20121

Whilst the electricity sector GHG emission projections in the MTAR for the NCCAP 2018-2022 are based on the MTP III, the most recent projections for the electricity sector's development are contained in the draft ERC's new LCPDP 2017-2037. Both the MTP III and the LCPDP 2017-2037 project similar pathways in the short term, as they are both based on committed electricity generation capacity. However, in the longer-term projections, up to 2030 and beyond, the LCPDP 2017-2037 deviates significantly from the MTP III. The latest LCPDP contains significantly lower demand forecasts than previous estimates, despite accommodating the already committed Vision 2030 flagship projects in these demand projections. It also projects a more significant role for solar PV, wind and geothermal in in the place of coal, oil and natural gas, due to the most recent information on the increasingly competitive costs of renewable energy technologies.

Although this MTAR's focus is on the plan period between 2018 and 2022, an analysis has been conducted carried out to access the longer-term implication of the LCPDP 2017-2037. The results of the analysis have been presented in this MTAR as an annex (Annex 3.2.2) to the section on energy sector.

Geothermal provides stable power and is more resilient to climate change than hydro power, although geothermal power development is comparatively more capital intensive and its exploration is riskier.

Table 3.2.3: Proposed Renewables Additions (2018- 2022) with CAPEX Estimates

Technology	Capacity (MW)	Year of Installation	Estimated Budget (Million USD)
Geothermal			Based on 3,557 USD/kW
Olkaria V	158	2019	562
Olkaria I Additional unit 6	70	2019	249
Olkaria I & IV Upgrade and Top-Up	47	2020	167
Olkaria I refurbishment	6	2021	21
Olkaria VI-PPP	140	2022	498
Olkaria Agil	140	2022	498
Wellheads Modular Plants	47	2019	167
GDC Menengai Phase 1 (Sosian, Quantum and Orpower 22)	105	2022	373
GDC Menengai Phase II	60	2021	213
Orpower 4	60	2021	213
Orpower 4	10	2021	36
Marine Power Akiira	70	2022	249
Total	**913**		**3,247**

Technology	Capacity (MW)	Year of Installation	Estimated Budget (USD)
Biomass			Based on 3,045 USD/kW
Kwale Sugar	10	2020	30
Cummins	10	2020	30
Roadtech (Kisaju)	10	2019	30
Biogas Holdings	0.25	2022	1
Rea Vipingo DWA	1.44	2020	4
Thika way Investment	10	2020	30
Crystal Energy	40	2021	122
Sukari	35	2021	107
Sustainable Energy Management	40	2022	122
Sub Total	**157**		**477**

Technology	Capacity (MW)	Year of Installation	Estimated Budget (USD)
Wind			Based on 2,030 USD/kW
Ngong Wind Farm III	10	2020	20
Meru (Isiolo) Wind Farm I	80	2021	162
Turkana Wind	300	2018	609
Oldanyat	10	2021	20
Kipeto Wind	100	2020	203
Prunus	50	2021	102
Electrawinds Kenya (Bahari) Phase I	90	2022	183
Chagem/Chania Green	50	2020	102
Kinangop/Aeolus	60	2022	122
Aperture Green	50	2022	102
Total	**800**		**1,624**

Table 3.2.3: Proposed Renewables Additions (2018- 2022) with CAPEX Estimates *(continued)*

Technology	Capacity (MW)	Year of Installation	Estimated Budget (USD)
			Based on 3,970 USD/kW
Hydro			
Tindinyo,	1.5	2019	6
KTDA	32.8	2022	130
Global Sustainable	23.9	2020	95
Powertech (Gatiki)	9.6	2022	38
Mutunguru	7.8	2019	31
Western hydro	10	2020	40
Frontier	5.6	2020	22
Kianthumbi	0.55	2020	2
Greenlight Holdings	1.5	2021	6
Sub Total	**93**		**370**

Technology	Capacity (MW)	Year of Installation	Estimated Budget (USD)
			Based on 1,695 USD/kW
Solar			
Strathmore	0.55	2018	1
Marco Borero	1.5	2019	3
Alten	40	2020	68
Kenergy Renewables	40	2019	68
Vateki International Holdings	40	2021	68
Greenmillenia Energy	10	2021	17
Solarjoule	10	2020	17
Kopere Solar Park (Subuiga)	40	2022	68
Radiant	40	2020	68
Elodosol (Cedate)	40	2020	68
Makindu	30	2021	51
Izera Ranch	10	2022	17
Asachi Powertech	10	2022	17
Quaint Energy	10	2019	17
Astonfield Sosian	10	2022	17
Tarita (Cherab Isiolo)	40	2021	68
Garissa Solar Plant	50	2018	85
Belgen	10	2022	17
Sayor	10	2022	17
Total	**442**		**749**
Total estimated capex for all the renewables			**6,468**

Source: Ministry of Energy (2018).

In addition, new grid-connected biomass, solar, wind and hydro are proposed under this action. To facilitate increased investment in renewable energy, an Atlas mapping out the renewable energy resources in the 44 counties has been developed. Implementation and prioritisation of the projects may consider a mixed renewable portfolio approach that balances regional resources, transmission and distribution requirements, investment costs, technical barriers and specific grid demands.

The Rural Electrification Authority has implemented a pilot mini-grid at Biyamadhow in Wajir South Constituency that will serve up to 200 homes in the town. The mini-grid comprises of a 60 kW solar unit with a 40 kW diesel backup to ensure uninterrupted power supply to the residents. Plans are underway to install 25 similar solar/diesel

systems in the five off-grid counties of Wajir, Mandera, Marsabit, Turkana and Garissa by 2020, with possible hybridisation to reduce GHG emissions. Solar PV and wind, which could be installed incrementally more effectively, have the challenge of intermittency, especially as a grid connected power source.

Further promotion of direct use of renewable energy resources is also planned. Such applications, not only offer long term cost effective solutions but also mitigate climate change. With the planned industrial park in Nakuru by 2022, the proposed activities include promotion of direct use of geothermal resources to power various industrial applications such as boilers and dryers. Such industrial applications could support agro-processing activities such as milk and meat processing, fish farming, greenhouse heating and flower farming. Further, direct use of solar energy for applications like water pumping, heating and even desalination will be considered. For recreational purposes, more geothermal steam baths have been proposed for the period up to 2022, after the successful pilot of the Olkaria Geothermal Spa which has been operational since 2012. The estimation of the mitigation potential of direct application of renewable energy has not been possible due to lack of data on the feasible extent of the proposed actions and for determination of the baselines. However, for conservativeness, it is considered that estimation of the emission reductions in the electricity generation sub-sector through the new grid connected renewables adequately represents the sub-sector's mitigation potential given their relative contributions.

The total mitigation potential of the action relative to the BAU is summarised in Table 3.2.4.

Table 3.2.4: Emission Reduction Projection from Energy Supply Sub- Sector Actions ($MtCO_2e$)

Action	Emission Reduction Potential-2018 to 2030 ($MtCO_2e$)			
	2018	2022	2027	2030
Developing new 2,405 MW of grid-connected renewable electricity generation and retirement of three thermal plants by 2022	4.09	13.20	13.20	13.20

Emission reduction trends have been estimated based on the plants listed in Table 3.2.2 above. From the analysis, up to 13.20 tCO_2e of GHG emission reductions relative to the baseline can be realised by 2022 through implementation of the proposed renewable energy projects and the retirement of the three thermal plants between 2017 and 2022. This action, as a priority, and with the technical mitigation potential of 13.20 $MtCO_2e$ by 2022 can deliver the high range of emission reductions of 12.6 $MtCO_2e$ by 2030. However, for conservativeness, and given that not all planned projects are likely to come on stream as planned, it was agreed with the sector stakeholders that, typically, about 70% on-schedule implementation would be more realistic. The adjusted emissions reduction potential is shown in Table 3.2.5 below.

Table 3.2.5: Emission Reduction Projection from Energy Supply Sub- Sector Actions (with 70% completion) ($MtCO_2e$)

Action	Emission Reduction Potential-2018 to 2030 ($MtCO_2e$)			
	2018	2022	2027	2030
Developing new 2,405 MW of grid-connected renewable electricity generation and retirement of three thermal plants by 2022	2.9	9.2	9.2	9.2

Beyond 2022, the net emission reductions will depend on the type and scale of additional generation capacity that will be installed. Beyond 2022, the existing power development plans indicate increased addition of fossil-fuel based generation capacity which would result in increased GHG emissions. The increased GHG emissions would have to be netted from the mitigation benefits in order to estimate the final mitigation potential the grid mix. Annex 3.2.2 (Implication of the 2017-2037 LCPDP for National Climate Change Action Plan) presents a brief analysis of the expected emission trends up to 2030 based on the latest LCPDP 2017-2037.

Improvement of energy efficiency and energy conservation is a key strategy in the plan period. The electricity grid system experienced 18% transmission and distribution losses in 2017. In the Annual Report and Financial Statement for the Year Ended 30 June 2017, Kenya Power and Lighting Company aims to reduce this from 'double to single digit' levels while the ULCPDP provides a target range of 1-5% for the whole system. At the 2017 generation level of 10,205 GWh, and assuming the losses are real (not book losses), a reduction of 1% loss is equivalent to a saving of 102 GWh (0.06 $MtCO_2e$) per year with the current grid mix, with an emission factor of 0.6 tCO_2e/MWh. A 10% loss reduction (from 18% to 8%) would mitigate 0.6 tCO_2e per year. Assuming a reduction of 4% (from 18% to 14%), this would have a mitigation contribution of 0.24 $MtCO_2e$ by 2022. This is not significant in relation to the low (7.5 $MtCO_2e$) and high (12.6 $MtCO_2e$) range of emission reduction target for the sector. It is therefore not prioritised.

This is a planned action that is already ongoing and should be monitored to track its contribution to the NDC but it is not expected to be a significant contributor to the NDC unless the efficiency gains are significant (reduction of losses by at least 5%).

Optimization of the Seven Forks Dam involves the operation of the cascade of dams as one big generating plant other than individual units. Preliminary Hydrological and Solar Modelling studies conducted by Tropical Power and Oxford University show that one unit of water at Masinga dam is more valuable than a unit of water at the downstream dams since it may be used to generate power from all five dams. The study concludes that:

- If the cascade is run optimally, there would be 15% more water in the system at the end of the 12-month period, compared to the baseline, to generate the same amount of power as in the baseline.
- If the system is run optimally at a continuous rate of 460 MW then the amount of water in Masinga would be the same at the end of the year as at the beginning and that 54% more power could have been generated than in the baseline. This would be equivalent to a reduction of 1.2 $MtCO_2e$ per year with the current grid mix.

These results assumed perfect forecast information on load and inflows, and neither prioritisation of water uses (irrigation, power generation, etc.) nor any required environmental flows is taken into account. Therefore, to implement the optimisation, weather forecasting and hydrology monitoring equipment together with trained staff would be key requirements. Because the initiative is still at the study stage, it has not been prioritised in the NCCAP 2018-2022.

From the above analysis, it is concluded that the only significant action in the electricity generation sub-sector that should be prioritised for implementation to contribute to the NDC mitigation target is the development of 2,405 MW of new renewables by 2022. However, the other actions should be implemented, monitored and reported for their contribution.

On the energy demand sub-sector, the following actions were proposed by the energy sector stakeholders for mitigation analysis (See Table 3.2.6):

- Development and distribution of 4 million improved biomass (charcoal and biomass) stoves by 2022
- Develop and distribute 1 million clean energy (LPG, biogas, and ethanol stoves) by 2022

These two options on the energy demand sub-sector are discussed in detail below.

Development and Distribution of 4 Million Improved Biomass (Charcoal and Biomass) Stoves by 2022

Over 80% of Kenyan families depend on biomass (charcoal and fuelwood) for primary energy, most of which is non-renewable. This leads to deforestation and indoor air pollution. Enhancing energy security and reducing dependence on unsustainable biomass energy resources is therefore of utmost importance. The action entails the design, manufacture and distribution of improved cookstoves that either use charcoal or firewood. This action is closely linked to the implementation of the Nationally Appropriate Mitigation Action (NAMA) for the Charcoal Sector in Kenya, the only action prioritised for the industry sector, and agroforestry with respect to growing fuel wood trees, which is an action in the agriculture sector.

For 4 million biomass (2 million charcoal and 2 million fuel wood) stoves to be in use by 2022, it has been assumed that each year at least 400,000 new stoves of each of the two types will be distributed. It is also assumed that these stoves will have a thermal efficiency level that is at least 10% higher than the baseline stoves of 10-18%. The assumed distribution trend for improved stoves is shown in Table 3.2.7. With the assumed efficiency level and for an average national Non-Renewable Biomass Fraction of 92% for Kenya,[45] the average emission reduction per stove per year is about 2 tCO_2e for charcoal and 2.5 tCO_2e firewood. These values have been used for estimation of the emission reduction potential of this mitigation action. It is assumed in this analysis that after 2022, the total number of improved stoves in use will remain constant at 4 million units. Any future initiatives to increase the adoption levels will be evaluated during the development of the next NCCAP.

To realise the adoption and use of 4 million efficient biomass stoves, the following activities have been proposed among others:

- Establishing loan programmes through micro-finance institutions and other affordable schemes to assist with the up-front cost of cookstoves
- Promotion of local manufacture, development and enforcement of quality standards and servicing of clean cookstoves, e.g., tax-relief incentives for manufacturers, training (both management and technical), loans and other required support for local service providers.
- Supporting local businesses to stock improved cookstoves, with an emphasis on women-led businesses
- Establishment of timber plantations for sustainable biomass supply through various programmes such as agroforestry.

Table 3.2.6: Proposed Priority Mitigation Actions in the Energy Demand Sub-Sector for the Period 2018-2022

Strategic Objective 3.2.2: Enhancing energy security and reducing dependence on unsustainable energy resources				
Issue/Problem: 80% of Kenyans depend on biomass for primary energy most of which is non-renewable. This leads to indoor air pollution and deforestation				
Opportunity	**Actions**	**Sector**	**Mitigation**	**SDG Target**
80% of Kenyans depend on biomass for primary energy.	• Develop and distribute 4 million improved biomass stoves by 2022 -Charcoal (2 million) -Biomass (2million)	MoE, KFS, ERC, County Governments, Local NGOs, Private sector	Mitigation and adaptation	1,2,3, 7,13,15
Existing technology, resources, and potential market for LPG, ethanol, and biogas	• Develop and distribute 1 million clean energy stoves by 2022 -Develop LPG, biogas, and ethanol stoves and related supply chains	Ministry of Petroleum and Mining (MPM), MoE, KFS, ERC, County Governments, Local NGOs, Private sector	Mitigation and adaptation	1,2,3, 7, 13,15
	• Strengthen the institutional frameworks that oversee household energy services and provide an adequate policy framework for the promotion of sustainable wood fuel production and plantations (See Agriculture sector) • Strengthen supervision and law enforcement with regard to sustainable wood fuel supply strategies	MPM, MoE, MEF, KFS, ERC, County Governments, Local NGOs, Private sector	enabler	

Table 3.2.7: Emission Reductions Though Development and Distribution of 4 million Improved Biomass Stoves by 2022

	tCO_2e per stove per year	**2018**	**2019**	**2020**	**2021**	**2022**	**2030**
Number of Charcoal Stoves		200,000	600,000	1,200,000	1,600,000	2,000,000	2,000,000
Number of Biomass Stoves		200,000	600,000	1,200,000	1,600,000	2,000,000	2,000,000
Emission Reductions from Charcoal Stoves	2.00	400,000	1,200,000	2,400,000	3,200,000	4,000,000	4,000,000
Emission Reductions from wood fuel Stoves	2.50	500,000	1,500,000	3,000,000	4,000,000	5,000,000	5,000,000
Total Annual ER from Improved Stoves ($MtCO_2e$)		**0.90**	**2.70**	**5.40**	**7.20**	**9.00**	**9.00**
Total Annual ER from Improved Stoves -Adjusted for 70% Implementation Rate ($MtCO_2e$)		**0.63**	**1.89**	**3.78**	**5.04**	**6.30**	**6.30**

From Table 3.2.7, it is estimated that the mitigation potential of this action is 9 $MtCO_2e$ by 2022 and it stays constant at that level through to 2030 unless other actions are implemented to increase the level of improved stoves adoption after 2022. This is equivalent to 120% of the low target (7.5 $MtCO_2e$), which is aligned with the proportional contribution that the sector would need to make in order for there to be a high level of certainty that the overall target will be achieved if all other sectors also meet their low target reduction by 2030. The potential mitigation contribution is nearly 148% of the proportionate NDC contribution target for the energy demand sub-sector by 2030. While the distribution targets are quite ambitious, they are considered achievable with enhanced private sector participation and appropriate and well targeted incentives. However, the energy-sector stakeholders agreed that 70% successful implementation rate for project is more realistic and should be applied to adjust the above mitigation potential. The adjusted emission reduction levels from distribution and adoption of improved biomass stoves are also shown in Table 3.2.7 above. The adjusted mitigation potential of the action by 2022 is 6.3 $MtCO_2e$ (84% of the 7.5 $MtCO_2e$ low level NDC target for the sector).

Develop and Distribute 1.5 Million Clean Energy (LPG, Biogas, and Ethanol) Stoves by 2022

This action has the potential to transform cooking in the country in a significant way. However, it requires significant development of the fuel supply chains, including storage, distribution and dispatch facilities. While LPG is to be imported in the foreseeable future, there is already some ethanol production with substantial opportunity for increased production by the sugar companies besides other potential producers. Distribution of ethanol stoves has been successfully piloted in the country and a number of initiatives, most under development, are targeting the expansion of ethanol production and use as cooking fuel in Kenya. Biogas generation requires availability of adequate amount of bio digester feedstock, such as biodegradable waste or livestock dung, and significant capital investment at household level.

Kenya's overreliance on biomass as a source of energy is perpetuated by poverty, especially in rural areas, low electrification levels and high cost of modern energy, among others. There has been a recent push towards the use of LPG, ethanol, biogas and solar energy as alternative sources of household cooking energy due to diminishing biomass stocks and greater awareness of the adverse impact of biomass use on the environment such as deforestation and pollution. Industry data show that LPG consumption increased from 93,000 tonnes in 2013 to 151,700 tonnes in 2016 and 189,000 tonnes in 2017 (25% increase in 1 year). Kenya has set a 100% access target to be reached by 2022 for clean cooking solution. To achieve this goal, and realise other related benefits, it is planned that between 2018 and 2022, up to 1 million households, with additional institutions, in Kenya will shift to using clean fuels. This will require a number of interventions similar to those required for promotion of improved biomass stoves. As part of the clean cooking drive, the GoK, through the Energy Regulatory Commission (ERC) has published new draft regulations allowing firms to apply for licences to operate reticulated systems that will transport LPG directly to households.

Additional activities required to promote the switch to clean fuels, most of which will target urban areas, include:

- Exploring the feasibility of expanding LPG use in rural areas (e.g., supply, distribution, cost impact on uptake, need for subsidy/loan programmes, etc.)
- Scaling up of biogas technology, and related research, to increase access to clean energy to more households across the country.
- Construction of 6,500 digesters every 5 years for domestic use and 600 biogas systems in various schools and public facilities by 2022.

- Developing strategic depots with clean fuels (LPG and ethanol) storage tanks and bottling machines and stock cylinders of various sizes, and reviewing LPG supply regulations for concentrated communities, that allow for localised large-scale storage with piped and metered distribution.
- Establishing a loan programme through micro-finance institutions, or some other suitable arrangements, to assist with the up-front cost of cookers and cylinders
- Promoting local manufacture and servicing of clean cookers, e.g., tax-relief incentives for manufacturers; training and loans for local service providers
- Supporting local businesses to stock and deliver LPG to consumers
- Engaging women and youth groups in the clean fuels supply chain
- Promoting the production and uptake of clean biofuels for cooking such as bio-ethanol
- Promoting and increasing production of non-forest biomass fuel briquettes (such as sugarcane waste, sawdust and human waste) with an emphasis on women and youth
- Promote the transition to clean cooking with alternative fuels, such as liquefied petroleum gas (LPG), ethanol and other clean fuels in urban areas

The Government of Kenya is piloting a USD. 20 million subsidised LPG programme (Mwananchi Gas Project) in two counties (Machakos and Kajiado)[46]. Kisumu County is putting up a USD. 3 million biogas plant which will use both industrial and human waste feedstock in an attempt to protect its forests[47]. There are also programmes working to roll out large scale adoption of ethanol cooking.

Table 3.2.8 show the emission reduction estimations for this action. It is assumed that each year, 100,000 stoves of each of the three types stoves (LPG, biogas and ethanol) will be distributed. The total emission reduction potential of this action is 1.19 MtCO2e per year by 2022 before adjustment of the 70% project completion rate. This is equivalent to 15% of the low target (7.5 MtCO2e), which is aligned with the proportional contribution that the sector would need to make in order for there to be a high level of certainty that the overall target will be achieved if all other sectors also meet their low target reduction by 2030. The potential mitigation contribution is nearly 61% of the proportionate NDC contribution target for the energy demand sub-sector by 2030.

Table 3.2.8: Emission Reductions Though Development and Distribution 1.5 Million Clean Energy Stoves by 2022

	tCO_2 per stove per year	2018	2019	2020	2021	2022	2030
Number of LPG Stoves		100,000	200,000	300,000	400,000	500,000	500,000
Number of Biogas Stoves		50,000	100,000	150,000	200,000	250,000	500,000
Number of Ethanol Stoves		50,000	100,000	150,000	200,000	250,000	500,000
Emission Reductions from LPG Stoves/HH per year	1.19	119,000	238,000	357,000	476,000	595,000	595,000
Emission Reductions from Biogas Stoves/HH/year	1.19	59,500	119,000	178,500	238,000	297,500	297,500
Emission Reductions from Ethanol Stoves/HH/year	1.19	59,500	119,000	178,500	238,000	297,500	297,500
Total Annual ER from Clean Fuel Stoves ($MtCO_2e$)		0.238	0.476	0.714	0.952	1.190	1.190
Total Annual ER from Clean Fuel Stoves -Adjusted for 70% Implementation rate ($MtCO_2e$)		**0.167**	**0.333**	**0.500**	**0.666**	**0.833**	**0.833**

Both actions for the energy demand side have significant mitigation impact. Table 3.2.9 shows the combined mitigation impact of the two priority energy demand actions. If implemented as proposed and allowing for 70% success rate, the two energy demand actions would make a mitigation contribution of 7.1 $MtCO_2e$ per year by 2022 and 2030, provided the distributed stoves continue to be used or replaced as they age out. In the NDC Sector Analysis (2017), it was established that the mitigation high target for the whole energy sector was 12.6 $MtCO_2e$ and that this target was intended to guide responsible ministries and agencies in terms of what they should objectively plan and prepare for should the sector require additional emission reductions by 2030. The mitigation potential of the proposed two actions in the energy demand sector is about 56.3% of this target in 2022 with another 8 years to go. The energy demand sub-sector therefore has the potential to deliver about 16% higher emission reductions than the 2030 NDC proportionate target for the sub-sector by 2022.

Table 3.2.9: Emission Reductions Through Energy Demand Actions by 2022

	Emission Reduction (tCO2e)					
Stove Types	**2018**	**2019**	**2020**	**2021**	**2022**	**2030**
Charcoal Stoves	280,000	840,000	1,680,000	2,240,000	2,800,000	2,800,000
Biomass/firewood Stoves	350,000	1,050,000	2,100,000	2,800,000	3,500,000	3,500,000
LPG Stoves	83,300	166,600	249,900	333,200	416,500	416,500
Biogas Stoves	41,650	83,300	124,950	166,600	208,250	208,250
Ethanol Stoves	41,650	83,300	124,950	166,600	208,250	208,250
Total Annual ER (tCO2e)	796,600	2,223,200	4,279,800	5,706,400	7,133,000	7,133,000
Total Annual ER (MtCO2e)	**0.8**	**2.2**	**4.3**	**5.7**	**7.1**	**7.1**

The mitigation potential of the proposed actions in the energy sector are summarised in Table 3.2.10 below.

Table 3.2.10: Summary of the Prioritised Mitigation Actions in the Energy Sector (2018-2022)

Sub-sector	Action	Emission Reduction (tCO_2e)	
		Action up to 2022	Action up to 2030
Energy Supply/Electricity Generation	Developing new 2,405 MW of grid-connected renewable electricity generation and retirement of three thermal plants by 2022	9.2	9.2
Energy demand side	Develop and distribute 4 million improved biomass (charcoal and biomass) stoves by 2022	6.3	6.3
	Develop and distribute 1 million clean energy (LPG, biogas, and ethanol) stoves by 2022	0.8	0.8
Total Sector Emission Reduction Potential of the Prioritized Actions		16.3	16.3

3.1.2 Enablers

Technology

A summary of the key technologies associated with the three priority mitigation options is provided in Table 3.2.11. The enabling actions are required for monitoring, reporting and verification.

Table 3.2.11: Key Technologies in the Energy Sector

Sub-Sector	Mitigation Option	Key Technologies Required
Energy Supply/ Electricity Generation	Geothermal	Feasibility studies and resource assessments, test drilling, directional and deeper drilling and construction of production wells, steam condensing turbines, injection optimization, scaling/corrosion, inhibition, reservoir simulation modelling.
	Wind	Wind turbine siting, electric system integration, advanced rotors and blades, advanced turbine control and condition monitoring, advanced drive trains, generators and power electronics.
	Solar	PV module manufacturing, cell efficiency, stability and lifetime, inverters, charge controllers, system structures, off-grid solar home systems.
	Hydro	Hydropower turbines technologies are mature. Some of the promising technologies under development are variable-speed and matrix technologies, fish-friendly turbines, hydrokinetic turbines, abrasive-resistant turbines, and new tunneling and dam technologies.
	Co-generation	Gasification technology, high-efficiency boiler and combustion technology, demonstration and awareness raising.
Energy Demand	Improved Cookstoves	Improved heat retention, formulation of standards for cookstoves, regulating fuel wood harvesting to reflect true value of resource. National Forestry Inventory and monitoring to determine sustainable forest harvesting levels.
	Clean fuel stoves	LPG and ethanol storage and distribution, standards for clean fuels and stoves, ethanol and briquette stove technology, LPG and ethanol safety regulations, briquette manufacturing technologies, ethanol production technologies

Source: Adapted from Government of Kenya (2017), NDC Sector Analysis

Capacity Building

There is need for improved data on biomass energy usage in Kenya. More capacity for research and data gathering is needed in the biomass sub-sector. Additional capacity is required in agroforestry to support growing of trees for fuel wood in the farm.

The following capacity building actions are proposed to support the energy sector actions:

- Training and public awareness programmes on energy efficiency
- Training on technical skills required for renewable energy at different scales. Examples include Strathmore University training programmes on solar PV and the training by Kenya Power International (Institute of Energy Studies and Research) on renewable energy technologies. While Kenya Power intends to train about 100 students per year, GDC and KenGen are training an average of 60 participants per year in the United Nations University – Geothermal Training Programme on geothermal development.

To facilitate infrastructure development, especially transmission and distribution lines, it is necessary to develop a policy to guide vegetation management, wayleaves acquisition and corridor for energy infrastructure. This will not only minimise environmental degradation but will also prevent delays such as those delaying the transmission of power from Lake Turkana Wind Power Project.

Kenya's 2016 Climate Change Act requires for steps to be taken to enhance the mainstreaming of climate change objectives in sector strategies. There remains a degree of misalignment between planning documents and processes related to climate change mitigation, and those from the electricity supply sector. In addition, there is currently no means available to quantitatively assess the costs and benefits of electricity sector options with regards to climate change and development outcomes. As such, these costs and benefits are not currently integrated into analysis or pathway development for the Least Cost Power Development Plan. Such tools are currently under development by the Ministry of Energy and the LCPDP planning committee, with the support of the Ambition to Action project. Therefore, for the electricity sector planning, the following two key actions have been planned as enablers:

- Development of tools to integrate climate change considerations and broader development impacts into electricity sector master planning processes. The tools should be developed that can assess and quantify the impacts of different electricity sector pathways for national development objectives and climate change, including key Sustainable Development Goals. These tools should be applied in the biennial Least Cost Power Development Plan (LCPDP) process to determine the optimal pathways that consider the costs and benefits associated with the assessed impacts.

Regular reporting of climate change mitigation implications in the electricity sector master planning documents - The biennial Least Cost Power Development Plan (LCPDP) reports, or their equivalent, should include clear information on what the proposed electricity sector pathways mean in terms of greenhouse gas emissions, and how these plans relate to national climate change mitigation and adaptation objectives as set out in Kenya's most current NDC and NCCAP

Finance and Budgets

Table 3.2.12 is a summary of the budgets for implementation of the priority actions.

Table 3.1.12: Estimated Budgets for Priority Options

Mitigation Option	Budgets (Million US $)	Remarks
Development of new 2,405 MW of grid-connected renewable electricity generation	6,468	See Table 3.2.3. The CAPEX is based on the estimated capital costs of the various technologies as provided in the ULCPDP 2011-2030
Development and distribution of 4 million improved biomass (charcoal and biomass) stoves	-	-
Develop and distribute 1 million clean energy (LPG, biogas, and ethanol) stoves	-	-

Annexes to the Energy Sector Analysis

Annex 3.2.1: Background Information on the Energy Sector in Kenya

Petroleum Fuels

Currently Kenya imports all its petroleum needs, although economically exploitable oil deposits were discovered in north-western Kenya in 2012. The Kenyan economy has historically been very exposed to international energy prices, as it imports all the fossil fuels it consumes and uses these across the economy for transport, industrial use, domestic energy (LPG and kerosene) and power generation (diesel and heavy oil). In 2016/2017, Kenya imported 6,347.7 thousand tonnes of various petroleum products.[48] As at December 2014 there were about 71 Oil Marketing Companies (OMCs) licensed to import petroleum products and 176 companies licensed to market petroleum products in Kenya. The market was liberalized in 1994 and licensing criteria have recently been simplified to facilitate the entry of new market players. However, the market is still largely oligopolistic with more than two-thirds being controlled by the five leading OMCs.

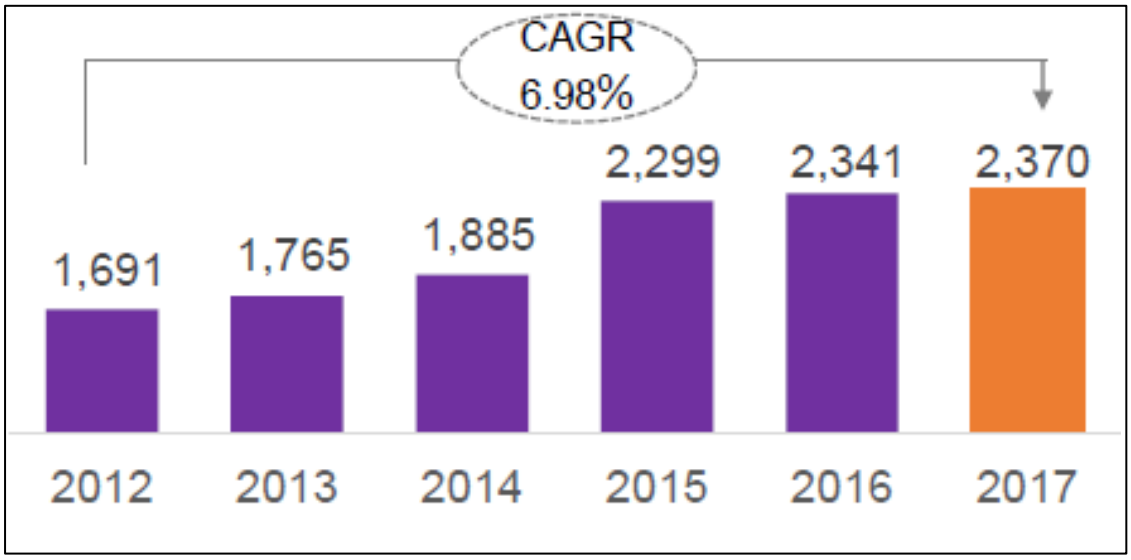
Kenya is looking at developing facilities and infrastructure to support the oil industry following the discovery of oil and plans are underway for Kenya to start oil exports by road in 2018 under the Early Oil Pilot Scheme (EOPS), which are to be followed by a full-scale export via pipeline by 2021 or 2022 estimated at 60 to 80 thousand barrels per day.[49,50] Besides the pending Petroleum (Exploration, Development and Production) Bill 2015, other impediments to the EOPS include low oil prices, the recent dip in Kenya's economy, and Uganda's decision in 2016 to withdraw support from the Kenyan-led construction of a port and the Lamu Port and South Sudan Ethiopia Transport Corridor (LAPSSET) for the transportation of oil by pipeline. Currently, the only oil facilities and infrastructure to support the oil industry is the 70,000-barrels-per-day refinery in Mombasa, which has been converted into a storage facility, and an 800-km pipeline transporting oil products from Mombasa to the south-western part of the country through Nairobi. KPC is currently building a new 450 km pipeline from Mombasa to Nairobi to increase the flow of product to the capital to meet expected demand growth. With increased activity involving petroleum production and export, GHG emissions in the energy sector are expected to increase.

In 2017, the national coal consumption was 462.7 thousand tonnes of oil equivalent (toe)[51],all of which was used for direct heat production in the cement sector. Coal imports are expected to increase when the 1,050 MW Lamu coal plant is commissioned.

Electricity

In 2017, electricity in Kenya was generated from geothermal (43.6%), hydropower (32.7%), thermal (21.3%) and others (2.4%). Kenya's current installed generation capacity is at 2.37 GW, with an effective capacity of 2.26 GW and a system peak demand of 1.66 GW[52] (Figure 3.2.1.1). Hydropower, which is reliant on unpredictable weather, constitutes the bulk of the installed capacity leading to frequent power outages (the average number of outages per month recorded in 2017 was 19,588). It costs approximately Ksh 35,000 (USD 350) to connect to the national grid and about 0.15 USD per kWh of electricity service compared USD 0.04 per kWh in South Africa. These are relatively high costs that pose a major obstacle to the connection expansion and use of electricity to low-income households and small businesses, which can therefore benefit from decentralized alternative sources of energy, such as solar.

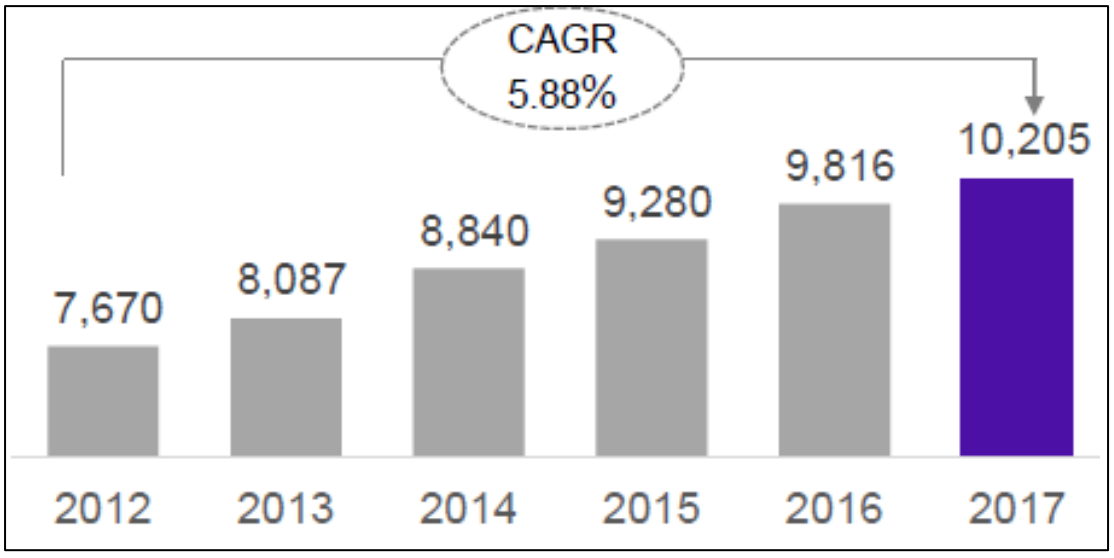
Figure 3.2.1.1: Total Installed Power Generation Capacity in MW (2012 to 2017)



Source: Kenya Power

Between June 2016 and June 2017, the electricity generation was 10,205 GWh, representing a 4% increase from the previous year[53] (Figure 3.2.1.2) and KenGen alone generated 74% the total energy. Large and medium companies (commercial consumers), who are favored by the current tariff patterns, consume nearly 70% of the total power consumed. Despite increasing generation capacity, generally the rate of growth of demand has historically been higher than that of supply.

Figure 3.2.1.2: Total Power Generation in GWh (2012 to 2017)

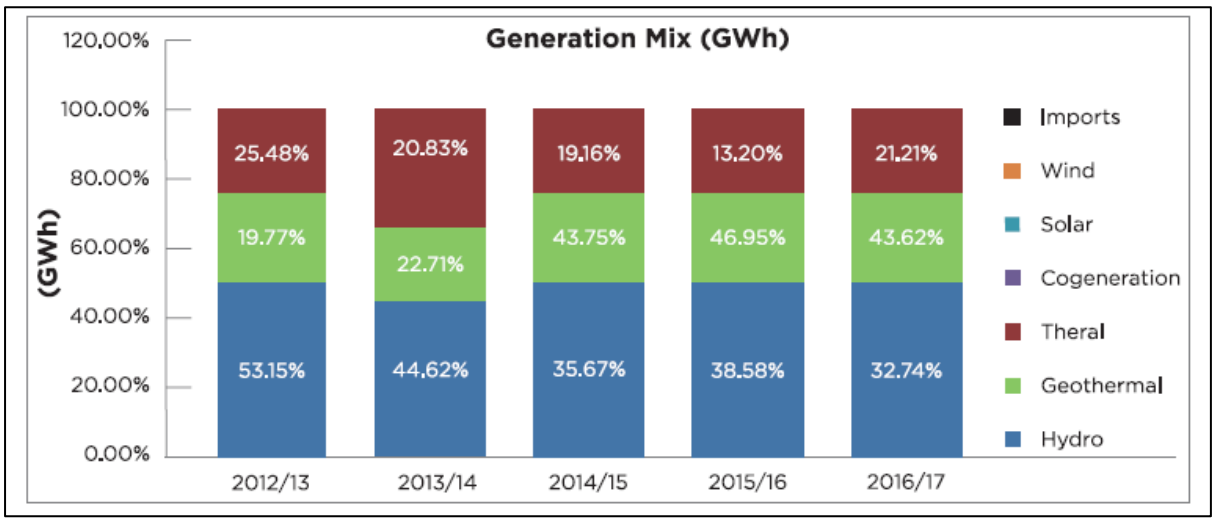


Source: Kenya Power

Figures 3.2.1.1, 3.2.1.2 and 3.2.1.3 show the electricity generation capacity, actual generation and the generation mix, respectively, for the period 2013 to 2017. Of the total 10,205 GWh of energy generated in 2017, 32.7%, 43.6%, 23.1% and 0.6% was from hydro, geothermal, thermal fossil and others, respectively. The electricity generation expanded by 3% from the generation in 2016, with 6.1% increase in geothermal generation, a 72.3% increase in thermal generation and 29.9% drop in hydro generation due to drought. About 77% of electricity was generated

locally using renewable energy sources while approximately 35% was generated using fossil fuels in the form of diesel plants.

Figure 3.2.1.3: The Generation Mix (2012-2017)



Source: Kenya Power; Annual Report 2018

Even though generation is dominated by the state-owned Kenya Electricity Generating Company (KenGen), the participation of independent power producers (IPP) has been rising and is now close to 30% of the national installed capacity. This trend of increasing private sector participation in generation is likely to continue because it is supported by the government and, for implementation, large capital is required (about USD 18-23 billion to realise the 2020 targets which covers, generation, transmission lines, system efficiency improvements and off-grid connections for up to 30% of the population)[54, 55] over the next 4-5 years. However, the few IPPs who have shown interest in investing in Kenya's energy sector demand high generation tariffs, government guarantees and letters of credit covering up to 7 months of payment for both capital and energy charges.

Kenya also imports grid-connected power from Uganda and non-grid connected power from Ethiopia. In 2017, Kenya imported 131.6 million kWh of electricity from Uganda (compared to only 34.5 million kWh in 2016) while imports from Ethiopia only served the border towns which are not grid connected. Kenya is a member of the East African Power Pool, a regional power pool of 10 countries including Egypt, Ethiopia, Tanzania and Uganda.

Kenya has a geothermal potential estimated at 7,000 to 10,000 MW, with high sub surface temperatures, which make it cheaper to produce geothermal in Kenya. The installation of Africa's largest wind power project (the 310 MW Turkana Wind Farm) is complete but the project has so far not been able to dispatch any power to the grid due to lack of power transmission infrastructure to the major consumption points. There are another 900 MW wind projects in development or online.

Two coal power plants, 750 MW in Mui Basin and a 1,050 MW in Lamu have been proposed. While the Mui Basin project plans to use 400 million tonne of the local coal and the Lamu plant plans to use coal imported from South Africa, both plants face strong opposition by local communities. There is also some concern over the economic viability of the Lamu plant.

In 2015, the first grid-connected 600 kW solar power system under the current feed-in-tariff, which marked a significant milestone in Kenya's energy sector, was commissioned by Strathmore Business School in Nairobi.

For the socio-economic transformation of the country, the Government set the goal of 70% and universal access to electricity by 2017 and 2020, respectively.[56] However, it now looks more realistic to assume that about 70-80% on grid connectivity could be achieved by 2020 while the other 20-30% of the population could be supplied off-grid.

4.1.3.1 Power Sector Development

Traditionally, Kenya's power industry generation and transmission system planning is undertaken on the basis of a 20-year rolling Least Cost Power Development Plan (LCPDP). According to the latest plan (Updated Least Cost Power Development Plan Study Report 2011-2031) of March 2011, the forecast peak demand and energy is 3,960 MW and 22,699 GWh in 2022 (Reference case). The optimal development plan includes geothermal, hydro, wind, imports, thermal, coal and nuclear energy sources.

The Rural Electrification Authority (REA) was formed under the Energy Act 2006, to develop and update the Rural Electrification Master plan (REM) and promote the use of renewable energy sources. The REM recognized that Kenya has considerable potential for renewable energy, mainly Solar PV, for less developed sparsely populated areas. It recommended the exploitation of wind energy as a substitute for fossil fuels, conducting detailed feasibility studies for small hydro projects for rural electrification and exploiting potential for energy generation from biomass. The renewable resource potential in the country is summarised in Table 3.2.1.1 below. It is estimated that the undeveloped hydroelectric power potential of economic significance is 1,449 MW, out of which 1,249 MW is for projects of 30 MW or bigger[57] although small hydropower might also offer vast generation options and studies are ongoing to establish the exact potential. Geothermal, with the potential estimated 5,000 MWe to 10,000 MWe, is currently the most promising indigenous resource for development of power.[58]

The sustainable use of tree-based biomass for modern energy requires collaboration between key sectors like energy, forestry and agriculture. No estimates are available on the power generation potential from tree-biomass and comprehensive studies are necessary to generate the required information. Bagasse based generation potential is estimated at 193 MW from the existing sugar factories although the sector performance has been deteriorating over the last 7 years. Biogas-based electricity generation potential has been identified in municipal waste, sisal and coffee production, and is estimated at 29-131 MW.

Kenya has great potential for the use of solar energy throughout the year because of its strategic location near the equator with 4-6 kWh/m^2/day levels of insolation. As of 2015, it was estimated that about 445, 000 to 470,000 PV systems with a total capacity of about 20 MWp had been installed in Kenya.[59, 60] This is projected to grow at 15% annually.

Kenya's wind potential is estimated at approximately 9 terawatts (TW) with 1,604 GW in wind speed of Class III, 642 GW in Class II and 4.6 GW in Class I.[61]

Table 3.2.1.1: Estimated Local Renewable Energy Resources Potential (MW)

Resource Type	Resource Potential (MW)
Hydro	3,000-6,00062
Geothermal	5,000-10,000
Cogeneration (bagasse-based)	193
Biogas	29-131
Wind	1,500-3,000
Solar	-

Sources: Various

According to Kenya Power (Grid Development and Maintenance Plan 2016/17 to 2020/21), under normal growth scenario, including 30 MW export to Rwanda, the peak demand is expected to rise from actual peak demand of 1,586 MW in June 2016 to 2,864 MW in 2021 as shown in Table 3.2.1.2 below. Total system generation capacity is targeted to reach 6,670 MW (under normal conditions) and 5,024 MW (under deferred growth) by 2021. Normal conditions would entail the following: electricity peak demand is expected to grow from 1,585 MW (2015/16) to 2,834 MW (2020/2021):

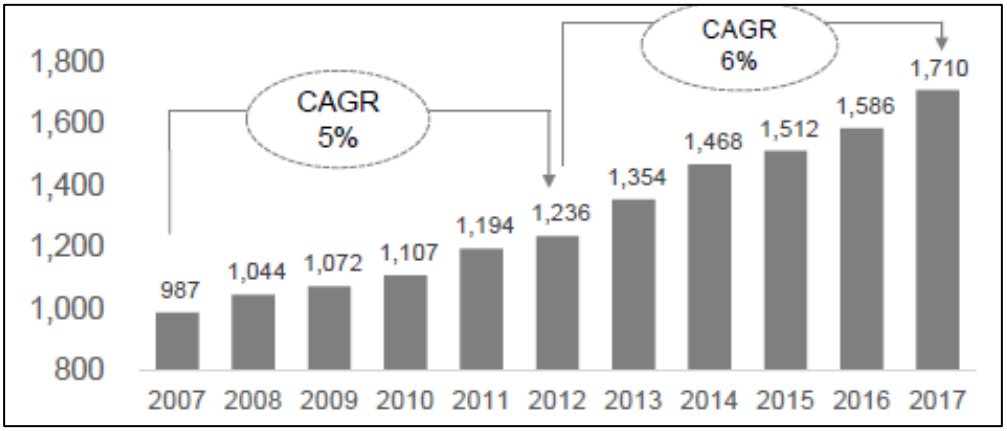
- Normal demand growth linked to growth in the national economy and to major new industrial and commercial investments.
- Vision 2030 flagship projects: namely the ICT Park, light rail, standard gauge railway, Port of Lamu new pipeline pumping stations, resort cities and iron smelting industry (See Table 3.2.1.3 below). With delayed implementation of most of the flagship projects, Kenya's actual peak load demand up to 2017 and, hence generation requirements, have been lower than the projections.

Table 3.2.1.2: Peak Demand Projections (2016 to 2021)

Year	GWh	Peak Load (MW)
2015/2016	9,817	1,585
2016/2017	10,341	1,750
2017/2018	10,895	1,959
2018/2019	11,478	2,205
2019/2020	12,093	2,494
2020/2021	12,740	2,834

Source: Adapted from Grid Development and Maintenance Plan 2016/17-2020/21; Kenya Power

Figure 3.2.1.4: Peak Demand (2007-2017)



Source: Kenya Power

Table 3.2.1.3: Vision 2030 Flag Ship Projects

Vision Flagship Projects	Completion Date	Energy Requirement (GWh)	Generation Capacity Requirements (MW)
ICT Park	2015	2,930	440
2nd Container Terminal and Mombasa Free Port	2014	746	2
Juba-Lamu railway	2014	19	9
Lamu Port including resort cities	2014	200	30
Special Economic Zones (Mombasa, Kisumu, Lamu)	2015	333	50
Iron and steel smelting industry in Meru area	2015	2,097	315
Mombasa-Nairobi-Malaba-Kisumu railway	2017	27	18
Light rail for Nairobi and suburbs	2017	16	8
Resort cities (Isiolo, Kilifi and Ukunda)	2017	200	30
Total		**6,568**	**902**

Source: The Kenya Power & Lighting Company Limited; Kenya Distribution Master Plan, Final Report

In a study by Power Africa (Development of Kenya's power sector 2015-2020) in 2015 however, the projected peak demand by 2020 is estimated at between 2,000 and 3,600 MW[63]. This demand includes baseline demand from anticipated growth in population and economic activity, conversion of latent demand through increased electricity access and implementation of large industrial projects under Vision 2030, which require significant electricity use.

With a focus on balancing supply and demand and based on updated timelines and projects in the pipeline by 2015, Power Africa estimated that Kenya could have 5,040 MW of installed generation capacity by 2020. This would represent about 2,700 MW of additional installed generation capacity (with 2015 capacity as the baseline) in 42 new plants. According to the projections, most of the new additions would be renewable (Figure 3.2.1.4 below), most of which will be geothermal at about 40% of the total installed capacity. Solar is also expected to play an increasingly important role growing from less than 1 MW in 2017 to about 430 MW by 2020. The Power Africa capacity requirement projections are very close to Kenya Power's projections for the deferred growth scenario and appears to be a more realistic forecast under the prevailing circumstance, especially with regard to the implementation Vision 2030 flag ship projects.

According to Power Africa projections, over 60% of the country's electricity will be generated by Independent Power Producers (IPPs) using steam from the Geothermal Development Company (GDC) through 52 plants.

Table 3.2.1.4: Kenya's Forecasted Generation Capacity in 2020/2021 by Power Africa

Technology	Total Installed Generation Capacity (MW)	No of Generating Plants
Geothermal	1,984	20
Hydro	921	25
Wind	786	11
Fuel oil	751	14

Solar	430	10
Biomass	108	4
Gas Turbine	60	1
Total	**5,040**	**85**

Source: Power Africa; Development of Kenya's Power Sector 2015-2020

Kenya has one of the largest, most diverse and rapidly modernising electricity sectors in the region, with a diversity of supply technologies, new policy tools to encourage renewables and medium- and long-term planning horizons that aim to meet the demands of Kenya's vision for its future. However, the sector faces a number of challenges and opportunities, the most important of which include:

- Low access to electricity and modern energy sources with rapidly growing demand for electricity,
- Enormous capital and investments needs for new electricity generation capacity to cover the increasing demand
- High dependence on hydroelectric power which has become less reliable compounded by the additional risk of climate change
- High costs of supply
- Need to invest in the transmission and distribution infrastructure.
- Inadequate capacity for integration of intermittent power generation in the national grid.
- Unsustainable use of biomass.
- Inadequate LPG infrastructure for cylinder filling, storage and distribution

Coal

There is no commercial production of coal in Kenya at present, but there are commercially viable reserves in the Mui Basin in the south of the country. 400 million tonnes of reserves were confirmed in 2010. Coal is identified as an indigenous energy source that will support achievement of Vision 2030 and provide low cost generation capacity when exploited. As previously mentioned, close to 2,000 MW coal generation plants have been proposed and are at different stages of development, albeit with significant local community opposition. Currently, all the coal used in the country is imported and used in the cement industry.

Energy Policy and Legislation

An energy policy providing a framework for ''sustainable, adequate, affordable, competitive, secure and reliable supply of energy to meet national and county needs at least cost, while protecting and conserving the environment' has been developed by the Government of Kenya.[64] The Draft National Energy and Petroleum Policy 2015 seeks to address the major challenges facing the energy and petroleum sector including improving the sector's competitiveness, quantity, reliability and quality of supply, high initial capital outlay and long lead times from feasibility studies to development of infrastructure, mobilizing adequate financial resources to undertake massive investment in the power sector, high cost of energy, low per capita incomes and low levels of industrialization. While the Ministries of Energy and of Petroleum and Mining are expected to provide overall leadership, oversight, guidance and direction to ensure full implementation of the policy, there are various and many stakeholders, including the 47 county governments and the private sector, who must play very critical roles for successful implementation.

The Energy Bill, 2015, that aims to consolidate the laws relating to energy and provide for National and County Government functions in relation to energy, was passed by the National Assembly in November 2016 and forwarded to the Senate for consideration.[65] The Bill: [66]

- Sets out institutions in the energy sector
- Promotes renewable energy
- Provides a framework for the exploration, recovery and commercial utilization of geothermal energy
- Regulates petroleum and coal activities
- Regulates electricity supply and use.

The objectives in the Draft National Energy and Petroleum Policy (2015) include:

- Increase access to affordable energy
- Promote indigenous sources
- Promote energy efficiency and conservation
- Encourage electricity generation from renewables
- Develop a natural gas master plan
- Achieve 1.9 GW geothermal power plants by 2017[67] and 5.5 GW by 2030
- Exploit the estimated 1,449 MW of large hydro, and the potential of small hydro, wind and solar PV
- Develop the transmission network and the interconnection capacities with Uganda and Tanzania

There is also the Petroleum (Exploration, Development & Production) Bill 2017, which if passed will regulate petroleum oil production.

Under the Sustainable Energy for All (SE4All) Action Agenda, Kenya has set the following targets:

- 19 GW of installed capacity by 2030, of which 26% will be geothermal, 9% will be wind and 9% hydro
- Connection to the electricity grid for 65% of urban population by 2022 and 40% rural by 2020 with 100% electrification by 2030
- 18% cooking with LPG by 2020 and 100% cooking with "modern energy" by 2030
- Reduce distribution losses below 15% by 2020 and to 9.3% by 2030.

The Government has developed the Solar Water Heating Regulations to make it mandatory for all premises within the jurisdiction of a local authority (to be confirmed) with hot water requirements exceeding 100 liters per day to install and use Solar Water Heaters. Programmes have also been implemented with the involvement of Civil Society Organizations. Some run jointly with the Government, for example UNDP's Development and Implementation of a Standards and Labelling Program in Kenya and Access to Clean Energy Services in Kenya. Some of the private initiatives implemented include Africa Biogas Partnership Program (ABPP) run by SN/ Hivos of Netherlands and KENFAP, Lighting Africa a joint IFC and World Bank program and various initiatives by key private sector players such as The Global Village Energy Partnership and Renewable Energy for Sustainable Development Africa.

In addition, the following key developments are likely to influence the development of the power sector in Kenya:

- The Draft National Geothermal Strategy which aims to provide guidance for investments in geothermal power generation.
- The ongoing review of the Feed-in-Tariff Policy, 2008 (2012)
- The Draft Renewable Energy Auction Policy which aims to improve power generation competitiveness in Kenya.
- Power Infrastructure Upgrades programme which aims to improve power supply quality and reliability in the country.
- Efficiency: Standards for electrical appliances; energy efficiency obligations for utilities. Energy Bill 2015 provides for the creation of an Energy Efficiency and Conservation Agency to enforce energy efficiency standards.

- Elimination of kerosene as a household fuel by 2022 and the requirement to install solar water heaters in buildings served by the grid.

The GoK has prioritised geothermal development as a source of green energy because the development addresses both adaption and mitigation in the energy sector. The GoK also promotes the increased use of renewable energy sources which include small hydros, solar, biogas, biomass, wind and hybrid systems taking into account the specific needs of rural areas. In future, it is planned that the Rural Electrification and Renewable Energy Corporation (RERC), a successor organisation to the current Rural Electrification Authority (REA), will become the lead agency for development of renewable energy resources other than geothermal and large hydro. Its proposed functions would include the development and updating of a renewable energy master plan, which will take into account the national energy policy produced by the MoE as advised by the yet to be established inter-ministerial Renewable Energy Resources Authority Committee (RERAC).

Recently discovered coal resources are expected to play an important part in Kenya's long-term electricity sector planning as set out in the Power Generation and Transmission Master Plan 2015-2035. The plan ranks coal as the fourth largest contributor to the generation capacity after geothermal, hydro, and imports in that order, from 2020 onwards. According to the plan, 300 MW of coal generation was to be commissioned in 2016, 2018 and 2021. This puts the total planned coal generation at 900 MW up to 2022. Although coal-fired power plants in Lamu and Kitui were included in the baseline GHG emissions projection for the NCCAP (2013-2017), the first 600 MW coal plants that was planned for 2016 and 2018 have not been installed to date. Nuclear is also expected to play a role in electricity generation in 2030[68] with the first unit of 1 GW scheduled to start operation in 2024. In the same period about 130 MW of medium speed diesel plants are scheduled for decommissioning as part of Kenya's deliberate substitution of thermal plants with those of geothermal. During the 5-year period and as a scale up of the biogas for life initiative, it is planned to construct 6,500 biogas digesters for domestic use and 600 biogas systems in various schools and public facilities across the country. REA also has plans to construct 25 mini-grids per year until 2020.

The government is also promoting direct use of renewable energy resources such as geothermal and solar energy solar applications.

Along with an increase in generation capacity, the Government of Kenya has prioritized action to increase grid connectivity. Reduced connection fees to the national grid, from KES 35,000 to KES 15,000 in May 2015 contributed to Kenya Power adding at least one million new connections. The national connectivity access rate increased from 47% in March 2013 to 55% in June 2016.[69] The Government's Last Mile Connectivity project aimed to attain a 70% electricity access rate by 2017 and universal access by 2020.[70]

An estimated 6.7 million households comprised the off-grid and decentralized electricity market in 2013. Supply consisted of micro and Pico systems, mini-grids, and stand-alone systems – with solar, wind and hydro being the main resources in use. Stand-alone solar photovoltaic (PV) systems are the most widely used technology in Kenya, with well over 200,000 systems installed and sales estimated at 20,000 systems per year.[71] Solar-based initiatives – including private sector businesses such as M-Kopa, Sunlar and Go Solar Systems – have been instrumental in increasing access for solar home systems that provide off-grid energy solutions for lighting and powering electronic devices. Households with access to solar energy increased from 3% in 2013 to 15% in 2016.[72]

Kenya is expected develop its domestic oil and gas reserves over the next few decades. The baseline includes only a small amount of crude oil production (about 6,000 barrels per day) starting in 2017 and rising modestly to 6,000 barrels per day by 2030. It is however, now projected that Kenya could be producing about 60,000 barrels of crude oil by 2030.[73]

Energy demand is divided among three main types of energy carriers: fossil fuels, biomass and electricity. Fossil fuels and biomass are used to produce heat for productive purposes in the commercial and industrial sectors, and for cooking, heating and lighting purposes in the household sector. Kenyans rely on the traditional use of biomass as the primary energy source for heating and cooking. About 87% of the rural population uses firewood for cooking and 82% of the urban population uses charcoal for cooking.[74] Considered holistically, the annual contribution of charcoal to the economy is estimated to be about KES 135 billion.[75] The charcoal industry faces several challenges, including unsustainable fuelwood resources and the informal nature of the sector's operations. Access to modern energy services is required to reduce the biomass (charcoal and wood) fuel dependency.

Energy efficiency measures help to reduce energy consumption in households and reduce the energy costs in commercial and industrial services and products. The government, in partnership with stakeholders, has taken several energy efficiency and conservation initiatives. The Ministry of Energy (MOE) has worked with the Kenya Association of Manufacturers (KAM) to establish a Centre for Energy Efficiency and Conservation (CEEC) that promotes energy efficiency in private sector companies and public institutions such as government buildings. Kenya Power has implemented a programme to distribute compact fluorescent lights (CFLs). MOEP has implemented improved cookstoves programmes and developed regulations that influence the update of climate-related technologies, such as for solar water heating, solar PV systems and cookstoves.

Annex 3.2.2: Implications of the 2017-2037 LCPDP for the National Climate Change Action Plan

Whilst the electricity sector GHG emission projections in the NCCAP 2018-2022 are based on the Third Medium Term Plan (MTP II) 2018-2022, the most recent projections for the electricity sector's development are contained in the Energy Regulatory Commission's new Least Cost Power Development Plan (LCPDP) 2017-2037.

Both the MTP III and the LCPDP 2017-2037 project similar pathways in the short term, as they are both based on electricity generation capacity which is already considered committed. However, in the longer-term projections, up to 2030 and beyond, the LCPDP 2017-2037 deviates significantly from the MTP III [76]. The latest LCPDP contains significantly lower demand forecasts (even with the committed Vision 2030 flagship projects included in these demand projections) than previous estimates. It also projects a more significant role for solar PV, wind and geothermal in in the place of coal, oil and natural gas, due to the most recent information on the increasingly competitive costs of renewable energy technologies.

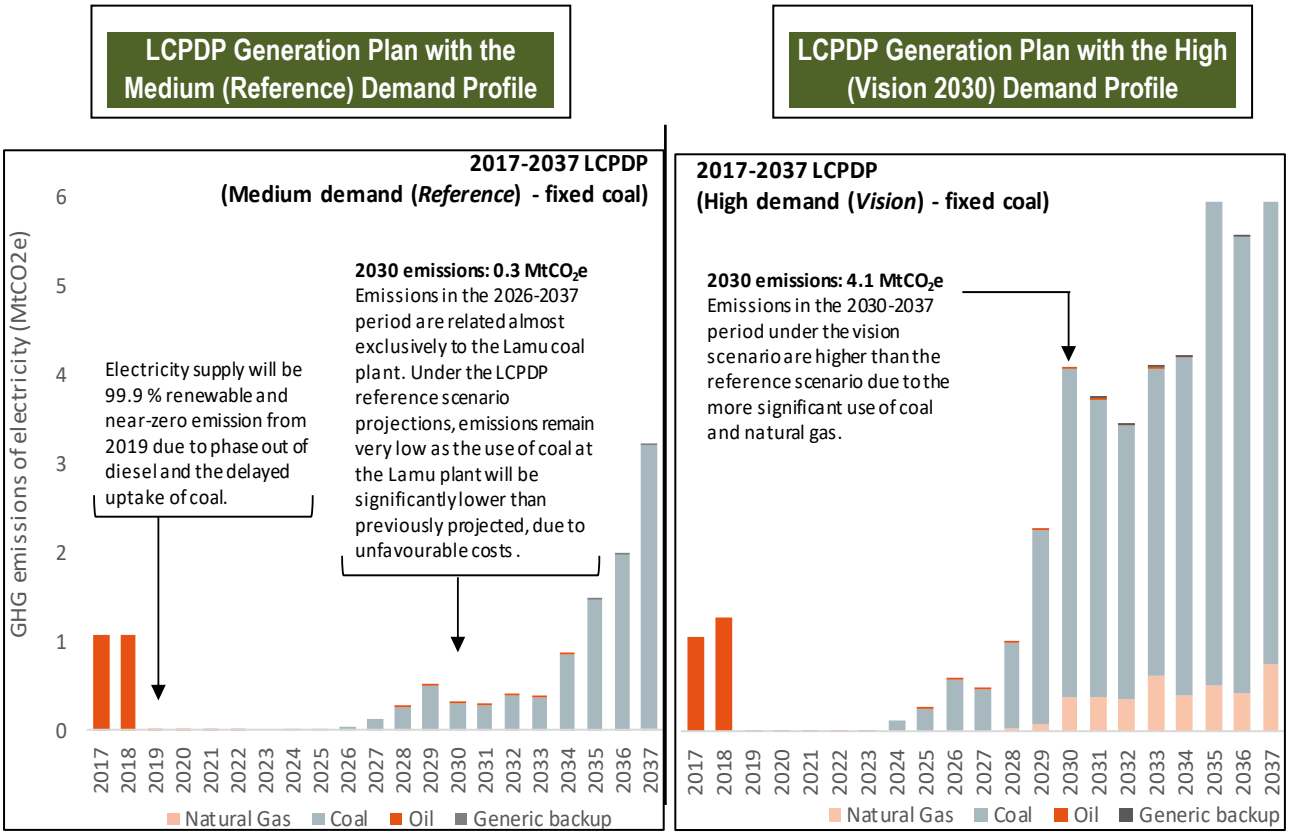
Figure 3.2.2.1 indicates what the implications of the LCPDP 2017-2037 pathway would be for GHG emissions. Under the LCPDP pathways, emissions from electricity supply will reduce to near-zero by 2019 due to the phase out of three medium speed diesel plants. Emissions will increase again due to the planned opening of the coal power plant in Lamu in 2024. However, even after the opening of the 981 MW coal plant, the LCPDP generation projections show very limited use of coal for generation under the reference demand scenario, leading to average annual emissions of 0.3 $MtCO_2e$ in 2030 and 1.08 $MtCO_2e$ in 2035. Under the LCPDP 2017-2037 vision scenario, emissions would increase to 4.1 $MtCO_2e$ in 2030 and 6.1 $MtCO_2e$ in 2035. This projection is in stark contrast to historical estimates from the LCPDP 2011-2031, reflected in the MTP III and adopted for the NCCAP 2018-2022, in which major new investments in coal, oil and gas were projected to increase electricity sector emissions to over 40 $MtCO_2e$. Adjusted demand forecasts and increased installation of wind, solar PV and geothermal technologies has brought the electricity sector more in line with national climate change objectives.

Figure 3.2.2.2 shows how the projected electricity supply sector emissions under the LCPDP 2017-2037 relate to the national target for limiting the growth of GHG emissions to 100 $MtCO_2e$ by 2030 (Kenya's NDC), when combined with the emissions from other sectors. The analysis shows that the projected generation pathways of the LCPDP 2017-2037 would have an insignificant impact on national GHG emissions up to 2028. However, under the vision scenario total national GHG emissions would increase to 108.7 $MtCO_2e$ in 2030, 9% higher than the 2030 limit of 100 $MtCO_2e$, with electricity supply accounting for approximately 4% of these national GHG emissions.

If the sector would develop in line with the LCPDP 2017-2037 projections, emissions from the electricity sector would be lower than previously estimated, and there would be a more limited scope for further mitigation measures in the electricity sector, if the role of coal remains low, as projected in the LCPDP reference scenario.

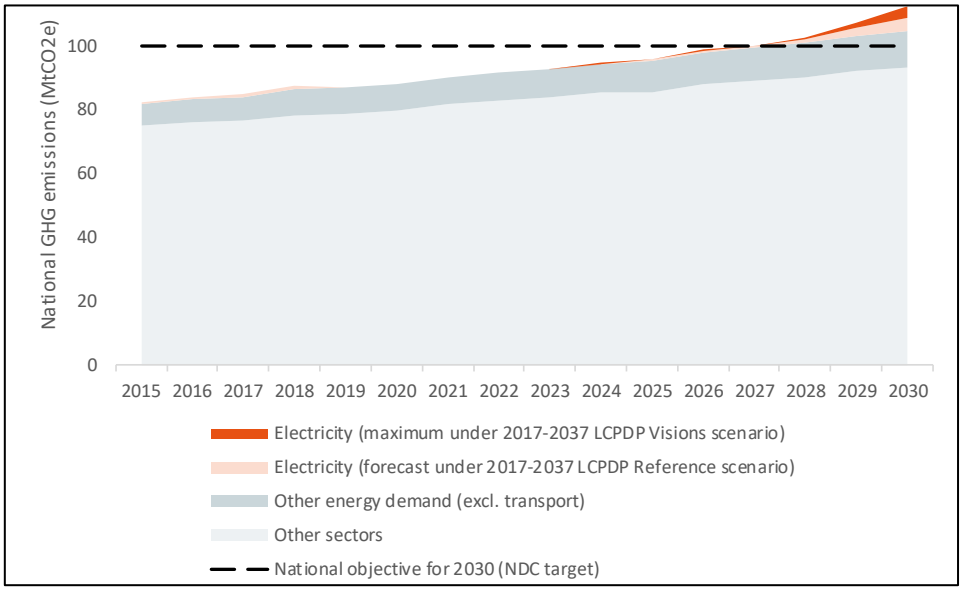
The projections in Figure 3.2.2.1 show that in the case of the LCPDP 2017-2037 pathway, the main measure required to ensure further emission reductions from the sector would be the restricted use or avoided installation of coal and natural gas capacity, through further expansion of other electricity supply options and/or energy efficiency improvements. According to the projected capacity installations of the LCPDP2017-2037, annual emissions in the years around 2030 could deviate between zero and 9.1 $MtCO_2e$, depending entirely on the rate of the utilisation of the installed coal and natural gas capacities. Therefore, the mitigation potential of alternative technologies would be a maximum of 9.1 $MtCO_2e$ per year if they could entirely displace generation from coal and natural gas capacities.

Figure 3.2.2.1: GHG Emissions from the 2017-2037 LCPDP Scenarios



Source: New Climate (2018): A2A Project

Figure 3.2.2.2: Total GHG Emissions from all Sectors in Kenya with the 2017-2037 LCPDP Reference Pathway



Source: New Climate (2018): A2A Project

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In the case that developments proceed along the lines of the LCPDP 2017-2037 reference scenario, with very limited use of coal and no use of natural gas, climate change mitigation targets would be met at the electricity supply sector level and also almost at the national level, with only moderate further reductions from other sectors required to meet the national objective for 2030, as shown in Figure 3.2.2.2.

For the further elaboration and implementation of the mitigation actions listed in the NCCAP2018-2022, it should be kept in mind that the mitigation potential of those actions may deviate from the NCCAP estimates should the 2017-2037 prove to be an accurate forecast of the sector's development. Enhanced alignment of future iterations of the MTP, the NCCAP and the LCPDP is important to improve certainty of emissions pathways and potential mitigation actions.

3.3: Forestry Sector

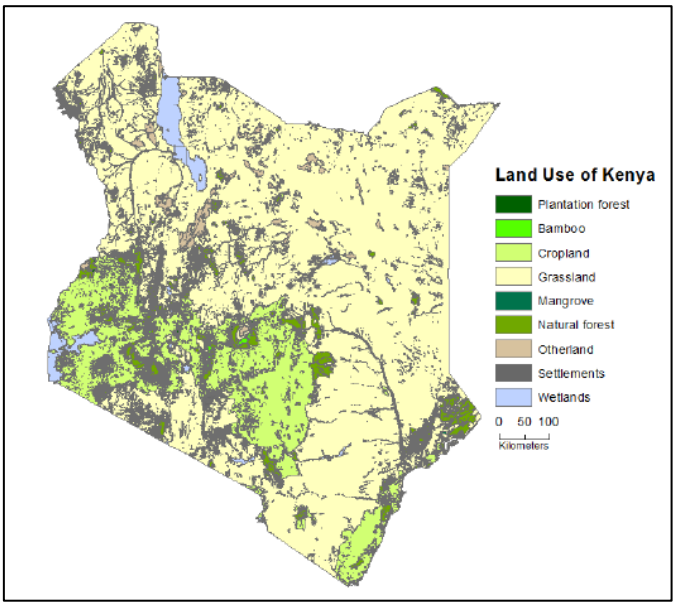
3.3.1.: Overview

This chapter focusses on the climate change mitigation role of forests and covers climate change mitigation analysis in the forestry sector and other land-use and land use change sector, normally referred to as the LULUCF sector, in Kenya. It covers natural forestlands, as well as other types of vegetation such as grasslands and bush lands. In the LULUCF sector, the transitions in forests, through clearing of forested lands for agriculture, urban development or settlement, as well as wood harvesting, account for most greenhouse gas (GHG) emissions of carbon dioxide (CO_2) in the sector. The predominant gas in this sector is CO_2, but there are also emissions of other greenhouse gases such as CH_4 and N_2O from imperfect burning of wood left in the field, in case of forest conversion to other uses.

The analysis considers the impact of human activities that change the way land is used or affect the amount of carbon in existing aboveground biomass, belowground biomass, deadwood/litter and soil carbon pools. The LULUCF sector includes estimates of emissions and removals of greenhouse gases associated with increases or decreases of carbon in living biomass as land-use changes occur over time, for example, in the conversion of a forest area to cropland, or when establishing new forest lands through reforestation or afforestation.

The total area of Kenya is 58.0 million hectares (Ha), of which 1.1 million Ha are inland water bodies. Kenya is composed of seven different agro-ecological zones (Figure 3.3.1). The land consists of 82% arid and semi-arid land (ASAL) and 18% humid to semi-humid land.[77]

Figure 3.3.1: Priority Mitigation Actions in the Waste Sector for the Period 2018-2022



Source: Government of Kenya (2016), Improving Capacity in Forest Resources Assessment in Kenya (IC-FRA): Proposal for National Forest Resources Assessment in Kenya (NFRA)

The Kenya Forest Service (KFS) defines a forest as land spanning more than 0.5 hectares (ha) with trees higher than 5 meters and a canopy cover of more than 15% or trees able to reach these thresholds. This includes natural and planted plantation forests in state and private lands.

The official estimate of the forest cover in Kenya by 2016 was 6.9% of the land area. This area comprises natural forests, plantation forests, open woodlands and a small amount of mangrove forests in coast. The most luxuriant forests are found in the humid to semi-humid areas in Western Kenya, the montane areas and in the coast. According to the Land Use (LU) map by the Forest Preservation Programme (FPP, 2013) most forest plantations are found in Central and Western Kenya. The ASAL zone extends over the whole Northern and Eastern Kenya except the lower south East (Lamu County where Boni forest is found) and according to the LU map, the main land use type in these areas is grassland. In the ASAL area, there are also scattered natural forests which are, however, small in area.[78]

Along the coastal strip of Kenya there are unique forests, namely mangrove forests. Mangrove forests are scattered along the coastline. The most common tree genera are Rhizophora, Ceriops and Avicenia. The largest continuous mangrove forests are found in Lamu, Gazi and Mombasa areas.

In principle, vegetation types and forest structure follow the agro-ecological zones. Forests with large amounts of above-ground biomass (AGB) are found in humid to semi-humid zones and forests with less AGB are found in arid areas. However, below-ground biomass (BGB) can be high also on arid areas, as was found out in the IC-FRA pilot inventory when the soil samples were analysed.

Kenya's forestry sector is central to its economy and its future. Forests rank high as some of the most important national assets in terms of economic, environmental, social and cultural values. It is estimated that the forest sector contributes about Kshs. 7 billion to the economy annually and employs over 50,000 people directly and other 300,000 indirectly. Five key forests regulate 75% of the country's renewable water supplies, while more than 80% of the energy generated in Kenya comes from wood. Forests offer water catchments and biodiversity conservation functions and can mitigate climate change by acting as carbon sinks.[79]

Kenya has continued to face the wrath of deforestation and forest degradation since independence with the result that today, Kenya is among countries of the world with a forest cover of less than 10% of total land mass. The principal drivers of this trend were summarised as:[80]

- Clearance for agriculture that is linked to rural poverty and rapid population growth
- Unsustainable utilization of forest products (including timber harvesting, charcoal production, grazing in forests)
- Past governance and institutional failures in the forest sector.

According to the KFS, a wall to wall forest resource mapping of 2013 showed that the forest cover in Kenya declined from 8% (4,670,877.3 Ha) in 1990 to 6% (3,492,116.2 Ha) in 2000, signalling an overall downward trend in carbon biomass stocks. The water towers and catchment areas, where more than 75% of the country's renewable surface water originates, are severely threatened. However, as a result of a number of Government actions, the forest cover increased marginally from 4.18 million Ha (7.22 %) in 2016 to 4.22 million Ha (7.29%) in 2017[81]. Much of the increase in forest cover is attributed to the entry of private commercial plantations and the sparsely populated woodlands. In 2017, the area under natural forests stood at 4.03 million Ha, while the area under Government forest plantations stood at 0.1351 million Ha.[82]

In the NCCAP 2013-2017, it was estimated that the total GHG emissions from the forestry (LULUCF) sector was 21 $MtCO_2e$ per year (30% of total national emissions) in 2010 and was projected to increase 26 $MtCO_2e$ (32.5% of the total national emissions) by 2015 before reducing to 22 $MtCO_2e$ per year (15.4%) by 2030. At this level, the forestry sector would be the second highest emitter of GHGs after the agriculture sector.

To mitigate climate change in the forestry sector, the following three actions were proposed in both the NCCAP 2013-2017 and the SNC:

- Restoration of forests in degraded lands
- Rehabilitation of degraded forest
- Reducing deforestation and forest degradation

In the NDC Sectoral Analysis Report 2017, these mitigation actions were further analysed to determine the sectors potential contribution to Kenya's NDC mitigation target. It was determined that relative to the proportionate mitigate reduction target for the sector of 20.1 $MtCO_2e$ by 2030, the sector's mitigation potential was between 11.3 and 20.1 $MtCO_2e$ per year with a technical maximum potential of 40.2 $MtCO_2e$ per year by 2030.

The government is taking action to address climate change in the forestry sector, including through tree planting initiatives and preparatory activities to enable participate in REDD+ (reducing emissions from deforestation and forest degradation plus the role of conservation, sustainable management of forests and enhancement of forest carbon stocks) as a climate change mitigation process. Under the Bonn Challenge, Kenya has established a restoration target of 4,210,000 hectares by 2030, described in Table 3.3.1. The Bonn Challenge is a global effort to restore 150 million hectares of the world's degraded and deforested lands by 2020 and 350 million hectares by 2030.[83]

Table 3.3.1: Kenya: Existing Forest Restoration Targets

Category	Description	Existing Restoration Target
Forest Land without Trees - Planted Forests and Woodlots	Planting of trees on formerly forested land. Native species or exotics and for various purposes, fuel-wood, timber, building, poles, fruit production, etc.	4,100,000 Ha
Degraded Forest Land - Silviculture	Enhancement of existing forests and woodland of diminished quality and stocking, e.g., by reducing fires and grazing and by liberation thinning, enrichment planting, etc.	10,000 Ha
Agricultural Land - Agroforestry	Establishment and management of trees on active agricultural land (under shifting agriculture), either through planting or regeneration, to improve crop productivity, provide dry season fodder, increase soil fertility, enhance water retention, etc.	100,000 Ha

Source: Bonn Challenge (2016). Kenya. Accessed at: http://www.bonnchallenge.org/flr-desk/kenya

In this MTAR, those mitigation actions that were proposed in the NCCAP 2013-2017 and the SNC, together with those that have been proposed for the NCCAP 2018-2022, have been assessed, analysed and prioritised for inclusion in the NCCAP 2018-2022.

- Reduce deforestation and forest degradation by rehabilitation and protection of additional 100,000 Ha of natural forests (including mangroves) by 2022 with an abatement potential of 2 $MtCO_2e$ by 2030
- Afforestation/reforestation/agroforestry of additional 100,000 Ha of land by 2022, with an abatement potential of 4.8 $MtCO_2e$ by 2030
- Restoration of 200,000 ha of forest on degraded landscapes (ASALs, rangelands) by 2022 with an abatement potential of 13 $MtCO_2e$ by 2030.
- Increase area under private sector-based commercial and industrial plantations from 71,000 Ha to at least 121,000 Ha with an abatement potential of 1 $MtCO_2e$ by 2030.

- Three forest resources efficiently utilised in all counties, especially dryland forests, by 2022

While these actions are considered ambitious relative to the past performance, the do not meet Bonn Challenge targets and just meet the NDC mitigation target for the sector, which is considered a major potential significant contributor to the realisation of the target given the relatively low cost of their implementation.

3.3.2 Mitigation Actions in the Forestry Sector

Forestry can play an important role in both mitigation and adaptation to climate change.[84] The focus of this MTAR is the mitigation role since the adaptation role has been addressed in Adaptation Technical Analysis Report.

Mitigation can be achieved through activities in the LULUCF sector that increase the removals of greenhouse gases (GHGs) from the atmosphere or decrease emissions by sources leading to an accumulation of carbon stocks. An important feature of LULUCF activities in this context is their potential reversibility hence, non-permanence of the accumulated carbon stocks. Forests play a role in mitigating the harmful effects of greenhouse gas emissions by acting as a "sink" by sequestering carbon and storing it for long periods of time. Therefore, forests present a significant global carbon stock accumulated through growth of trees and an increase in soil carbon.

The Forest Conservation and Management Act, 2016 (Section 42) indicates that indigenous forests and woodlands are to be managed on a sustainable basis for, *inter alia*, carbon sequestration. Section 8 indicates that KFS is to manage water catchment areas in relation to soil and water conservation, carbon sequestration and other environmental services; and Section 21 notes that County Governments are to promote afforestation activities.

The Global Forest Resources Assessment 2010 (FRA 2015) estimates that the world's forests and other wooded lands store more than 485 billion tonnes of carbon (53% in the biomass, 8% in dead wood and litter and 39% in soil). While sustainable management, planting and rehabilitation of forests can conserve or increase forest carbon stocks, deforestation, degradation and poor forest management do reduce carbon stocks. For the world as a whole, carbon stocks in forest biomass decreased by an estimated 0.22 billion tonnes annually during the period 2011-2015. This was mainly because of a reduction in the global forest area.[85]

According the baseline analysis of the NCCAP 2013-2017 and SNC (See Chapter 2 of this MTAR), the LULUCF sector is the second largest contributor to Kenya's GHG emissions after agriculture, accounting for 32.5% of emissions in 2015 largely as a result of deforestation through clearing of forested lands for agriculture, wood harvesting, for fuelwood, charcoal and other wood products and urban development or settlement. According to the analysis, in the baseline or business-as-usual (BAU) scenario, LULUCF emissions would increase from 10 $MtCO_2e$ in 1995 to 26 $MtCO_2e$ in 2015 and then decline gradually to 22 $MtCO_2e$ by 2030 as shown in Figure 3.3.2.[86] The decrease from 2015 would be as a result of a number of policies and initiatives by the GoK in its efforts to increase the forest towards the constitutional target of 10%. However, the forestry sector is also vulnerable to climate change, which is expected to have important effects on the composition, growth rates and regenerative capacity. Reports show that climatic changes are expected to increase desertification and forest degradation, with impacts on economic benefits and livelihoods derived from the forestry sector.

Baseline

The Land-Use, Land Use Change and Forestry (LULUCF) sector includes estimates of emissions and removals of greenhouse gases associated with increases or decreases of carbon in living biomass as land-use changes occur over time. Such land-use changes include the conversion of a forest area to cropland, when establishing new forest lands through reforestation or afforestation.

Kenya's forest cover has been substantially reduced over the last 50 years, signalling an overall downward trend in carbon biomass stocks over the period. However, recent reports indicate that the forests have started to recover

because of various Government initiatives and it is currently estimated that the country forest cover is between 7 and 8%.,

The predominant gas in this sector is CO_2, but there are also emissions of other greenhouse gases such as CH_4 and N_2O from imperfect burning of wood left in the field, in case of forest conversion to other uses.

According to the SNC baseline scenario, the LULUCF sector emissions were about 21 $MtCO_2e$ (30% of the total national emissions) in 2010. The emissions were projected to increase to 26 $MtCO_2e$ (32.5% of the total national emissions) in 2015 before reducing gradually to 22 $MtCO_2e$ (15.4% of the total national emissions) by 2030 (Figure 3.3.2 and Table 2.1.1). Loss of forest land alone account for nearly 86% of the projected total forestry sector emissions in 2030. Table 3.3.2 shows a breakdown of the LULUCF baseline emissions between the year 2000 to 2030.

Figure 3.3.2: Forestry Sector Baseline Emission Projection for Kenya (MtCO2e)

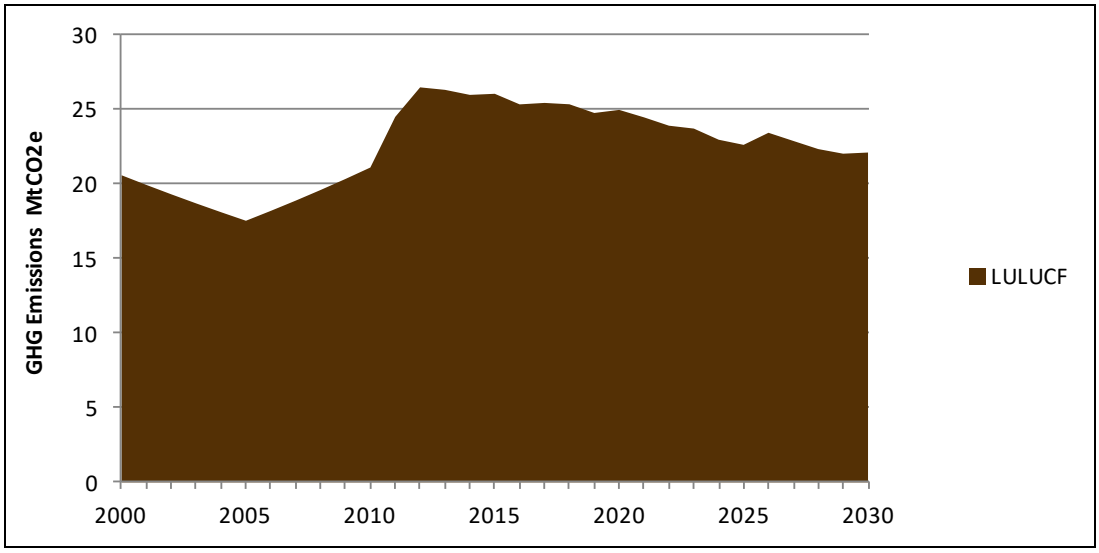


Table 3.3.2: Forestry Sector Baseline Emission Projection for Kenya (MtCO2e)

LULUCF Sector	LULUCF Baseline GHG Net Emissions (MtCO2e)						
	2000	2005	2010	2015	2020	2025	2030
Forest Land	14.1	14.1	19.7	19.7	20.2	17.8	18.9
Cropland	4.6	3.4	4.6	6.0	4.5	4.4	2.9
Grassland	0.3	0.3	0.2	0.3	0.3	0.3	0.3
Wetlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Settlements	0.1	0.0	-0.1	0.0	0.0	0.1	0.0
TOTAL	**19.1**	**17.8**	**24.4**	**26.0**	**24.9**	**22.6**	**22.1**

Source: Government of Kenya (2015), Second National Communications

However, the estimates of the carbon stocks of forest (that is forest land remaining forest land in the LULUCF sector) has the highest uncertainty of emission estimates because of uncertainty in the actual extent of total forest cover, activity data and emissions factors.

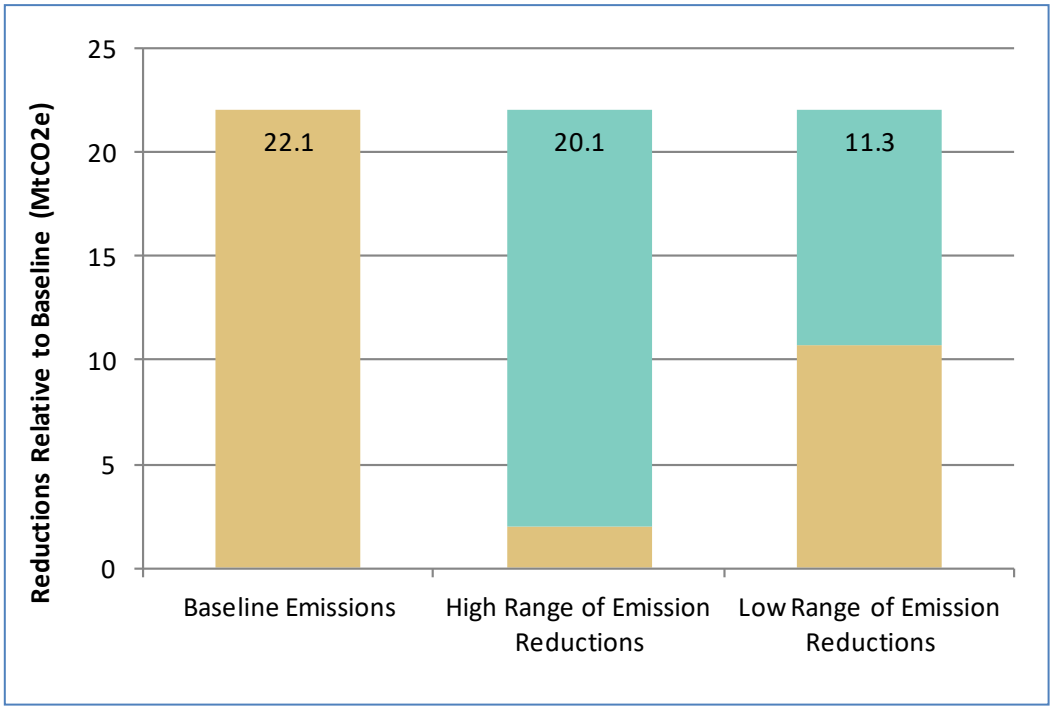
During the NDC Sector Analysis 2017, the biomass literature available as part of the System for Land-Based Emissions Estimation in Kenya (SLEEK) project was reviewed. It was determined that it is likely that total biomass stocks of forests were underestimated in the modelling work conducted for Kenya's Second National Communication (SNC), which is one of the primary data sources for estimating net baseline emissions. However, more modelling and forest inventory data would be required to determine if net baseline emissions are more or less than the baseline LULUCF emissions projected in the SNC and summarised in Figure 3.3.2 below.[87]

NDC Target for the Forestry Sector

The proportionate emission reduction contributions required from the forestry sector to meet the NDC overall target was estimated in Table 2.2.2 (Chapter 2) as 20.1 $MtCO_2e$, against a sector baseline emission level of 22 MtCO2e and a total sector emission reduction potential of 40.2 $MtCO_2e$ per year by 2030.

The NDC Sector Analysis Report 2017 determined a reasonable low (minimum) GHG emission target reduction for the forestry sector as 11.1 $MtCO_2e$ per year and a high target for GHG emission reduction of 20.1 $MtCO_2e$ (Figure 3.3.3).

Figure 3.3.3: Comparison of Baseline GHG Emissions and the NDC Target Emission Reductions (MtCO2e)



Source: Government of Kenya (2017), NDC Sector Analysis Report 2017

Both the low and high targets for the sector are so high (51% and 915 of the total sector emission in 2030) reduction potential of the sector because of the unique position of the forestry sector to create net sinks of carbon when, for example, new forests are planted. It is possible for emission reductions to exceed baseline emissions as identified by the maximum technical potential of 40.2 $MtCO_2e$ in the NCCAP 2013-2017. Emission reductions in the forestry

sector are attractive because of the relatively low cost to create these carbon sinks compared to actions in other sectors.[88]

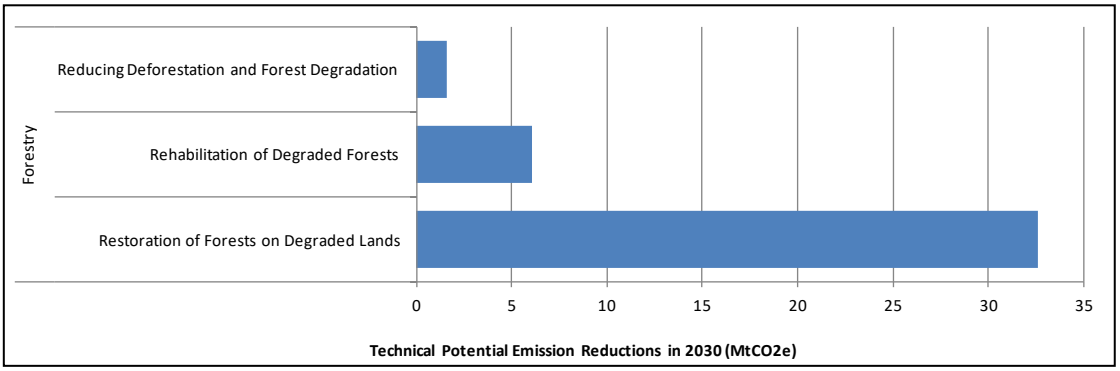
Mitigation Actions Identified in Kenya's Second National Communication and the NDC Sector Analysis (2017)

In both the NCCAP 2013-2017 and the SNC, the following three mitigation actions were analysed and prioritised for implementation:

- Restoration of 960,000 Ha of forests on degraded lands, with an average annual sequestration rate of 33.9 tCO2e per Ha between 2015 and 2030 leading to the abatement of 2.2 $MtCO_2e$ in 2015 and 32.6 $MtCO_2e$ in 2030.
- Reforestation of degraded forests by reforesting 240,000 Ha of degraded forests between 2015 and 2030 at an average annual sequestration rate of 25.2 tCO_2e per Ha. This would lead to 0.4 Mt CO_2e in 2015, rising to 6.1 $MtCO_2e$ in 2030.
- Reducing deforestation and forest degradation on about 63,000 Ha of forest by 2030, which after allowing for leakage and potential increase in agroforestry and plantations, was estimated at 75% of the total sequestered carbon. The average abatement potential was based on the average above ground carbon density of Kenyan forests of 95.4 tCO_2 converted to other land uses based on FAO data.[89] Consequently, about 0.1 $MtCO_2e$ would be abated in 2015, rising to 1.6 $MtCO_2e$ in 2030.

Based on the above three priority mitigation options, the technical mitigation potential of the forestry sector was further assessed in the NDC Sector Analysis Report with the results as illustrated in Figure 3.3.4.

Figure 3.3.4: Technical Potential Emission Reductions (MtCO2e) in 2030 of Mitigation Options (NDC Sector Analysis 2017)



Source: Government of Kenya (2017), NDC Sector Analysis Report 2017

Proposed Mitigation Actions for the NCCAP 2018-2022 in the Forestry Sector

The following three mitigation actions were proposed for the forestry sector for assessment and analysis before prioritisation for inclusion in the NCCAP 2018-2022 period are shown in Table 3.3.3 below. These actions were proposed by forestry sector stakeholders led by the Kenya Forest Service, with further consultations with the Mitigation Thematic Working Group.

- Reduce deforestation and forest degradation by rehabilitation and protection of additional 100,000 Ha of natural forests (including mangroves) by 2022.
- Afforestation/reforestation/agroforestry of additional 100,000 Ha of land by 2022.
- Restoration of 200,000 ha of forest on degraded landscapes (ASALs, rangelands) by 2022.

- Increase area under private sector-based commercial and industrial plantations from 71,000 Ha to at least 121,000 Ha
- Three forest resources efficiently utilised in all counties, especially dryland forests, by 2022

The first three options are the same as those previously assessed and analysed under the NCCAP 2013-2017, SNC and the NDC Sector Analysis. However, the proposed implementation scales vary slightly from those previously considered. The consultations conducted during the NCCAP (2018-2022) process have not been as extensive and detailed as those conducted during the NCCAP (2013-2017) process and the subsequent NDC Sector Analysis (2017). Therefore, for the mitigation analysis of the prioritised actions, the values, information and assumptions made during the two earlier analyses have been applied, the latest being the NDC Sector Analysis Report (2017). Adjustments have been made to compensate for the scale of the proposed actions

Reduce deforestation and forest degradation by rehabilitation and protection of additional 100,000 Ha of natural forests (including mangroves) by 2022

This action is similar to the action 'Reducing Deforestation and Forest Degradation' that was prioritised and analysed in the NDC Sector Analysis 2017. The action is a component of the REDD+ programme and includes measures to reduce emissions from deforestation and forest degradation, relative to a pre-determined reference case or BAU scenario. In the NDC Sector Analysis (2017), it is reported that increasing Kenya's forest cover to 10% would also entail halting and eventually reversing deforestation and forest degradation, such that net forestation would increase.

There is considerable uncertainty in the historic rate of deforestation. 2010 FAO data indicates that the historic deforestation rate between 1990 and 2010 was approximately 12,000 hectares per year.[90] The most recent FAO Global Forest Resources Assessment in 2015 indicates that the deforestation rate of Natural Forests was approximately 26,000 Ha per year over the same 20-year period, but that the total area of Natural Forest has actually increased between 2000 and 2010.

Reducing deforestation and forest degradation on about 100,000 Ha of natural forest by 2030, which after allowing for leakage and potential increase in agroforestry and plantations, was estimated at 75% of the total sequestered carbon. The average abatement potential was based on the average above ground carbon density of Kenyan forests of 95.4 tCO_2 converted to other land uses based on FAO data.[91] Consequently, about 2.0 $MtCO_2e$ would be abated in 2030.

Other actions that contribute to reduction in deforestation and forest degradation such as sustainable charcoal production, efficient biomass cookstoves are discussed under industry sector and energy sector, respectively. Agroforestry is covered under both forestry and agriculture sectors and has also been included in the energy sector to the extent that fuel trees are involved.

Afforestation/reforestation/agroforestry of additional 100,000 Ha of land by 202

This action involves planting trees on lands that have been severely degraded and is the same as the previously planned action; 'Rehabilitation of Degraded Forests'. This includes lands that do not strictly meet the definition of forest because they have fallen below a threshold of tree cover or biomass density. These degraded forests are characterized by significantly diminished tree cover and inhibited natural regeneration. This action also includes planting trees in farmlands through agroforestry practices.

In the NCCAP (2013-2017), it was assumed that 20% of net increase in forest cover would be achieved through rehabilitation. This meant that 240,000 Ha would be replanted over a period of fifteen years, or approximately 16,000 Ha per year between 2015 and 2030. Achievement of the Bonn Challenge target of planting of trees on 410,000 Ha of formerly forested land would exceed the NDC target. The proposed action, targeting replanting of

100,000 Ha of additional land over the 5-year period means, averagely planting 20,000 Ha per year between 2018 and 2022. This target is slightly more ambitious than the previous target. Therefore, if this rate of the next 12 years to 2030, additional 240,000 Ha would be planted over the period

At an average annual sequestration rate of 25.2 tCO_2e per Ha between 2015 and 2030 (15 years),[92] reforestation of degraded forests by reforesting 100,000 Ha of degraded forests between 2015 and 2030. This would lead to 0.8 Mt CO_2e in 2018, rising to 2.0 $MtCO_2e$ in 2030. With 240,000 Ha planted over the 12-year period (2018 to 2030), 4.8 $MtCO_2e$ would be sequestered by 2030.

Restoration of 200,000 ha of forest on degraded landscapes (ASALs, rangelands) by 2022

This action targets degraded lands of all types of land uses, including grazing lands, bushland, woodland and forest, where previously established tree cover has been reduced and degraded by excessive harvesting of wood and non-wood products, poor management, repeated fires, grazing or other disturbances that damage soil and vegetation to a degree that inhibits or severely delays the re-establishment of forests.

The NCCAP (2013-2017) assumed that half of the 10% tree cover is achieved by 2030 through 'Restoration of forests on degraded lands', resulting in the establishment of 1.2 million Ha of forest to be restored over 15 years, an average of 80,000 Ha per year over the period. Consultations with KFS experts determined that 80% of this amount, or approximately 960,000 Ha, could be attained through enhanced natural regeneration of degraded lands through conservation and sustainable management over the period 2015 to 2030, whereas the other 20% could be attained through tree planting. This action had the GHG abatement potential of about 32.6 $MtCO_2e$ per year by 2030.

For the NCCAP (2018-2022) however, it is proposed to restore 200,000 Ha through this action over the next 5 years (2018 to 2022). This is an average of 40,000 Ha per year to be restored over the period. If this rate of restoration is sustained for the next 12 years (2018 to 2030), a total of 480,000 Ha would be restored by 2030. This is significantly less than the 1.2 million Ha that was assumed in previous analyses.

Restoration of 200,000 Ha of forests on degraded lands, with an average annual sequestration rate of 33.9 tCO_2e per Ha between 2015 and 2030,[93] abatement 0.9 $MtCO_2e$ in 2018 and 5.4 $MtCO_2e$ in 2030. If the same rate of restoration (40,000 Ha per) is maintained to 2030 over a 12-year period, 480,000 Ha of forest would be restored. This would result in the abatement of 13.0 tCO2e by 2030.

Other Proposed Actions

The forestry sector had the following two additional actions proposed:

- Increase area under private sector-based commercial and industrial plantations from 71,000 Ha to at least 121,000 Ha
- Three forest resources efficiently utilised in all counties, especially dryland forests, by 2022

The action to increase area under private sector-based commercial and industrial plantations from 71,000 Ha to at least 12,000 would result in additional 50,000 Ha of plantation forest. At an average annual sequestration rate of 25.2 tCO_2e per Ha between 2015 and 2030 (15 years),[94] this would lead to an abatement of about 1.0 $MtCO_2e$ by 2030.

Efficient utilisation of firewood and charcoal have already been accounted for in the energy sector (improved cookstoves) and industry sector (implementation of the NAMA for the Charcoal Sector in Kenya). To avoid double counting, the emission reductions have therefore not been counted here.

Table 3.3.3: Priority Mitigation Actions in the Forestry Sector for the Period 2018-2022

Strategic Objective 3.3.1: To increase tree cover to 10% of the total land cover				
Issue/Problem: Increasing GHG emissions from deforestation and degradation of forest ecosystems and other landscapes				
Opportunity	**Actions**	**Sector**	**Mitigation**	**SDG**
REDD+ Initiative, Community Forest Associations, Participatory Forest Management Plans	Reduce deforestation and forest degradation by rehabilitation and protection of additional 100,000 Ha of natural forests (including mangroves) by 2022 • Community/participatory forestry management • Limiting access to forests • Preventing disturbances through improved enforcement and monitoring • Developing alternative technologies to reduce demand for biomass (e.g., clean cooking and efficient charcoal production) • Carbon stock enhancement (tree planting) in existing forests • Financial innovations including payments through REDD+ / carbon markets	MEF, KFS, KEFRI, CoG, County Governments, Community Forestry Association (CFAs), Private Sector, NGOs	Mitigation	1,7,15,13 6
Afforestation/reforestation/ agroforestry potential in the counties	Support afforestation and reforestation in Counties, with the aim of planting one million trees per County per year. • Institute an annual National Tree Planting Day • Implement the National Mangrove Ecosystem Management Plan. • Revive Green Schools Programme – 10% of school land areas planted with trees • Increase tree nurseries and production and availability of seedlings • Tree planting • Expand and protect mangrove forest cover (for coastal adaptation and blue carbon sequestration) • Promote trees on farms • Forest management and planning • Silviculture interventions sequestration) • Promote trees on farms	MEF-KFS, MAI, KEFRI, CoG, County Governments, Farmers, Community Institutions, Private sector	Mitigation	7,9,12,13 15

	• Forest management and planning • Silviculture interventions			
African Forest Landscape Restoration Initiatives	Restoration of up to 200,000 Ha of forest on degraded landscapes (ASALs, rangelands) • GCF Dryland Resilience Project - Enhanced natural generation of degraded lands through conservation and sustainable management - Ecosystem-based Adaptation through rangeland and forest landscape restoration and sustainable management (sites include rangelands, woodlands/forests, wetlands, and croplands). - Process to initiative restoration processes on 33% of land area in 7 counties. • AFR100 commitment in 2016 to restore 5.1 million Ha - Analysis of priority landscapes, existing restoration successes - Economic analysis of restoration options - Identification of financing options to scale up landscape restoration	MEF-KFS, MAI, NDMA, KEFRI, National Treasury, Frontier Counties Development Council, 7 ASAL County Governments, IUCN, FAO, UNEP, Greenbelt Movement, Community institutions		1,7,8,9
Encourage sustainable timber production on privately-owned land	Increase area under private sector-based commercial and industrial plantations from 71,000 ha to at least 121,000 Ha • Standards and regulations for sustainable forestry management (voluntary moving to regulated)	KEPSA, KAM, Private Sector (Tea Industry, Kenya Commercial Bank, Green Pot Timsales, Rai Ply, Kakuzi, LaFarge, East Africa Breweries)	Mitigation	1,7,8,9
Increase efficiency of use of forest products *Linked to energy efficiency*	Three forest resources efficiently utilised in all counties, especially dryland forests, by 2022 ▪ The three areas of focus are timber, charcoal and firewood *(establish the current number of forest resources, and number of forest resources efficiently utilised [determine the metric])*	MEF-KFS KEFRI CoG County Governments	Mitigation	

improvement (Energy and Industry Sectors)				
Enabling action (capacity development and technology)	MRV technologies, including remote sensing and global positioning systems, computer tagging and tracking systems	MEF-KFS	Enabling	

The mitigation options and their potential are summarised in Table 3.3.4 below.

Table 3.3.4: Emission Reduction Potential of the Prioritised Actions in the Forestry Sector ($MtCO_2e$ per year)

Options	GHG Emission Reduction Potential by 2030 (MtCO2e)	
	Action up to 2022	Action up to 2030
Reduce deforestation and forest degradation by rehabilitation and protection of additional 100,000 Ha of natural forests (including mangroves) by 2022	2	2
Afforestation/reforestation/agroforestry of additional 100,000 Ha of land by 2022	2	4.8
Restoration of 200,000 ha of forest on degraded landscapes (ASALs, rangelands) by 2022	5.4	13
Increase area under private sector-based commercial and industrial plantations from 71,000 Ha to at least 121,000 Ha	1	1
Total Emission Reduction Potential in 2030	**10.4**	**20.8**

From the analysis of the four options, the proposed actions in the forestry sector, if implemented only up to 2022, will not be able to deliver the low range emission reduction target required for the forestry sector. However, if the actions are continued at the same rate up to 2030, the abatement potential meets the high range of the emission reductions target of 20.1 MtCO2e per year in 2030. Because the forestry sector offers one of the cheapest options to achieve the NDC target, it is advisable that the targeted areas for all the actions be reviewed with a view to setting more ambitious targets. This way, the Government will be able to meet the NDC mitigation target even if other sectors, like agriculture are not able to meet their sectoral targets.

3.3.3 Enablers

Technology

The required mitigation technologies and initiatives for the forestry sector are summarised in Table 3.3.3 below.

Table 3.3.3: Key Mitigation Technologies and Initiatives in the LULUCF Sector

Mitigation Option	Key Technologies Required
Restoration of forests on degraded lands	Community forestry programmes, research into degraded lands and appropriate conservation techniques, forest management and planning, protection and conservation programmes
Rehabilitation of degraded forests	Tree nurseries and production of tree seedlings, tree planting, tree genetics, forest management and planning, silvicultural interventions
Reducing deforestation and forest degradation	Technologies for community monitoring, forest management tools, development of alternatives to reduce demand for fuel wood, financial innovations including payments through carbon markets

Enabling actions	MRV technologies, including remote sensing and global positioning systems, computer tagging and tracking systems)

The details of the technologies were provided in the NDC Sector Analysis Report 2017.

Actions to ensure effective restoration of forests on existing degraded lands in Kenya will accelerate natural processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and reducing disturbance, such as grazing, wood harvesting and fire. Actions include protection and conservation actions including limiting or prohibiting access to forests; community management programmes; and preventing disturbances through enforcement and monitoring. Forest restoration and sustainable enhancement of forest carbon stocks through sustainable forest management or conservation could fall within the "plus" scope of REDD+ and be part of the government's REDD+ strategy.

Rehabilitation of degraded forests involves planting seedlings over an area of land where the forest has been harvested or damaged by fire, disease or human activity. Tree planting, if performed properly, can result in the successful regeneration of a deforested area. Plantations established through afforestation or reforestation can effectively sequester carbon. Agroforestry or initiatives to plant trees on farms are considered in the NDC agriculture analysis (Chapter 3). Clean Development Mechanism (CDM) projects under the "Afforestation and Reforestation" category were restricted to include actions to replant trees commercial or indigenous tree species on areas of land that had no forest cover since 1990.

Capacity Building

To improve the data quality and monitoring capacity in the sector, it will be necessary to train the staff in order to improve their ability to measure, report on and verify (MRV) the actions and achievements of forestry projects. This includes improving the knowledge and understanding of carbon biomass stocks in Kenya.

Finance and Budgets

USD 5.65 million for implementation of the National Mangrove Ecosystem Management Plan[95]

Restoration of forests on degraded lands USD 2.2 - 3.4 billion over the period 2017 to 2030. (0.8-1.3 billion USD by 2022 (NCCAP)

Reforestation of degraded forests (USD 0.56 - 0.71 billion) to 2030. (0.2-0.27 billion USD by 2022)

3.4: Industry Sector

3.4.1 Overview

Kenya's primary industrial sector comprises the manufacturing, construction, mining and quarrying as the key sub-sectors, among others. Although Kenya is the most industrially developed country in the East Africa region, manufacturing still accounted for only 14% of gross domestic product (GDP) in 2017.[96] The industrial sector is critical to achieving the Vision 2030 goal of transforming Kenya into "a newly-industrializing, middle-income country providing a high quality of life by 2030."[97] Kenya's Industrial Transformation Programme aims to revitalise the sector and turn Kenya into an industrial hub.[98] Industrialisation has been the modernising force in every developed and emerging economy and this is likely to be the case for Kenya, with industry acting as the bedrock upon which the country will grow GDP, while growing incomes. The development of renewable energy technologies represents a major opportunity for "Growth of green industry in manufacturing" in Kenya. This can be a major sector of industrial growth in Kenya if it can position itself to be a regional technology hub, whilst in the same regard it can also be a significant missed opportunity if not pursued.

The country has economically viable quantities of coal, iron ore, fluorspar, titanium, gypsum, limestone, soapstone, gemstones, soda ash, diatomite, lead, gold, silicon oxide and marble. Recent discoveries of oil, gas and rare earth minerals suggest that these will be potentially important resources for Kenya going forward. There has been little exploitation of these resources, and development of the mining and quarrying sector is expected to support resource-based industries such as iron and steel, cement, building and construction, chemical and ornamental industries, among others. The oil, coal and other mineral resources sub-sectors have been identified as additional priority sub-sectors under the Economic Pillar of Vision 2030. Development and decisions in the sub-sectors are expected to impact future industrial sector GHG emission profile.

The industrial sector GHG emissions include both process-related emissions involving chemical and/or physical change of inputs, and production and use of hydrofluorocarbons. The sub-sectors of importance, regarding greenhouse gas emissions in Kenya, include mineral products, pulp and paper, food and beverage and consumption of HFCs. Other industrial processes sub-sectors such as chemical industry and metal production were determined to have no significant production activities leading to greenhouse gas emissions.[99] Direct greenhouse gas emissions of Carbon Dioxide are a result of cement production, lime production and soda ash production. HFC emissions are related to the import of HFCs into Kenya through products and bulk imports.

The manufacture of cement, the leading emitter of greenhouses in the industrial sector in Kenya[100], is identified as a core industrial sub-sector, with a growing demand for cement from within Kenya and from neighbouring countries.

Another major emitter in the industry sector is the charcoal manufacturing sub-sector, which still operates informally despite its key role in Kenya's energy sector. Charcoal manufacturing is an important part of the Kenyan economy, but the wood-fuel sector is systematically neglected in formal economic analyses due to its informal nature.

Kenya's industrial sector (excluding direct fuel combustion) contributed 3.8 % (3 $MtCO_2e$ per year) of total national GHG emissions (80 $MtCO_2e$ per year) in 2015.[101] These emissions are projected to increase to 4.2% (6 $MtCO_2e$ per year) by 2030.[102] This is because of the significantly larger contributions by land use, land-use change and forestry (LULUCF), energy and agriculture sectors, as well as the fact that Kenya produces insignificant amounts of industrial gases, such as perfluorocarbons and hydrofluorocarbons, that have high global warming potentials (5,000 to 10,000 times the global warming potential of CO_2). With direct fuel combustion emissions included, the absolute emissions from Kenya's industry sector are projected to grow from 5.4 $MtCO_2e$ in 2015 to 9.9 $MtCO_2e$ in 2030, with their proportion to the total national emissions remaining constant around 7% through the period.[103]

In the NDC Sector Analysis 2017, the following three mitigation actions were prioritised.

- Improved charcoal production, with a mitigation potential of about 1.6 $MtCO_2e$ per year by 2030
- Cement energy efficiency improvement, with a mitigation potential of about 0.2 $MtCO_2e$ per year by 2030
- Industrial energy efficiency improvement, with a mitigation potential of about 1.1 MtCO2e per year by 2030

In this MTAR, the three mitigation options have been reassessed and analysed together with the other options that were presented by the industry sector representatives. The analysis has prioritised the following mitigation actions for implementation in the NCCAP 2018-222:

- Implementation of the Nationally Appropriate Mitigation Action (NAMA) for the Charcoal Sector in Kenya, with a mitigation potential of 5 $MtCO_2e$ per year by 2030.
- Industrial energy efficiency improvement, with a mitigation potential of about 1.1 MtCO2e per year by 2030.

Implementation of cement energy efficiency improvement, a mitigation potential of about 0.2 MtCO2e per year by 2030, has been considered unrealistic with insignificant mitigation result while the industrial symbiosis action has been proposed for inclusion in the Solid Waste NAMA, which is already prioritised for implementation in the NCCAP 2018-2022 in the waste sector.

Although industrial energy efficiency improvement and cement energy efficiency improvement have been included in this section as potential mitigation actions, the mitigation benefits should not be counted as additional since these have been accounted for in the energy sector actions. Their inclusion here is purely to create visibility of these options for the manufacturing sub-sector whose members are expected to lead their implementation.

3.4.2 Mitigation Actions in the Industry Sector

The emissions baseline for the industrial processes sector is aligned with the sector definitions of the Intergovernmental Panel on Climate Change (IPCC) for Industrial Processes and Product Use (IPPU). These definitions cover GHG emissions occurring from industrial processes from the use of GHGs in products and from non-energy use of fossil fuel carbon. One exception to this alignment is that charcoal production from the partial combustion of fuelwood is included as an industrial process, while in the IPCC Guidelines it is included in the energy sector along with charcoal consumption.

With the envisaged accelerated industrialization,[104] GHG emissions are expected to increase under the BAU scenario unless Kenya makes deliberate efforts and plans to identify and take the low carbon development pathway in its industrialization programme.

The manufacture of cement, the leading emitter of greenhouses in the industrial sector in Kenya[105], is identified as a core industrial sub-sector, with a growing demand for cement from within Kenya and from neighbouring countries. There are two aspects of cement production that result in emissions of GHG emissions in form of Carbon Dioxide. The first is the chemical reaction involved in the production of the main component of cement, clinker, as carbonates (largely limestone) are decomposed into oxides (largely lime) and Carbon Dioxide by the addition of heat. The second source of emissions is the combustion of fossil fuels to generate the significant energy required to heat the raw ingredients to well over $1,000^0C$. Some of the cement manufacturers in Kenya have been using coal to fire their kilns as a way of managing the escalating fuel costs, a practice which increases GHG emissions from the sector. Process emissions from cement manufacturing can be reduced by replacing clinker in the cement mix with alternative materials such as Pozzolana.

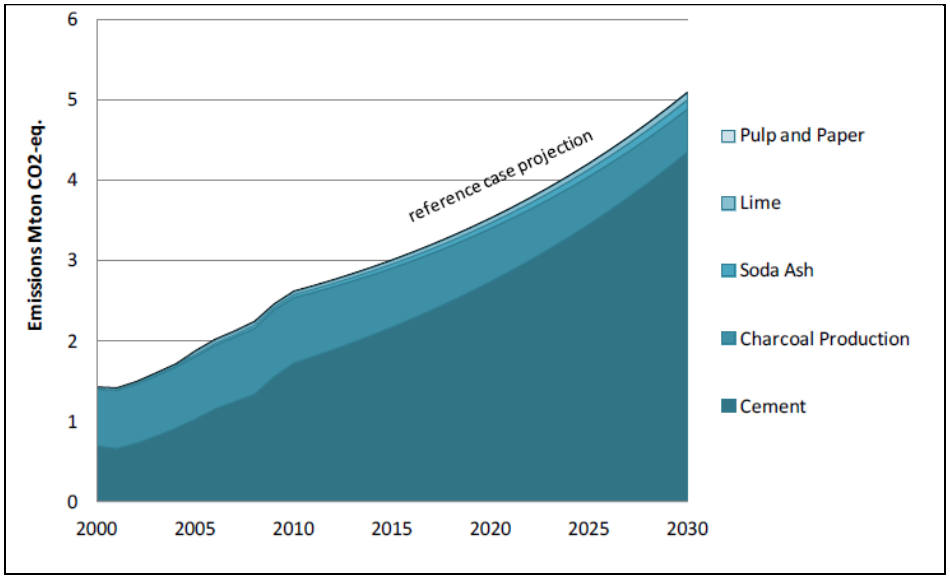
These process or industry and energy emissions are most often reported separately in GHG emissions inventories, with the combustion emissions going to the energy sector. However, in the NDC Sector Analysis 2017, the energy emissions were included in the industry sector emissions basically because the expected mitigation actions would be implemented mostly by the cement manufacturers.

Another major emitter in the industry sector is the charcoal manufacturing sub-sector, which still operates informally using mainly traditional inefficient technologies. Current legislation in Kenya has legalised sustainable charcoal production, and efforts are underway by the government to implement this legislation.[106] Although charcoal manufacturing is an important part of the Kenyan economy, the wood-fuel sector is systematically neglected in formal economic analyses due to its informal nature. Emissions in the charcoal sub-sector can be reduced by using sustainably sourced biomass feedstock, improved kilns and efficient cookstoves, an approach which is the basis of the Nationally Appropriate Mitigation Action (NAMA) for the Charcoal Sector in Kenya.

Baseline

According to the NCCAP 2013-2017 and the SNC where only the industrial processes were considered under the industry sector emissions charcoal production biomass feedstock was assumed to be 100% renewable, the industry sector emissions in the BAU scenario were projected to double from 3 $MtCO_2e$ (3.8% of the total national GHG emissions) in 2015 to 5.5 $MtCO_2e$ (3.8% of the total national GHG emissions) in 2030 (Figure 3.4.1 and Table 2.1.1). Cement manufacture was identified as the largest industrial process that contributes nearly 80% industry sector emissions between 2010 and 2030.

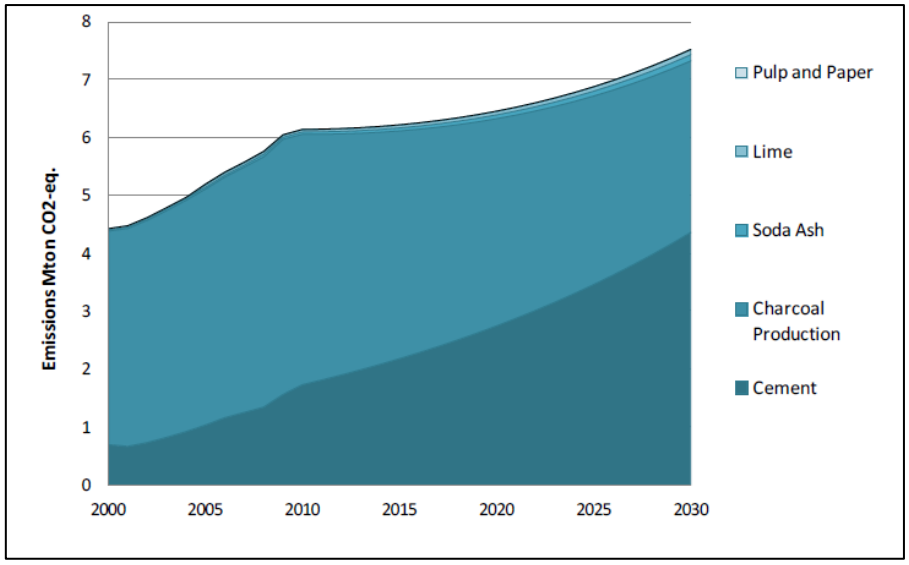
Figure 3.4.1: Industry Sector Baseline Emission Projection for Kenya (MtCO2e)



Source: Source: Government of Kenya (2013), National Climate Change Action Plan

If carbon emissions from the use of unsustainably harvested biomass (assumed to be 35% of total biomass usage) were considered, emissions from charcoal production would be substantially larger as shown in Figure 3.4.2. These emissions are usually accounted for in the forestry and land use land use change (LULUCF) sector. However, in this MTAR, the emissions have been discussed under industry sector to facilitate the assessment of the option to implement the Nationally Appropriate Mitigation Action (NAMA) for the Charcoal Sector in Kenya.

Figure 3.4.2: Industry Sector Baseline Emission Projection for Kenya Including 35% Non-Renewable Biomass for Carbon Production (MtCO2e)

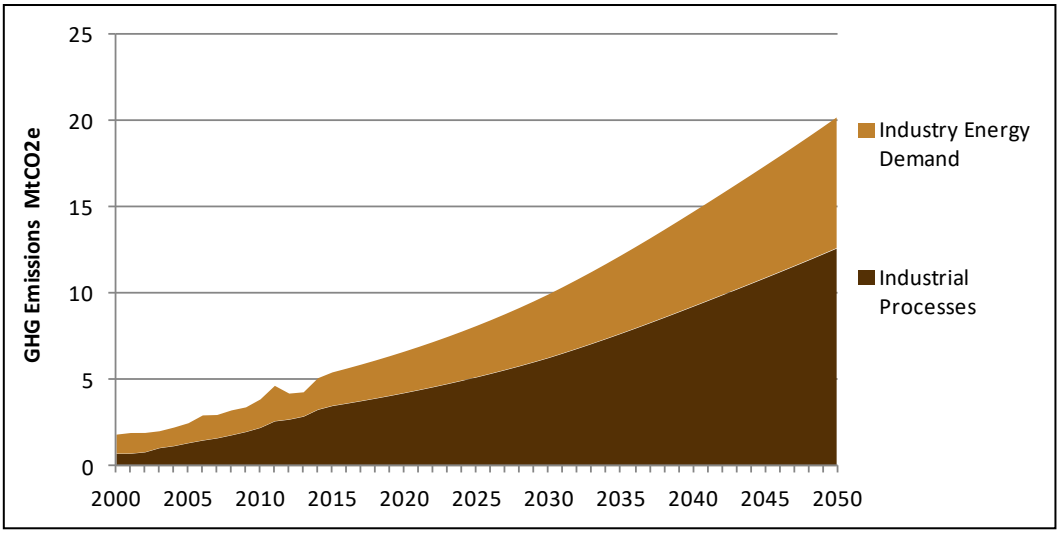


Source: Source: Government of Kenya (2013), National Climate Change Action Plan

In the BAU scenario of the NCCAP and SNC, it was assumed that all the charcoal was produced using traditional earth mound kilns which generally have a low efficiency of 10-22%. Charcoal production emits Carbon Dioxide (CO_2) and methane (CH_4) from incomplete combustion of biomass. More efficient carbonization technologies or kilns reuse these gasses in the carbonization process hence have lower emissions.

In the NDC Sector Analysis Report of 2017, the baseline industry sector GHG emissions, including emissions from energy used by the industry sector, were estimated at 5.4 $MtCO_2e$ (6.8% of the total national GHG emissions) in 2015. This was projected to increase to 9.9 $MtCO_2e$ (6.9% of the total national GHG emissions) by 2030 (Figure 3.4.3 below). In the analysis, the fuel combustion emissions associated with the industry sector, which is already accounted for in the energy sector were included because implementation of the mitigation options would focus on the manufacturing sector.

Figure 3.4.3: Industry Sector Baseline Emission Projection for Kenya Including Fuel Combustion Emissions (MtCO2e)



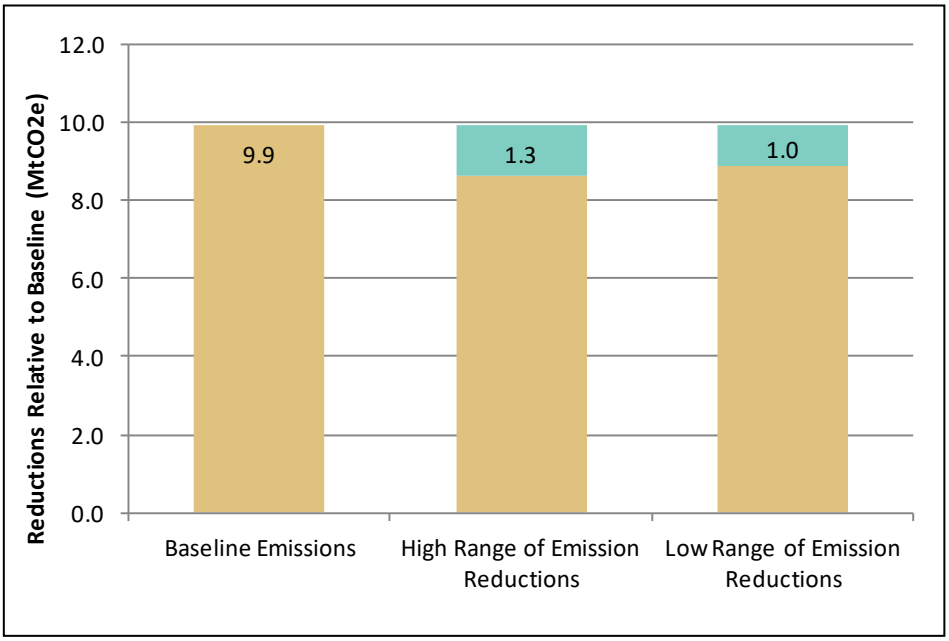
Source: Government of Kenya (2017), NDC Sector Analysis Report 2017

NDC Target for the Waste Sector

The proportionate emission reduction contributions required from the industry sector to meet the NDC overall target was estimated in Table 2.2.2 (Chapter 2) as 0.78 $MtCO_2e$, against a sector baseline emission level of 5.5 MtCO2e and an emission reduction potential of 1.6 $MtCO_2e$ per year by 2030. This did not include industry sector fuel combustion emissions which were included in the energy sector emissions.

In the NDC Sector Analysis Report of 2017, and with the fuel combustion emissions included, the total baseline emissions were estimated as 9.9 $MtCO_2e$ per year by 2030. The NDC Sector Analysis Report 2017 determined a low (minimum) GHG emission target reduction for the industry sector as 1.0 $MtCO_2e$ per year and a high target for GHG emission reduction of 1.3 $MtCO_2e$ (Figure 3.4.4).

Figure 3.4.4: Comparison of Baseline GHG Emissions (Including Industry Sector Energy Emissions) and the NDC Target Emission Reductions ($MtCO_2e$)



Source: Government of Kenya (2017), NDC Sector Analysis Report 2017

In the mitigation analysis in this MTAR, it has been considered more effective and practical to consider the implementation of a mitigation option that covers the whole charcoal supply chain from biomass feedstock production, kiln efficiency improvement and adoption of efficient cookstoves.

It is however very important that the emissions reporting is aligned with the sector definitions of the Intergovernmental Panel on Climate Change (IPCC) for the six sectors for inventory reporting.

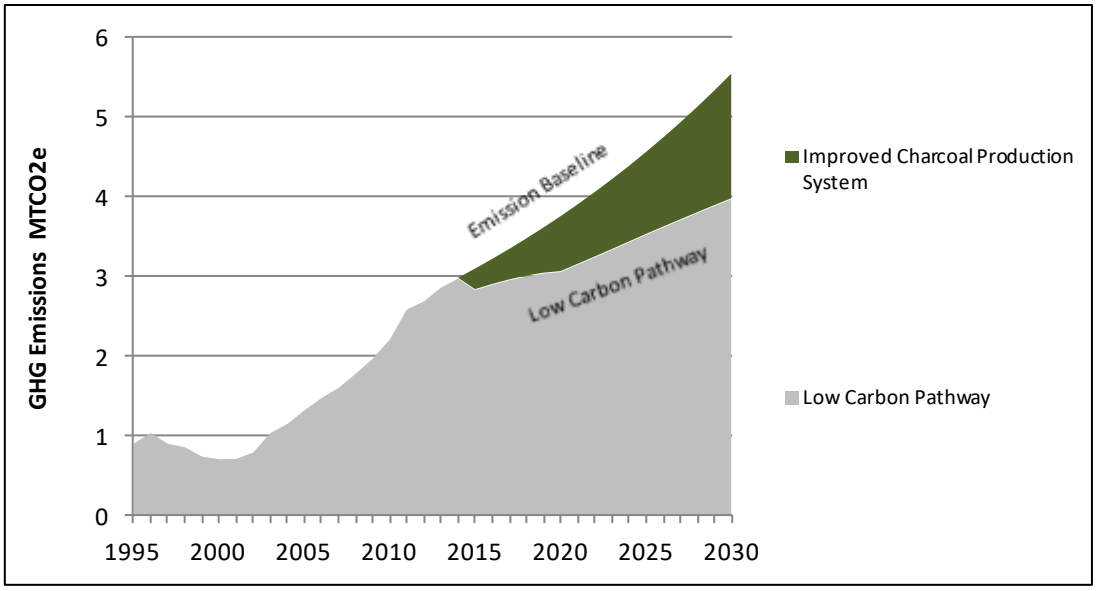
Mitigation Actions Identified in Kenya's Second National Communication

In the NCCAP 2013-2017 and the SNC, only one mitigation action, improved charcoal production with the mitigation potential of 1.56 $MtCO_2e$ by 2030, was proposed and analysed for the industry sector (Figure 3.4.5).

This action was based on the introduction of more efficient kilns for charcoal production, assuming that the BAU emissions can be reduced by 75% through the use of more efficient charcoal kilns (50% adoption by 2030) compared to the traditional earth mound charcoal kilns. This would be mostly through policy interventions promoting the use of efficient kilns. The improved charcoal production mitigation option considers a shift from the use of traditional earth mound kilns, which generally have an efficiency of 10% to 22% (calculated using oven-dry wood with zero percent water content) to an increased use of improved charcoal production systems (ICPS) using retort kilns with an efficiency of approximately 30% to 42%.[107]

This mitigation opportunity still exists and was the basis of the Nationally Appropriate Mitigation Actions (NAMA) for the Charcoal Sector in Kenya Proposal that was developed in 2016 but with a wider scope.

Figure 3.4.5: NCCAP 2013-2017 Mitigation Options and their Technical Potential Emission Reductions in 2030

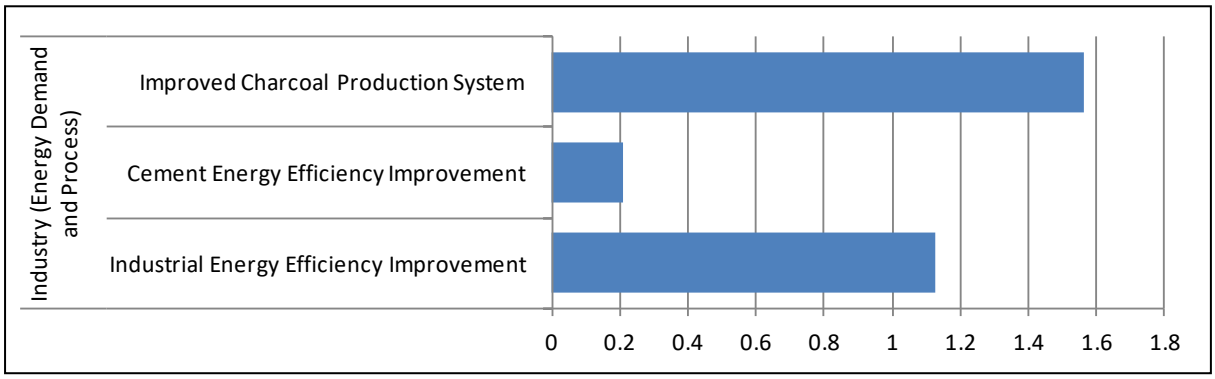


	Emission Reductions (MtCO2e)			
	2015	2020	2025	2030
Improved Charcoal Production System	0.26	0.69	1.03	1.56

Source: Government of Kenya (2017), SNC

The NDC Analysis Report 2017, on the other hand analysed mitigation options addressing two types of GHG emissions. The first type being industrial process-related emissions and the other type being industry sector energy-related emissions. In Kenya, the industrial process emissions are dominated by charcoal and cement manufacturing but no mitigation options exist in the cement manufacturing process as all the existing and new plants would already be optimised with respect to Pozzolana blending.[108] However, significant mitigation opportunities, estimated at 1.56 MtCO2e by 2030, exist with respect to charcoal production-related emissions (Figure 3.4.6).

Figure 3.4.6: Estimated Technical Potential Emission Reductions in 2030



Source: Government of Kenya (2017), NDC Sector Analysis Report 2017

Energy efficiency improvements cover mitigation actions that improve industrial energy efficiency (fuel-combustion and electrical energy). In the NDC Sector Analysis Report 2017, the energy efficiency improvement actions for the cement sector were separately analysed from the rest of industry sector. In the cement industry, which is the highest emitting industry in Kenya, about 40% of emissions are direct energy-related emissions from fossil fuel combustion for calcination and 5 to 10% are indirect energy-related emissions from electricity consumption used to power machinery.[109] A 10% improvement in total energy efficiency through equipment improvements in the cement sub-sector by 2030 was assumed in the analysis.

In view of the recent trend in the Kenyan cement sector showing that coal is the preferred fuel substitute and considering that Kenya is expected to mine its own coal soon, emission reductions through efficiency improvements relative to the baseline does not look realistic for the cement sub-sector. While it is recognised, is recognised that some effort will be made by the cement sector to improve energy efficiency, the related emission reductions are insignificant and this action has not been analysed further for prioritisation in the NCCAP 2018-2022.

On the other hand, the industrial energy efficiency mitigation option, which assumed a 15% energy efficiency improvement by 2030, is realistic and feasible. The industrial and commercial sector in Kenya is dominated by small and medium enterprises, which use a wide range of equipment and appliances with varying degrees of mitigation options. The upfront costs are often a barrier to adoption of the energy efficient technologies.

In the following section, both process-related emissions for charcoal production and energy related-emissions for the industry have been analysed and prioritised for inclusion in the NCCAP 2018-2022. However, it should be noted that while implementation of these two options would be in the industry sector, the emission reductions associated with industrial energy efficiency improvements would be accounted for in the energy sector, while those associated with the use of renewable biomass for charcoal production would be accounted for in the LULUCF sector in order to avoid double counting.

Proposed Mitigation Actions for the NCCAP 2018-2022 in the Industry Sector

The mitigation actions proposed in the industry sector for the 2018-2022 period are shown in Table 3.4.1 below. These actions were proposed by industry sector stakeholders led by the Kenya Association of Manufacturers. The actions that address energy efficiency improvement

The following low carbon development options have been analysed for prioritisation in the NCCAP 2018-2022. The options are broadly of the following types:

- Actions that address industrial process-related emissions
  - Nationally Appropriate Mitigation Actions (NAMA) for the Charcoal Sector in Kenya
  - Optimised cement production to reduce GHG emissions from clinker production
- Actions that address energy used in the industry sector and waste generated from the sector
  - Improving industrial efficiency through energy audits and energy standards
  - Improved waste recycling and re-use through industrial symbiosis
  - Use of sustainable energy resources for industrial heating.
- Industrial symbiosis.
  - Set up waste exchange clearance centres in all Special Economic Zone (SEZ) by 2022 (This action should be made part of the implementation of the Solid Waste NAMA in the Waste Sector)
  - Undertake a baseline survey of all SEZs and Industrial Parks (IPs) by 2022
  - Set up a Waste and Bye-product Exchange database for match making.
  - Set up common waste management facilities for all SEZ (effluent Treatment Plants) by 2022.
  - Establish infrastructure for waste recovery, reuse and recycling to create 20,000 decent green jobs by 2022 (5% of jobs created under four sectors: leather, textiles and apparel, fish and agro-processing)

These options are analysed in detail below.

Table 3.4.1: Priority Mitigation Actions in the Industry Sector for the Period 2018-2022

Strategic Objective 3.4: Promote/encourage the growth of green industry to drive jobs in the manufacturing sector				
Issue/Problem: Inefficient use of resources				
Opportunity	**Actions**	**Sector**	**Mitigation**	**SDG**
Energy efficiency	• Increase the number of companies participating in energy efficiency initiatives by1,000 and increase the number of energy audits by 1,000 by 2022: • Develop Minimum Energy Performance Standards (MEPS) for 5 more appliances, and upscale the existing testing facilities to include these 5 appliances	Ministry of Industry, Trade and Cooperatives (MITC), KIRDI, Kenya Bureau of Standards (KEBS), KAM, KIRDI, Private Sector (Industrialists)	Mitigation and Enabler	9,12,13
Industrial symbiosis.	• Set up waste exchange clearance centres in all Special Economic Zone (SEZ) by 2022 (This action should be made part of the implementation of the Solid Waste NAMA in the Waste Sector) – Undertake a baseline survey of all SEZs and Industrial Parks (IPs) by 2022 – Set up a Waste and Bye-product Exchange database for match making. • Set up common waste management facilities for all SEZ (effluent Treatment Plants) by 2022. • Establish infrastructure for waste recovery, reuse and recycling to create 20,000 decent green jobs by 2022 (5% of jobs created under four sectors: leather, textiles and apparel, fish and agro-processing)	MITC, KIRDI, KAM, KIRDI, Private Sector (Industrialists), KEPSA, County Governments	mitigation	9,12,13,17
Industrial process improvements and optimization	• Implement the NAMA for the Charcoal Sector in Kenya. (Linked to the forestry sector mitigation actions) • Introduce process improvements and energy efficiency in the cement sector (Energy efficiency already covered in the energy sector) • Increase number of entities adopting environmentally sound technologies by 50% by 2022 • Promote sustainable energy sources for industrial heating processes (Under energy sector)	KFS, MITC, KEBS, KIRDI, KAM, KEPSA, Farmers, KEFRI, Charcoal producers, Cement manufacturers, County Governments, Police, MEF, Private Sector	Mitigation	9,13,17,
Eco- innovation for productivity and competitiveness	• Strengthen academia- industry- government- civil society (quadruple helix) collaboration to boost research and innovation for productivity and competitiveness and attract funding opportunities.	MITC, KIRDI, KAM, KEPSA, Private sector, Academia, Civil society	Capacity building	9,12,13,17

Actions that Address Industrial Process-Related Emissions

Implementation of the NAMA for the Charcoal Sector in Kenya

The aim of developing a NAMA for Charcoal Sector in Kenya was to trigger a low-carbon development, to minimize the impact of the current charcoal value chain, while acting on causes of deforestation and improve the energy independence of the country. Charcoal production results in Carbon Dioxide and Methane emissions from incomplete combustion of biomass and also from using non-renewable biomass to produce charcoal. Although the NAMA is at the national level, it requires a very strong involvement of the County governments, and forestry. This is particularly important because in Kenya, charcoal management is a devolved function and implementation of the NAMA will have important impacts at the county or local level. The NAMA estimates that 40% of the forestry BAU emissions (7.6 $MtCO_2e$) in 2010 were due to charcoal production.[110]

Biomass is the main source of cooking energy for households in Kenya, and a major energy source for the whole country. In 2013, 72% of the country's total primary energy supply came from bioenergy and waste.[111] According to the Kenya Forest Service (KFS), a large share of the biomass used is in the form of charcoal, which provides 70% of household energy in urban areas, and 30% in rural areas. With rapid population growth and urbanization, charcoal use is likely to remain high for decades to come. The charcoal sector employs nearly 1 million people in production and trade and has been estimated to contribute USD1.6 billion per year (same as the national tea industry) to Kenya's economy.[112] The charcoal sub-sector operates informally and is at present outside of the fiscal system of Kenya. Often considered as an industry of the poor, one of the challenges that exists with regards to introducing new technologies into the sector is the need for these to be both affordable as well as offering optimal recovery of the wood fuel that is used.

In Kenya, the annual demand for wood is estimated at 41.7 million cubic metres (m^3), including 18.7 million m^3 for fuel wood and 16.3 million m^3 for charcoal, but the amount that can be harvested sustainably is estimated at just 31.4 million m^3.[113] That means that every year, Kenya is losing 10.3 million m^3 of wood from its forests, a serious environmental concern.

While charcoal production now occurs almost entirely in the informal sector, it has great potential to be transformed through effective regulation, to become environmentally sustainable and contribute to low carbon development in Kenya. Previously, Kenya tried to ban charcoal production in order to protect forests but given that both charcoal production and sale are mostly informal, those efforts have not been successful. With the Forests (Charcoal) Regulations 2009, known as the "Charcoal Rules", Kenya set out to try a different approach, adopting policies and regulatory frameworks to formalize the charcoal sector by requiring that, in order to obtain a license, producers organize themselves in Charcoal Producer Associations (CPAs). As of 2013, there were about 150 CPAs across Kenya. The CPAs would be responsible for sourcing wood sustainably and ensuring that their members harvest the right species, use the right carbonization technologies, and sell from central collection points. They are also expected to facilitate charcoal deliveries and negotiate better prices, given that, even with the CPAs in place, nationally, an estimated 78% of profits goes to transporters and retailers, and only 22% to producers.

Most county governments have yet to adopt charcoal legislation, even though they have a key role to play in implementing national policies under Kenya's new devolved government system. Access to finance remains a major challenge for CPAs, and producers need significantly more capacity-building.

Implementing the NAMA on charcoal

In an effort to support the charcoal value chain and address most of the charcoal subsector challenges, the GoK, with UNDP support, commissioned the development of a National Appropriate Mitigation Action (NAMA) for Kenya's charcoal sector. Kenya's NAMA for the charcoal value chain, has the following three main objectives:[114]

- **Achieving a sustainable supply of biomass:** Two options are being considered: one relies on community-based forest management, and the other uses private-sector-based forest management. There would also be activities to raise awareness of sustainability issues, of the government's goals, and of different stakeholders' roles in achieving those goals. This is to be achieved by working with the county governments, the KFS, KEFRI and universities.
  According to the NAMA Proposal, the NAMA is expected to reduce the emissions from deforestation linked to charcoal production by up to 75% (3.9 $MtCO_2eq$) per year by 2030.
- **Implementing efficient charcoal production technologies:** This intervention would disseminate efficient charcoal production technologies to all commercial producers in Kenya through the CPAs, with a goal of ensuring that 90% of largescale charcoal production is done using efficient technologies.
  The emission reduction target for this intervention is to reduce the BAU emissions by 90% (1.08 $MtCO_2eq$) per year by 2030.
- **Establishing a charcoal certification and labelling scheme:** This intervention would develop a simple but robust nationwide certification and labelling scheme for all of the charcoal sourced from local biomass and producers. The assumption is that charcoal consumers would be able to easily identify and purchase only sustainably sourced and efficiently produced charcoal. The proposed activities include certifying biomass and charcoal production (carbonization and briquetting).

The NAMA when fully implementation therefore has the potential to reduce emissions by a total of 5 $MtCO_2e$ per year by 2030. However, because the sustainable biomass component has already been accounted for in both the forestry and agriculture sectors, on the 1 MtCO2e reduction potential of the component on implementing efficient charcoal production technologies has been accounted for under the industry sector.

Introduce Process Improvements and Energy Efficiency in The Cement Sector

The sources of GHG emissions are very different for the cement and charcoal manufacturing sectors. Process emissions from the cement sector are due to calcination, whereby limestone releases CO_2 as it is heated in the kiln and transformed into clinker.

A reduction of process and energy emissions from cement is feasible by replacing a certain amount of clinker with slag or Pozzolana (the latter being volcanic ash that is abundantly available in Kenya), which reduces the generation of CO_2 from the heating of limestone to produce clinker. However, this is not considered a low-carbon option because existing cement plants are either using the maximum allowable level of Pozzolana in the blended cement or are at advanced stages of implementing such blending projects because they are financially very attractive. New cement plants are designed for maximum Pozzolana blending.

While energy efficiency improvement actions are expected in the cement sector and are estimated to have the potential of reducing emissions by about 0.2 $MtCO_2e$ per year by 2030 with ambitious assumptions,[115] the mitigation results are unlikely because the cement manufactures have been shifting to coal to reduce costs and also Kenya is expected to start mining its own coal, a significant proportion of which will be used by the cement sector. This action has therefore not been prioritised for the NCCAP 2018-2022.

Industrial Energy Efficiency

As already discussed above under section 'Mitigation Actions Identified in Kenya's Second National Communication', this option assumed a 15% energy efficiency improved by 2030. Industrial efficiency improvements reduce cost and enhance competitiveness and profitability while promoting a clean and healthy environment. There are already institutions in the country offering energy efficiency support services, including professional technical services for developing, designing and implementing energy efficiency projects to suit the needs of commercial, institutional and industrial consumers. This is therefore a feasible and realistic mitigation option.

Results from energy audits undertaken in different commercial and industrial facilities in Kenya indicate potential for measures like the use of more efficient pumps and motors. With payback times of less than two years, savings in electricity consumption of between 8% (for a tourist resort) and 26% (for a tea factory) could be achieved.[116] Fuel efficiency improvements of more than 9% could be achieved for a boiler in a tea factory through an adjustment of the oxygen for combustion, a measure with a payback time of about half a year. If longer payback times of up to five years would be acceptable, the level of energy savings would be significantly higher. From the NDC Sector Analysis Report 2017, the mitigation potential of this action is 1.1 $MtCO_2e$ by 2030.

Industrial Symbiosis.

Industrial symbiosis involves setting up of waste exchange clearance centres in all Special Economic Zone (SEZ) by 2022. The action aims to improve recycling and re-use with an ultimate objective of reducing industrial waste while improving utilisation efficiency of inputs. A baseline survey of all SEZs and Industrial Parks (IPs) to determine the extent and potential for industrial symbiosis is yet to be undertaken and there is not enough information to estimate the mitigation potential of this action.

The action also proposes to set up:

- A waste and bye-product exchange database for match making
- Common waste management facilities for all SEZ (effluent treatment Plants) by 2022.
- Infrastructure for waste recovery, reuse and recycling to create 20,000 decent green in the leather, textiles and apparel, fish and agro-processing sub-sectors.

While the action has some mitigation potential, depending on the nature and amount of the waste involved, it is proposed that this action be included and implemented as part of the Solid Waste NAMA, which is one of the mitigation actions proposed for the waste sector with an emission reduction potential of 0.79 MtCO2e per year by 2030. This NAMA is based on Circular Economy Solid Waste Management Approach for Urban Areas and is well aligned with the industrial symbiosis approach.

Table 3.4.2 is a summary of the emission reduction potential of the only prioritised mitigation action in the industry sector.

Table 3.4.2: Emission Reduction Projection from Industry Sector Actions ($MtCO_2e$)

Option	Emission Reduction Potential-2018 to 2030 ($MtCO_2e$)	
	2022	2030
Implementing the NAMA on charcoal	0.45	1.08
Total	**0.45**	**1.08**

Even with partial implementation of the NAMA for the Charcoal Sector in Kenya (5 MtCO2e per year by 2030) alone, the sectors high range of emission reductions (1.3 $MtCO_2e$ per year by 2030) can be easily surpassed without the fuel combustion related emission reduction activities which would be accounted for in the energy sector.

3.2. 4 Enablers

Technology

The NAMA for Charcoal Sector in Kenya requires the adoption of technologies in the whole charcoal value chain from establishing sustainable forest, improved charcoal kilns and more efficient charcoal-burning technologies.

Industrial energy efficiency improvement will need technology transfer including acquisition of efficient equipment such as motors, pumps, boilers with efficient air flow control systems, burners, air pre-heaters, waste heat recycling facilities, and other energy management and control systems.,

Table 3.4.3 is a summary of the key technologies required for the priority mitigation actions in the sector.

Table 3.4.3: Key Mitigation Technologies and Initiatives in the Industrial Sector

Mitigation Option	Key Technologies Required
Improved Charcoal Production Systems	Metal kiln or drum kiln charcoal production technologies, regulations to control illegally produced charcoal.
Cement Energy Efficiency Improvement	Efficient cement kilns, including high efficiency motors and drives, variable speed drives, high efficiency calcifies, and efficient grinding technologies, energy management and process control systems, oxygen-enhanced combustion, waste heat utilization; clinker substitutes (pozzolans); and biomass and waste fuels.
Industrial Energy Efficiency Improvement	Motors with variable speed drives / high efficiency motors, more efficient boilers, upgraded burners, air preheaters, waste heat recycling/utilization, biomass fuel substitution, combined heat and power systems, energy management and control systems

Source: Adapted from GoK (2017); NDC Sector Analysis Report

Capacity Building

Local producers often lack the skills, raw material and investment capacities to switch towards more efficient technologies.

Finance and Budgets

The financial resources for the NAMA implementation are estimated at 77,327,592 US Dollars.[117]

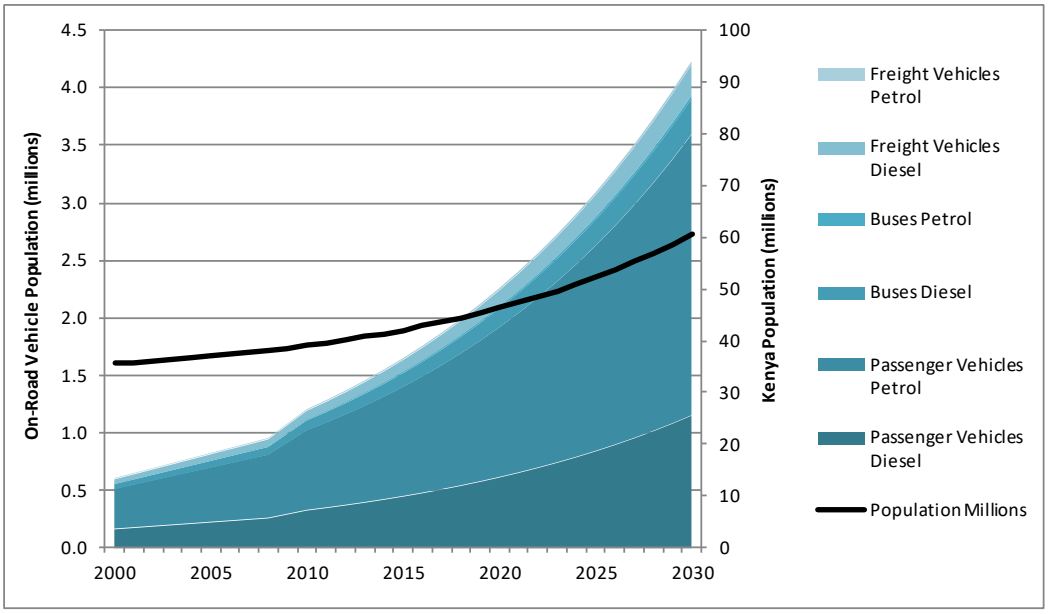
3.5: Transport Sector

3.5.1 Overview

Kenya's transport sector consists of road, rail, air, water (maritime and inland water), pipeline and non-motorised transport and immediate means sub-sectors.[118] The transport sector in Kenya is very vital as it facilitates most of the other sectors and is also the largest consumer of petroleum products accounting for more than two thirds of the total petroleum products consumed in the country. The Integrated National Transport Policy of 2009 puts emphasis on an efficient transport system, noting that it is an important prerequisite for facilitating national and regional integration, promoting trade and economic development, contributing to poverty reduction and wealth creation, and achieving the objectives of Vision 2030.

With the total vehicle population (excluding motorcycles) expected to double in ten years to 1.2 million in 2020, the sector has been experiencing tremendous growth with the number of vehicles expected to hit 69.9 vehicles per thousand population by 2030, having grown from 30.7 vehicles per thousand population in 2010. (See Figure 3.5.1).[119]

Figure 3.5.1: Vehicle Numbers, Type and Population Growth (2000 to 2030)



Source: GoK, Ministry of Environment and Forestry (2015); SNC

The National Transport and Safety Authority (NTSA) estimated the fleet size at the end of 2015 as 2,776,374 vehicles and an average 10% annual increase in number of vehicles. By 2020 and 2030, Kenya is projected to have 4.1 and 5 million vehicles, respectively,[120] 46% of which will be privately owned cars, a trend that is consistent with the growing economy and rising income levels.[121] At the same time, the registration of motorcycles rose from 6,350 in 2006 to 166,870 in 2015.[122] According a study conducted by the Energy Regulatory Commission (ERC) under the Global Fuel Economy Initiative (GFEI) in 2015, the average fuel economy of Kenya's 110,474 light duty vehicles (LDVs) in 2012 was established as 7.5 litres per 100 kilometres (L/km) compared to the global average of 7.2 L/100km and the average CO_2 emission was 181.7g/km for the period 2010-2012. Under the GFEI, the global target referred to as "50by50" is designed to achieve 50 per cent reduction in the average CO_2 emission and fuel consumption by the year 2050.

Kenya has implemented many transport sector infrastructural development programmes over the last 15 years that aim to meet the growing demand for transportation services arising from economic growth and rapid urbanisation and aim to address the challenges in the sector. Most importantly, a number of these projects aim to address climate change through low carbon climate resilient development pathways.

The transport sector in Kenya is a significant source of GHG emissions, directly accounting for about 11% of Kenya's total GHG emissions in 2015, which are projected to grow to about 14.7% by 2030 as a result of the sector's steady growth.[123] In the NCCAP 2013-2017, a number of priority mitigation actions were identified, most of which offer opportunities for savings on imported fuels through improved efficiency, alternate modes of transport and fuel substitution, besides other benefits.[124]

In the NDC Sector Analysis Report of 2017, it was determined that the strategic mitigation actions to improve transport systems could deliver 2.0 to 3.5 $MtCO_2e$ by 2030, through a number of actions, some of which have begun implementation.[125]

In this section, low carbon development actions have been presented, evaluated and prioritised based on their mitigation potential. The following three actions have been prioritised while several other actions have been listed for action:

- Implementation of the Mass Rapid Transport System (Bus Rapid Transit System with Light Rail) for Greater Nairobi (mitigation potential of 0.44 $MtCO_2e$ annually by 2022 and 2.3 $MtCO_2e$ by 2030).
- Transfer of Freight from Road to Rail Between Nairobi and Mombasa (mitigation potential of 0.82 $MtCO_2e$ annually by 2022 and 1.1 $MtCO_2e$ annually by 2030)
- Improvement of the Heavy-Duty Truck Efficiency (mitigation potential of 0.97 $MtCO_2e$ annually by 2030)
- Electrification of the SGR Line Between Nairobi To Mombasa by 2022 (0.24 $MtCO_2e$ per year by 2022 and 0.32 $MtCO_2e$ by 2030.

The proportionate emission reductions required from the transport sector to meet the NDC target is 3.46 $MtCO_2e$, with a possible high and low range of 2.0 and 3.5 $MtCO_2e$ by 2030. Different combinations of the above prioritised actions will deliver beyond the proportionate NDC target. The BRT action assumes that all the vehicles are diesel propelled. If electric or LPG/Natural Gas buses are included, the action will deliver more emission reductions than estimated. The transfer of freight from rail to road has only considered the stretch from Nairobi to Mombasa. However, by 2022, it will be possible to transfer shift cargo to rail on the Nairobi-Kisumu SGR line with a corresponding increase in mitigation benefits. If our grid continues to be green, further mitigation benefits will accrue from electrification of the rail line. However, if the grid emission factor goes above 0.28 tCO_2/MWh (currently at around 0.4 tCO2/MWh and expected to be practically zero by 2022), electrification of the train becomes a net emitter relative to a diesel train baseline.

The above priority actions will be supported by important, but less significant actions, in the aviation and maritime sub-sectors, among others, that nevertheless have mitigation benefits but have not been prioritised simply because of their individual low mitigation potential. However, the actions are important for reasons other than climate change mitigation and must therefore be prioritised against those other objections when it comes to implementation.

3.5.2 Mitigation Actions in the Transport Sector

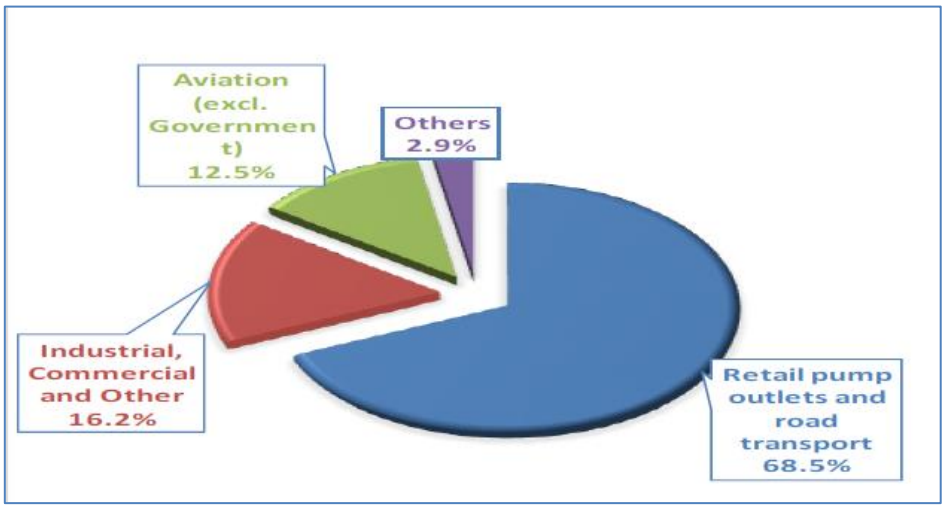
In the NDC Sector Analysis Report 2017, six mitigation options were analysed for the transport sector. The option with the largest mitigation potential is the development of an extensive mass transit system for Greater Nairobi in the form of bus rapid transit (BRT) corridors, complemented by light rail transit (LRT) in high thoroughfare corridors. This public transport system had an abatement potential of approximately 2.3 $MtCO_2e$ a year by 2030. The second largest mitigation potential is the 30-40% shift of cargo[126] from road to rail between Mombasa and Nairobi having

a potential of approximately 1.1 MtCO2e a year in 2030. The third highest option is the improvement of the Heavy-Duty Truck Efficiency with mitigation potential of 0.97 $MtCO_2e$ annually by 2030. These three options in different configurations can deliver more emission reductions than the NDC target for the transport sector. There are other mitigation actions that have been assessed but not prioritised for the NCCAP 2018-2022 implementation.

Baseline

The transport sector is the largest consumer of liquid fossil fuels in Kenya, accounting for 81.3% (68.5% by road transport and rail and 12.5% by aviation) of final consumption of oil products in 2017).[127] Combustion of fossil fuels result in carbon dioxide emissions.

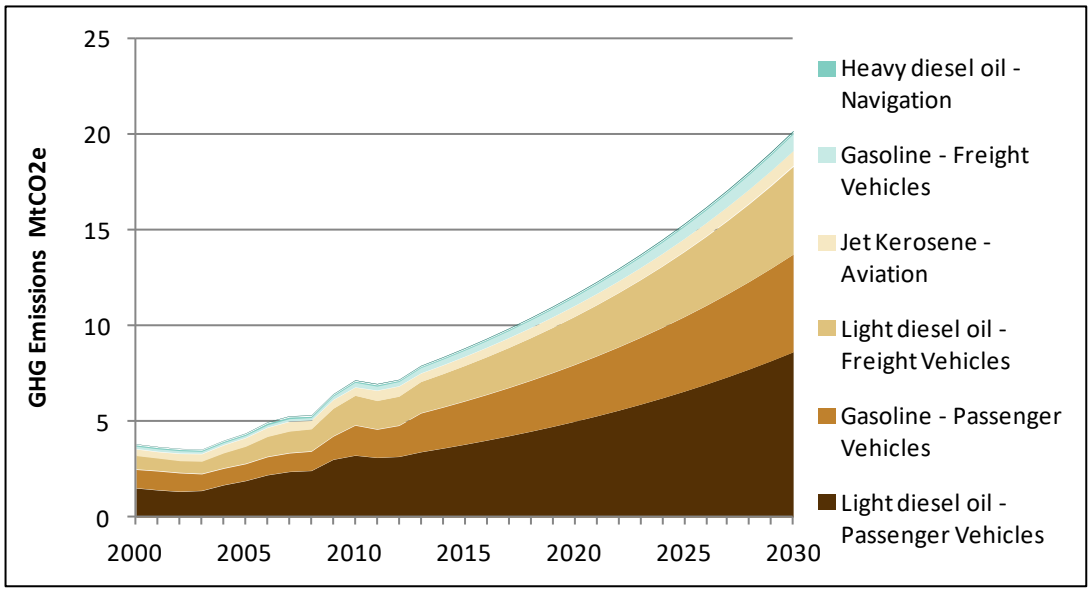
Figure 3.5.2: Fossil Fuel Consumption by Sector in Kenya



Source: Kenya National Bureau of Statistics (2018); Economic Review 2018

According to the NCCAP 2013-2017, transport emissions in the BAU scenario are projected to grow from 9 $MtCO_2e$ in 2015 to 21 $MtCO_2e$ in 2030[128]. Much of this increase is attributed to increased population light duty vehicle over the period. (Figure 5.5.3 and Table 2.1.1).

Figure 3.5.3: Transport Sector Baseline Emission Projection for Kenya (MtCO2e)

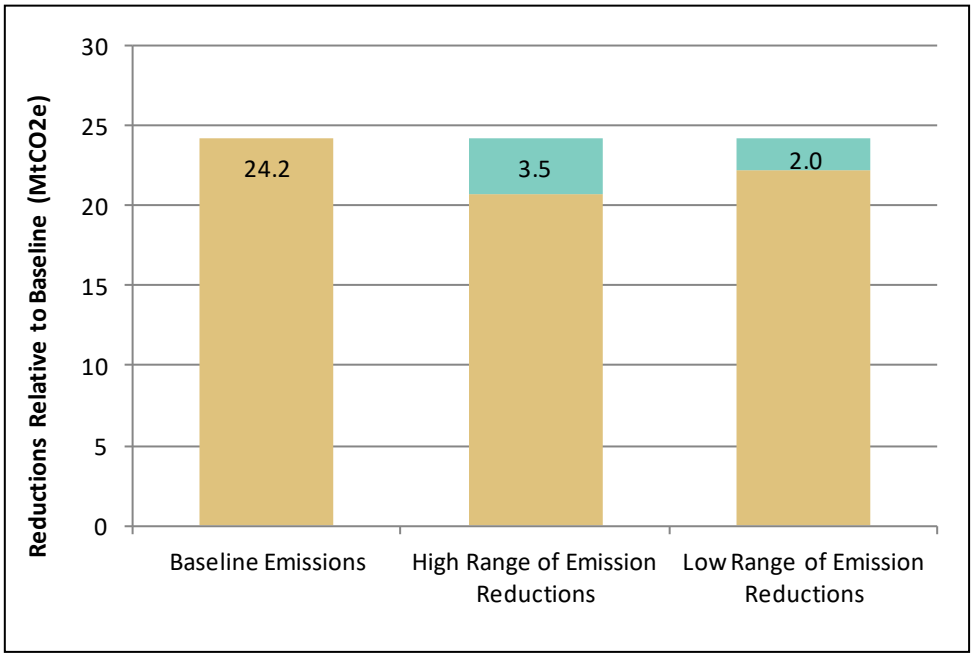


Source: Government of Kenya (2015), Second National Communication

NDC Target for the Transport Sector

The proportionate emission reduction contributions required from the transport sector to meet the NDC overall target was estimated in the NDC Sector Analysis Report of 2017 as 3.46 $MtCO_2e$ by 2030 (Table 2.2.1, Chapter 2). In the same analysis the mitigation potential for the transport sector was then estimated as lying between 3.5 and 2.0 $MtCO_2e$, the high and low range of emission reductions, respectively, for the sector as illustrated in Figure 3.5.4 below. From the analysis, it was evident that the transport sector was not expected to make a significant contribution to the NDC target beyond the proportionate contribution and the sector was not likely to compensate for the much lower proportionate contributions expected from other sectors like agriculture. However, the prioritised mitigation actions have the potential to surpass the proportionate NDC target for the transport sector and support other sectors with less mitigation potential. It is however noted that due to the high cost of mitigation in the transport sector relative to other sectors like forestry, it may not be possible to implement all the prioritised mitigation actions in full over the plan period.[129]

Figure 3.5.4: Comparison of 2030 Baseline Emissions and INDC Target Emission Reductions (MtCO2e)



Source: Government of Kenya (2017), National Determined Contribution Sector Analysis Report (2017)

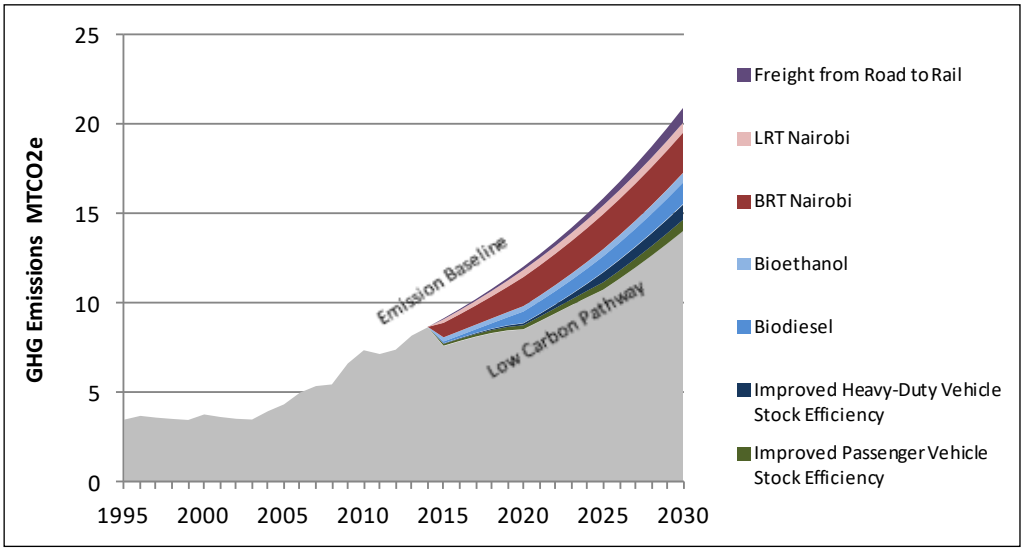
Mitigation Actions Identified in Kenya's Second National Communication

In the NCCAP 2013-2017 and the SNC, seven mitigation actions were proposed and analysed for the transport sector (Figures 3.5.5 and 3.5.6). The option with the largest mitigation potential was the development of an extensive mass transit system for greater Nairobi in the form of bus rapid transit (BRT) corridors, complemented by light rail transit (LRT) in very high thorough fare corridors. This public transport system had an abatement potential of approximately 2.8 $MtCO_2e$ a year in total by 2030. The second largest mitigation potential, the introduction of biodiesel, with a 10% blend requirement with a potential of 1.2 $MtCO_2e$ a year GHG emission reductions by in 2030, is longer considered a viable option because production of adequate biodiesel is no longer

envisaged. Bioethanol remains as a feasible option, if the sugar industry increases production which will be required also by the bioethanol stoves (see energy sector).[130]

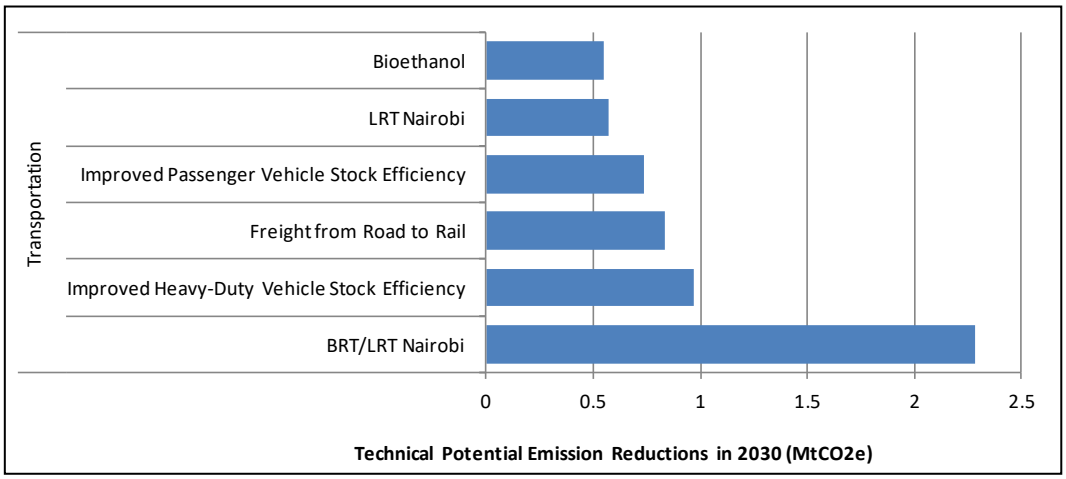
Two BRT system NAMAs have been proposed and one of them has already received a Euro 20 million support for implementation. In addition, Kenya standard gauge railway from the Port of Mombasa to Nairobi has been is constructed and is operational. The stretch of the line from Nairobi to Kisumu is under construction. This will facilitate high speed train transport and has started to shift a significant amount of freight from road to rail. The SGR may have shifted passenger travel from road or air to rail, but data is not available. The line also offers an opportunity for electrification which has already started. The implementation of the large truck efficiency improvement action is yet to be fully developed and implemented but is on course for implementation over the next 5 years.

Figure 3.5.5: NCCAP 2013-2017 Mitigation Options and Technical Potential Emission Reductions in 2030



Source: Government of Kenya (2013), NCCAP

Figure 3.5.6: Mitigation Potential of Various Mitigation Options in the Transport Sector



Source: Government of Kenya (2017), NDC Sector Analysis

Proposed Mitigation Actions for the NCCAP 2018-2022 in the Transport Sector

The mitigation actions proposed in the transport sector for the 2018-2022 period are shown in Table 3.5.1 below. These actions were proposed by the State Department of Transport, in consultation with key sector players and development partners.

The following four prioritised actions in the transport sector are discussed below:

- Implementation of the Mass Rapid Transport System (Bus Rapid Transit System with Light Rail) for Greater Nairobi
- Transfer of Freight from Road to Rail Between Nairobi and Mombasa
- Improvement of the Heavy-Duty Truck Efficiency
- Electrification of the SGR Line Between Nairobi To Mombasa by 2022

Table 3.5.1: Proposed Priority Mitigation Actions in the Transport Sector for the Period 2018-2022

Strategic Objective 1: Establishment of efficient, safe, sustainable, world-class transportation system and logistic services				
Issue/Problem: Operational inefficiency, heavy congestion, heavy fuels, and high fuel consumption leading to high levels of GHG and air pollutant emissions				
Opportunity	Actions	Sector	Mitigation	SDG Target
Need for affordable, safe and efficient public transport for passengers and freight	• Design, construct and implement 13 km of the Bus Rapid Transit for Nairobi Metropolitan Area • Upgrade Nairobi commuter rail system • Extend of SGR from Nairobi to Naivasha by 2022 • Shift at least 30% of road passengers (Nairobi-Mombasa) • Shift at least 30% of road freight (Nairobi-Mombasa)	TMOTIHUD, Nairobi Area Transport Metropolitan Authority (NAMATA), County governments, Kenya Railways Corporation (KRC)	Mitigation	7, 9.1, 10, 11.2, 13
Reduced fuel consumption and fuel overhead costs	• Electrify the SGR (Nairobi to Mombasa) by 2022 • Develop and start implementation of a roadmap for the improvement of heavy-duty truck efficiency improvement, including increased use of low-rolling resistance tyres, super structure fittings etc., vehicle standards. • Construct and commission the 2nd runway at JKIA to reduce holding of aircrafts and diversions by 2022 • Establish a new Air Navigation Area Control Centre by 2020	MOTIHUD, KRC, National Transport Authority (NTSA), County governments, KETRACO, Kenya Civil Aviation Authority (KCAA), Kenya Airports Authority (KAA)	Mitigation	7.2, 7.3. 9, 11.2,12.2
Adoption of electric modes of transport to improve air quality	• Import and pilot the use of 150 electric hybrid vehicles (buses, GoK cars) by 2019 and provide appropriate incentives for their use by 2022 • Pilot the use of electric 2- and 3-wheeler vehicles in at least two counties by 2020 • Develop and implement Standards for electric/hybrid vehicles in Kenya by 2019	MOTIHUD, NTSA), County governments, KETRACO, KP, Kenya Urban Roads Authority (KURA), Kenya National Highways Authority (KENHA), Kenya Rural Roads Authority	Adaptation and Mitigation	7.2, 7.3 11.2, 3.9

		(KURA) Kenya Bureau of Standards (KEBS), Kenya Revenue Authority (KRA)		
Transit oriented development	• Update and implement planning and building control regulations to encourage compact development, mixed use, and reduced provision of parking near MRT stations. • Construct 150 km of NMT facilities, including pedestrian and bicycle access within and to town centres and MRT stations • Review and implement the Integrated National Transport Policy 2021	MOTIHUD, County governments, National Construction Authority (NCA)	Mitigation	9.1, 11.2,
Uptake of low carbon technologies (aviation and maritime)	• Install shore power infrastructure for 4 berths to provide power to the ships while at berth instead of using their engines (cold ironing project) • Purchase of 2 new aircraft (B787) which have fuel efficient engines • Domesticate and implement international standards on aviation (ICAO Annex 16 Vol 4) by 2021 and maritime (MARPOL Annex VI) by 2020. • Implement Service Charter on Sustainable Aviation Fuels (certification and use of biodiesel production for captive use at the airports) by 2020. • Install and commission 0.5 MW of solar power plant at Moi International Airport by end 2018	KCAA, KPA, KQ, KAA, SDOT MOTIHUD (SDMSA), Kenya Ports Authority (KPA), Kenya Maritime Authority, (KMA), Kenya Airways (KQ), KEBS	Mitigation	7.2, 7.3, 9.1, 11.2, 14
Capacity Building and Awareness Creation	• Train officers on GHG on emissions quantification and mechanisms of reduction, fuel consumption data reporting requirements and low carbon technology	Transport, KCAA, KMA, SDMSA, KPA, KQ, KAA and SDOT.	Capacity Building	13.3, 11.2, 17.19

Implementation of the Mass Rapid Transport System (Bus Rapid Transit System with Light Rail) for Greater Nairobi

BRT is a system that provides for buses to have their own segregated ways within cities. The segregated ways prevent the buses from being caught in traffic (unlike single user private cars) thereby enabling them to adhere to fixed routes and schedules. The BRT system brings efficiency and reliability within the public transit systems of the city. It is sometimes viewed as an alternative version of Light Rail transit where articulated buses are used in place of trains. Where such buses are used for BRT, they are much cheaper to install and they allow for flexibility of routing and timing. A more attractive and reliable public transport system will increase the share of the population that uses public transport, and non-motorised transport will be encouraged through improved bicycle lanes and sidewalks.

Kenya plans to develop a mass rapid transport system that comprises 5 routes of BRT complimenting light rail transport. Work has started on the first BRT Line 3, the 13-km route along Ngong-Juja Road with 100 buses, that was developed as BRT NAMA and received Euros 20 million from the International NAMA Facility. Line 3 is one of five bus corridors planned as part of greater Nairobi's Mass Rapid Transit (MRT) system. This component of the mass transport system is expected to reduce 0.04 $MtCO_2e$ annually.[131] The reduction of greenhouse gas emissions will be achieved by replacing private car, matatu and bus trips and some non-motorised transport with public transport, improved flow of traffic, acceptance of traffic lights, and integration of different modes of transport in the public concept.

Another BRT NAMA, developed as an electric bus rapid transit system (eBRT) and running from the Airport to the city centre (route Ndovu/A104), is yet to get international climate funding[132]. According to the eBRT NAMA proposal, the mitigation potential of this action (Ndovu Route BRT) would be 0.46 $MtCO_2e$ annually, because it is a very busy route and the eBRT would apply renewable electricity instead of diesel.[133]

The Nairobi commuter rail system is also to be upgraded to provide efficient movement of passengers from the SGR terminal in Syokimau to the city centre. This upgrading is part of the Nairobi Metropolitan Mass Transport Master Plan that aims to create a mass rapid transport (MRT) system comprised of bus rapid transit and commuter rail, complemented by NMT.

Assuming that that the number of BRT buses would gradually increase from 100 in 2018 to 800 in 2022 and that the BRT capacity is the limiting factor, with each bus carrying about 70 people and making ten 47-kilometre trips daily, the emission reduction potential of the action is estimated at 0.44 MtCO2e by 2022. Due to inadequate data, it was not possible to estimate the mitigation potential of this action by 2030. However, in the NCCAP 2013-2017 and SNC, the mitigation potential of this action was estimated at 2.3 MtCO2e by 2030. (For more details on the emission reduction estimation up to 2022, please refer the spreadsheet on emissions estimation for the BRT system).

Transfer of Freight and Passengers from Road to Rail Between Nairobi and Mombasa

A large majority of freight movements (imports and exports) have been undertaken by road transport. This scenario assumes that approximately 30-40%134 of transit freight is moved on the Standard Gauge Railway by 2030.12 With the SGR operating, the Government has now started to transfer freight from road to the road system. Besides its potential climate change mitigation benefits, rail is energy- and time-efficient, cost-effective, saves road maintenance costs, and reduces safety exposure on our road. In the NCCAP 2013-2017, the SNC and the NDC

Sector Analysis Report 2017, and with an assumption that 30-40% of the road freight will be shifted to rail, it was estimated that the mitigation potential of this action is 0.82 $MtCO_2e$ annually by 2022 and 1.1 $MtCO_2e$ by 2030.

The freight data applied for the estimation were obtained from the Mombasa – Nairobi Railway Project, Feasibility Study Report by China Road and Bridge Corporation for the GoK in 2011. The forecasted freight figures in the study are closer to 40% of the total cargo handled at the Port of Mombasa. With increasing proportion of the freight being shifted to rail, the GHG emissions abatement of this action could be increased significantly.

Electrification of the SGR Line Between Nairobi To Mombasa by 2022

Electrification of the SGR which will lead to further emission reductions for both freight and passenger operations. Typically, an electric train emits between 20% and 35% less carbon per passenger mile than a diesel train.[135] However, the exact mitigation potential of electrification of the SGR line will depend on the exact grid mix.

With increasing cargo, if Kenya's grid energy mix were to remain green (with a grid emission factor lower than 0.28 tCO_2e/MWh, now it is around 0.4 tCO_2eMWh but is expected to get to nearly zero by 2022) and the train system was electrified, the GHG emissions reductions through this action could be increased by up to 0.24 $MtCO_2e$ in 2022 and 0.32 $MtCO_2e$ by 2030.

With the planned coal generation after 2022, the mitigation contribution of this action would be negligible relative to the NDC target for the transport sector and could even be reversed with the action becoming a net emitter. A contract involving the construction of 14 sub-stations between Nairobi and Mombasa has already been signed for electrification of the SGR line.

Improvement of the Heavy-Duty Truck Efficiency

Improvement of the heavy-duty truck efficiency can be achieved through many different policies including new vehicle fuel efficiency standards, removing low efficiency vehicles from the market, and providing subsidies or incentives for higher efficiency vehicles. Higher efficiency vehicles include hybrid and electric vehicles that can significantly reduce emissions per kilometre provided the national electricity generation mix remains predominantly based on renewable generation. The technical potential of the improvement in freight vehicle efficiency mitigation option considered an improvement of approximately 15% in overall freight vehicle efficiency in 2030 resulting in 0.97 $MtCO_2e$ emission reductions. A 1% improvement in overall freight vehicle efficiency in 2030 would reduce emissions on the order of 0.064 $MtCO_2e$.[136]

The adoption of technologies to improve vehicle fuel efficiency can be complemented with support programmes that monitor and enforce vehicle emission standards. Testing and inspection of vehicles, either as a mandatory program or as part of highway enforcement, even if it affects only a small percentage of vehicles, can still significantly improve overall vehicle emission efficiency as they target the highest emitters.

The total mitigation potential of the prioritised mitigation actions in the transport sector is summarised in Table 3.5.2. While the transport sector has the potential to deliver the sector's high range emission reduction target towards the delivery of the NDC mitigation targets by 2030, most of the four prioritised actions have to be implemented to a significant degree. The transfer of freight from road to rail has the potential to be doubled the emission reductions if about 60-80% of the freight is transferred to rail. In addition, the BRT also has significant potential for enhanced emission reductions through faster BRT route development and increased number of buses in the routes. According to the NCCAP 2013-2017 and the SNC, up to 2.3 $MtCO_2e$ of GHG emission reductions could be realised through a mass transit system that achieves an estimated peak hourly ridership of 148,000 passengers in 2030. This mitigation potential has been applied for the BRT in 2030.

The emission reduction associated with electrification of the SGR assumes a clean grid mix by 2022 (a grid emission factor of zero tCO2e/MWh) which is expected by 2022. If, however, fossil fuel generation is added is as expected after 2024, this action will seize to reduce GHG emissions at a grid emission factor of 0.27 tCO_2e/MWh and become a net emitter as the grid gets dirtier.

Table 3.5.7: Proposed Priority Mitigation Actions in the Transport Sector for the Period 2018-2022

	Action	GHG Emission Reductions (tCO_2e)	
		Action up to 2022	Action up to 2030
Transport Sector	Implementation of the Mass Rapid Transport System (Bus Rapid Transit System with Light Rail) for Greater Nairobi	0.44	2.3
	Transfer of Freight from Road to Rail Between Nairobi and Mombasa	0.82	1.1
	Improvement of the Heavy-Duty Truck Efficiency	0.32	0.97
	Electrification of the SGR Line Between Nairobi To Mombasa by 2022	0.24	0.32
	Total Emission Reduction Potential	**1.82**	**4.69**

The priority actions combined are therefore able to deliver the 3.5 $MtCO_2e$ high range of emissions target by 2030 with a significant part of the contribution coming from the BRT system with light rail.

Other Mitigation Options

Several other mitigation options that can contribute to emission reductions but are not significant enough to individually have an impact on the NDC target have not been analysed above. However, they have been listed below. The technical mitigation potentials of the options have not been estimated either because additional information would be required or quantification of the emission reductions at this stage would be too inaccurate to justify the value.

Below are the additional mitigation options (Table 3.5.8).

Table 3.5.8: Summary of Additional Mitigation Options for the Transport Sector

Additional Mitigation Options	Preliminary Estimates of Emission Reduction Potential
Aviation actions that have been proposed contribute to mitigation but quantification requires studies to establish baselines.	• Construct and commission the 2nd runway at JKIA to reduce holding of aircrafts and diversions by 2022 • Establish a new Air Navigation Area Control Centre by 2020
Non-Motorised Transport	• Encouragement of transit-oriented development, including non-motorised transport • Update and implement planning and building control regulations to encourage compact development, mixed use, and reduced provision of parking near MRT stations. • Construction of 150 km of NMT facilities, including pedestrian and bicycle access within and to town centres and MRT stations
Update of low carbon technologies (aviation and maritime) combines several activities that contribute to mitigation.	• Installation of shore power infrastructure for 4 berths to provide power to the ships while at berth instead of using their engines (cold ironing project) • Purchase of 2 new aircraft (B787) which have fuel efficient engines • Domesticate and implement international standards on aviation (ICAO Annex 16 Vol 4) by 2021 and maritime (MARPOL Annex VI) by 2020.

	• Implement Service Charter on Sustainable Aviation Fuels (certification and use of biodiesel production for captive use at the airports) by 2020. • Install and commission 0.5 MW of solar power plant at Moi International Airport by 2018
Electrification of vehicles	• Development and implementation of standards for electric/hybrid vehicles in Kenya by 2019 • Shifting to electric 2- and 3-wheelers and electric hybrid vehicles in Kenya will result in emission reductions. However, the shifts are not expected to be significant relative to the NDC target for the sector in the 2018-2022 period. During this period the initiatives will be piloted. Typical fuel consumption of a petrol/diesel 3-wheeler lies between 2.3 to 9 L/km.
Electric Motorcycles	A shift from petrol motorcycles (100cc) to electric motorcycles of a similar power would likely reduce emissions in the order of 60% or roughly a reduction of 56 gCO_2e/passenger•km shifted based on the emission intensity of the grid in 2015. However, if significant fossil fuel electricity generation is developed (~5000 additional megawatt by 2030), the reduction falls to approximately 18% or roughly a reduction of 14 gCO_2e/passenger•km shifted. If the 2-wheelers replace cyclists, there would be no mitigation benefits, especially if the electricity is not clean and the manufacture of the lead batteries are considered. Typical 2-wheeler emissions are 19 to 55 g/km.
Road Passenger to Rail	A shift from passenger private vehicle to rail would likely reduce emissions in the order of 80% or roughly a reduction of 288 gCO_2e/passenger•km shifted. This assumes a low road passenger vehicle occupancy (2 persons).
Air Passenger to Rail	A shift from passenger air travel to rail on domestic short haul would likely reduce emissions in the order of 60% or roughly a reduction of 104 gCO_2e/passenger•km shifted.
Transport of Oil by Pipeline	A shift of the transport of oil by truck to pipeline would likely reduce emissions in the order of 90% or roughly a reduction of 10 gCO_2e/barrel•km shifted based on the adoption of electric pumping stations.

3.5. 3 Enablers

Technology

A summary of the key mitigation technologies in the transport sector is provided in Table 3.5.9.

Table 3.5.9: Summary of Key Technologies in the Transport Sector

Mitigation Option	Key Technologies Required
Public Transit (BRT and/or LRT)	Financial incentives and modification of road infrastructure to create enabling conditions, consideration of electric rail and hybrid electric buses (provided Kenya's energy mix remains largely based on renewables)
Freight and Passenger Vehicle Fuel Efficiency	Hybrid or electric vehicles, electric vehicle charging network, fuel efficiency standards for new or imported used vehicles, regulatory and economic framework that will lead to reduction of old inefficient vehicles, vehicle testing equipment. Hybrid or electric vehicles, fuel efficiency standards for new or imported used vehicles, regulatory and economic framework that will lead to reduction of old inefficient vehicles.
Freight and Passenger from Road to Rail	Efficient engines and streamlined locomotives, logistical planning to maximize loads and reduce engine idling, consideration of electrification (provided Kenya's energy mix remains largely based on renewables)
Electrification of Rail	Stable, adequate and clean electrify supply, electric train technology, electrification of rail lines

Capacity Building

Staff will need training and capacity building on the management of a mass rapid transit system, including on the maintenance of the BRT buses. Similar expertise will be required for the train system.

Further, capacity to construct and maintain reliable power lines for electrified rail systems will be critical for successful electrification of the rail system

Finance and Budgets

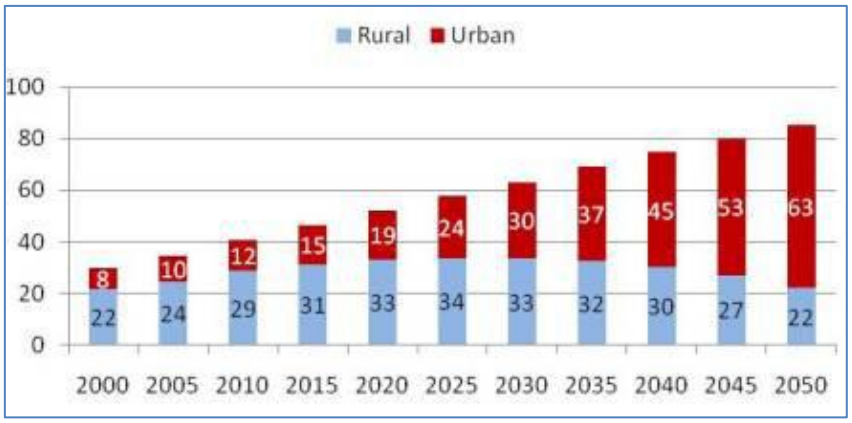
According to the NCCAP, the cost of the proposed multiple line BRT+ system and the LRT upgrades (a comprehensive (5 route) BRT system and two supporting light rail transport (LRT) lines) are estimated at US $ 250 million and USD 1.75 billion, respectively.[137]

3.6.: Waste Sector

3.6.1 Overview

Kenya, with an urban population of 30% of total population (2017), is urbanizing at the rate of 4.15% annually (Figure 3.6.1). At the same time, urban life styles are changing as the economic status of urban dwellers improves resulting in the generation of an ever-growing daily amount of municipal solid waste (MSW), currently estimated at 0.5 kg per capita, and wastewater. In most urban areas, the amount of MSW generated is growing faster than the rate of urbanization making waste management, in such areas like Nairobi, a major challenge.

Figure 3.6.1: Kenya's Urban and Rural Population, 2000-2050



Source: World Bank, 2013

In most urban areas of Kenya, MSW disposal is a neglected area and a major environmental health hazard. The cost of disposal of large quantities of waste is often beyond the financial capacities of the County Governments who have the disposal responsibility. There is also poor institutional capacity and low political will to address the problem with most urban areas in Kenya lacking the facilities for safe disposal of MSW. The most common MSW disposal practice is uncontrolled dumping in official and also in illegal dumpsites, which are operated in an unsystematic, unplanned and highly unsanitary way.

Besides the environmental health hazards associated with poor waste disposal, badly managed waste also has negative consequences in terms of GHG emissions. Waste, through the processes of disposal, treatment, recycling and incineration, produces GHG emissions, the most important of which is methane (CH_4). Major sources of CH_4 production are solid waste disposal to land and wastewater and sewage treatment. Waste incineration, like other forms of combustion, generates CO_2.

According to the SNC (2015), the waste sector is the lowest contributor to GHG emissions of all sector. About 3% of Kenya's GHG emissions from 2015 to 2030 will be from the waste sector, mostly as a result of methane generation from solid waste dumpsites, sewage and wastewater disposal.[138] This represents an increase in GHG emissions from the waste sector from 2 $MtCO_2e$ per year in 2010 to 4 $MtCO_2e$ in 2030.

The NCCAP 2013-2017 and SNC identified one priority mitigation action, landfill gas methane capture and generation, with an abatement potential of 0.78 $MtCO_2e$ per year by 2030. In the NDC Sector Analysis Report of 2017, it was determined that this strategic mitigation action could deliver between 0.2 and 0.4 $MtCO_2e$ against the NDC proportionate GHG emission reduction target of 0.39 $MtCO_2e$ by 2030.

In this section, mitigation actions in the waste sector are presented, evaluated and prioritised based on their mitigation potential. One mitigation action has been prioritised for implementation for the period 2018 to 2022 while several other actions have been listed for implementation during the same period as well. The prioritised action is

the implementation of the Solid Waste NAMA to achieve 30% waste recovery (recycling, land fill and composting) and 70% controlled dumping (tipping, compacting, and recovery) in at least one urban area in 20 counties by 2022. For Nairobi urban area only, the NAMA entitled 'A Circular Economy Solid Waste Management Approach for Urban Areas in Kenya' (Solid Waste NAMA)[1] has an abatement potential of 0.1 $MtCO_2e$ per year by 2030. In the GHG estimations, as in the NCCAP 2013-2022 and SNC, a constant solid waste generation per capita and fraction organic have been assumed.

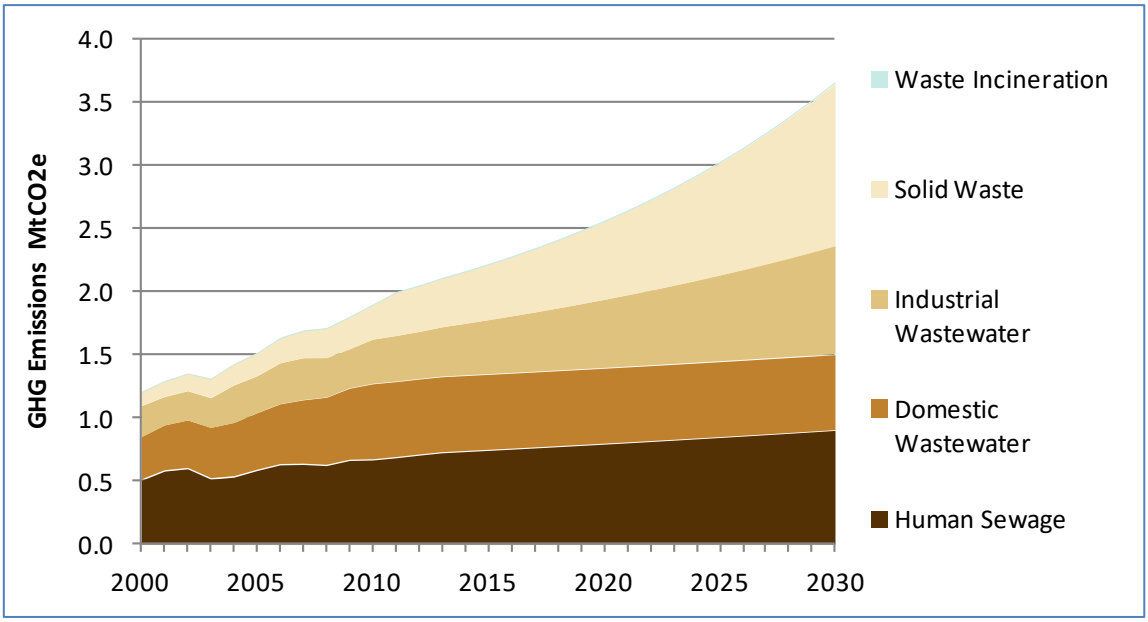
3.6.2 Mitigation Actions in the Waste Sector

For priority mitigation action of implementing the Solid Waste NAMA, the mitigation potential was estimated as 0.1 $MtCO_2e$ per year by 2030, with emission reductions coming from both plastic recycling and composting of the organic components. If instead, the organic component is used to generate landfill methane gas which is then used for electricity generation, the total emission reductions would be 0.79 $MtCO_2e$ by 2030.

Baseline

According to the NCCAP 2013-2017 and the SNC, the waste sector emissions in the BAU scenario are projected to double from 2 $MtCO_2e$ in 2015 to 4 $MtCO_2e$ in 2030. Much of this increase is attributed to increasing urbanisation and changing urban lifestyles (Figure 3.6.2 and Table 3.6.1). Currently, waste is estimated to account for approximately 3% of total national emissions and this contribution is expected to remain relatively constant in the future to 2030. This contribution is the lowest of all Kenya's six emission sectors.

Figure 3.6.2: Waste Sector Baseline Emission Projection for Kenya (MtCO2e)



Source: Source: Government of Kenya (2015), Second National Communication

Table 3.6.1: Waste Sector Baseline Emission Projection for Kenya ($MtCO_2e$)

Waste Source	Waste Baseline GHG Emissions (MtCO2e)						
	2000	2005	2010	2015	2020	2025	2030
Human Sewage	0.5	0.6	0.7	0.7	0.8	0.8	0.9
Domestic Wastewater	0.3	0.5	0.6	0.6	0.6	0.6	0.6
Industrial Wastewater	0.2	0.3	0.3	0.4	0.5	0.7	0.9
Solid Waste	0.1	0.2	0.3	0.4	0.6	0.9	1.3
Waste Incineration	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**1.2**	**1.5**	**1.9**	**2.2**	**2.6**	**3.0**	**3.7**

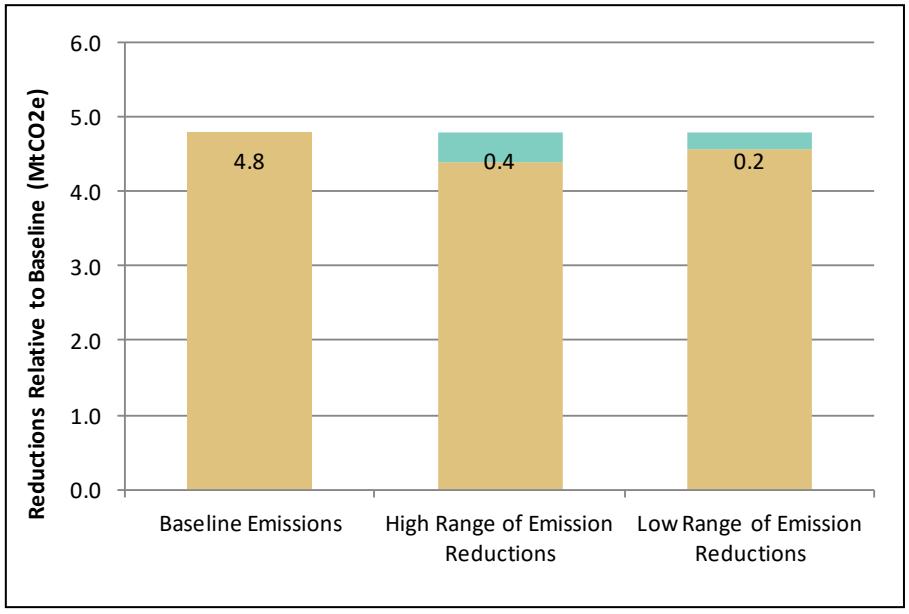
Source: Government of Kenya (2015), Second National Communication

NDC Target for the Waste Sector

The proportionate emission reduction contributions required from the waste sector to meet the NDC overall target was estimated in the NDC Sector Analysis Report of 2017 as 0.39 MtCO2e by 2030 (Table 2.2.1, Chapter 2). In the same analysis the mitigation potential for the waste sector was then estimated as lying between 0.4 and 0.2 $MtCO_2e$, the high and low range of emission reductions, respectively, for the sector as illustrated in Figure 3.6.3 below.[139]

Because of the limited mitigation opportunities, the waste sector in Kenya is not expected to make a significant contribution to the overall realisation of the NDC mitigation target. The mitigation potential estimates and prioritised mitigation action is however based largely on solid waste generation in Nairobi. There is therefore potential for replication in other major urban areas provided adequate data is collected and the action is prioritised by the urban areas.

Figure 3.6.3: Comparison of 2030 Baseline Emissions and INDC Target Emission Reductions ($MtCO_2e$)



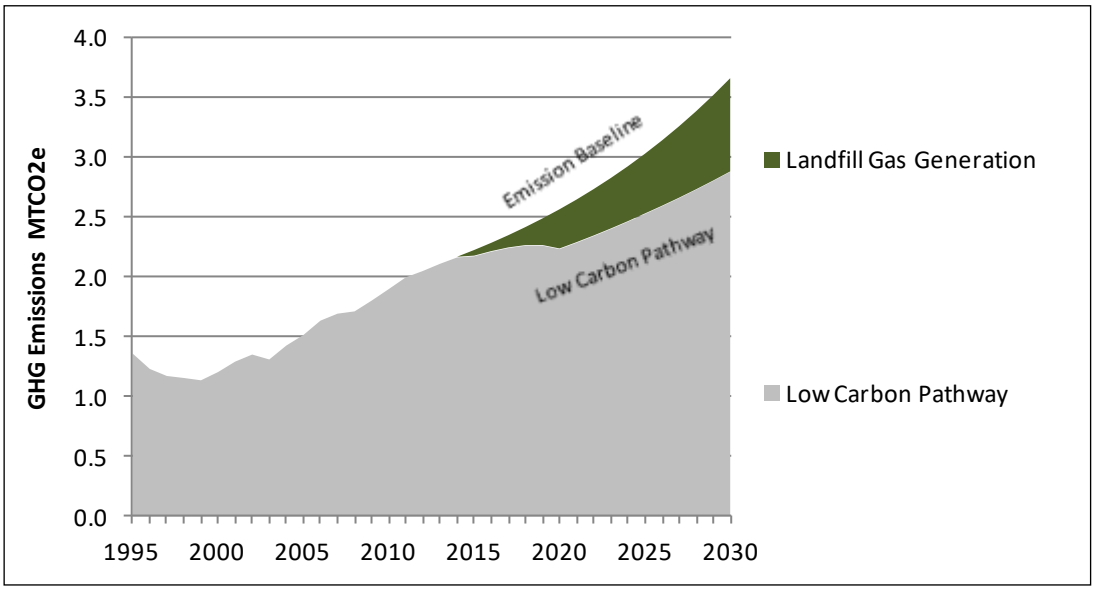
Source: Government of Kenya (2017), National Determined Contribution Sector Analysis Report

Mitigation Actions Identified in Kenya's Second National Communication

In the NCCAP 2013-2017 and the SNC, only one mitigation action, land fill gas capture and utilization with the mitigation potential of 0.78 $MtCO_2e$ by 2030, was proposed and analysed for the waste sector (Figure 3.6.4). Although several studies and proposals have been made towards solid waste management project implementation in Nairobi's Dandora dumpsite, no action has actually been implemented. The Government has however banned the use of collapsible packaging plastics and this has indirectly contributed to solid waste management in the country. A number of county Governments are currently developing their waste management strategies.

In 2015, the Ministry of Environmental and Natural Resources, with support from the USAID-funded UNDP-managed Low Emission Capacity Building Programme, developed a solid waste a NAMA entitled Circular Economy Solid Waste Management Approach for Urban Areas in Kenya. This NAMA has provided a basis for the prioritised mitigation action for the waste sector.

Figure 3.6.4: NCCAP 2013-2017 Mitigation Options in the Waste Sector and their Technical Potential Emission Reductions in 2030



	Emission Reductions Potential (MtCO2e)			
	2015	2020	2025	2030
Landfill Gas Capture and Generation	0.05	0.33	0.50	0.78

Source: Government of Kenya (2017), NCCAP

Proposed Mitigation Actions for the NCCAP 2018-2022 in the Transport Sector

The mitigation actions proposed in the waste sector for the 2018-2022 period are shown in Table 3.6.2 below. These actions were proposed by the County stakeholders, NEMA and other stakeholders. A number of the proposed actions are enablers and have not direct mitigation impacts. However, they are expected to contribute significantly to the implementation of actions with direct mitigation impacts.

Table 3.6.2: Priority Mitigation Actions in the Waste Sector for the Period 2018-2022

Strategic Objective 3.6: Improved Solid Waste Management in Major Urban Areas				
Issue/Problem: Poor solid waste management system in major urban areas of the country leading to poor sanitation, low waste collection levels and environmental pollution.				
Opportunity	Actions	Sector	Mitigation/ Adaptation/	SDG Target
Poor solid waste management in major urban areas	• Implement the Solid Waste NAMA to achieve 30% waste recovery (recycling, land fill and composting) and 70% controlled dumping (tipping, compacting, and recovery) in at least one urban area in each 20 counties by 2022. • Explore options for methane capture and power generation at landfill sites.	MEF-NAMA, CoG County Governments, private sector, NGOs	Mitigation	2, 1, 6, 13
Enabling Action (policy, plans and regulation)	• Adopt the Zero Waste policy to substantially reduce waste generation through prevention, reduction, recycling and reuse. • Develop extended producer responsibility regulations. • Formulate a policy to increase use of recycled and biodegradable content in packaging materials. • Prepare County-based waste management plans that are consistent with the National Waste Management Strategy and other relevant policies. • Enact County laws to include waste recovery and disposal to serve as regulatory requirement for use of waste as a resource by 2019.	CoG County Governments MEF-NEMA	Enabling	

The following low carbon development options have been analysed for prioritisation in the NCCAP 2018-2022:

1. Implementation of the solid waste NAMA; A Circular Economy Solid Waste Management Approach for Urban Areas in Kenya.

The assessment of the mitigation potential of this action and related assumptions has been based on the NAMA Proposal, together with information from both the NCCA 2013-2017, the SNC and the NDC Sector Analysis Report 2017. The mitigation potential of the action is based on solid waste generation in Nairobi only as there was no adequate data on other urban areas. However, the action targets at least 20 urban areas.

Implementation of the solid waste NAMA; A Circular Economy Solid Waste Management Approach for Urban Areas in Kenya

A Nationally Appropriate Mitigation Action (NAMA) proposal for a Circular Economy Solid Waste Management Approach for Urban Areas in Kenya was developed by the MENR in 2016. The NAMA concept included the creation of recycling points for waste sorting and subsequent recycling, and composting facilities for organic waste treatment. The recycling and reuse would substantially reduce the amount of disposed waste and the related GHG emissions. The NAMA would support the recycling of up to 600 tonnes of waste each day, thereby reducing GHG emissions by more than 800,000 tonnes of CO_2e over the 15-year project period. If implemented successfully and scaled up to other cities, it has the potential to be a NDC mitigation option. This NAMA is the only priority mitigation action proposed for the waste sector.

This NAMA, with an abatement potential of 0.1 $MtCO_2e$ per year by 2030, applies the circular economy concept offering a unique opportunity for urban governments (cities and municipalities) in Kenya to transform Municipal Solid Waste (MSW) management practices and to accelerate the adoption of sustainable MSW management methods, with significantly more recycling than currently practised. Instead of waste being collected for disposal only, the NAMA facilitates the diversion of at least 90% of collected waste away from disposal sites and towards various recycling practices. The NAMA aims to significantly improve MSW collection, recycling and composting through a robust framework and incentives for the private sector.

The mitigation component of the NAMA is the composting of organic fraction of the solid waste to produce commercial organic manure with a mitigation potential of only 0.1 $MtCO_2e$ per year. An alternative technology that can be applied on the organic fraction after recycling is the methane capture with power generation. This approach has a mitigation potential of 0.79 $MtCO_2e$ per year by 2030. At the forecasted solid waste generation rate of Nairobi by 2022 (5,791 tonne/day)[cxl], and assuming no significant change in the proportion of the waste that is biodegradable, the GHG emission reduction are estimated at 0.62 $MtCO_2e$ per year by 2022. Previous assessments have estimated that Nairobi's Dandora dumpsite alone can generate between 11 to 64 MW of electricity from the captured gas at the site. For optimal mitigation benefits, implementation of the NAMA, but with gas capture and electricity generation would be the preferred route.

The estimations are based on data from a JICA study in 2010 on solid waste management in Nairobi that reported that Nairobi produced 2,400 tons of waste every day, of which only 38% is collected and less than 10% is recycled. Due to limited data on the amounts of waste in other major urban areas, only the Nairobi figures were used for the estimations. A constant waste per capita and a fixed fraction collection rate was assumed for the period after 2015. Therefore, a higher mitigation potential could be expected if the other major urban areas are considered.

Waste-to-Energy Incineration

Although this option has been rejected in previous consultations with key stakeholders and was not included in the recommended options for NCCAP 2018-2022, it still offers an opportunity for addressing the solid waste management problem in the bigger cities in Kenya (Nairobi, Mombasa, Kisumu, Nakuru and Eldoret). Plans are at an advanced planning stage for a waste-to-energy plant in Eldoret. Bamburi cement is incinerating tires and municipal waste near Mombasa.

Waststovee incineration is popular in Europe, where nearly one quarter of all municipal solid waste is incinerated, with France alone having 126 waste-to-energy plants, while Germany has 121 and Italy 40. Modern waste-to-energy incineration plants operate within the strict emission limits of the European Union and adopt modern back-end flue gas treatment technology to drastically reduce the release of heavy metals and dioxins produced from the burning.

In cities where land is in short supply like Nairobi, "waste-to-energy" incineration saves precious space, generates electricity, prevents the release of toxic chemicals into groundwater, and reduces the release of methane. From Nairobi's 2,400 tonnes of MSW generated every day, a waste-to-energy" incineration plant would produce 35-40 MW of renewable electricity (Ethiopia is producing 25 MW from 1,400 tonnes of MSW in the Reppie project, Koshe landfill site). This would reduce not less than 0.17 $MtCO_2e$ of GHG emissions annually with the potential for growth as the urban waste generation increases with increasing urban population in future. With Nairobi's forecasted solid waste generation (5,791 tonne /day by 2022 and 7,427 tonne/day by 2030)[cxli], the projected emission reductions from this action would be 0.36 and 0.46 MtCO2e per year by 2022 and 2030, respectively. This assumes all waste is incinerated. A feasibility study together with the related data would be required to guide further decisions making.

As previously discussed in the NCCAP 2013-2017 and the NDC Sector Analysis Report, additional options were not considered for analysis mainly because of lack of reliable data to accurately estimate emission reduction potentials. These include the use of human waste for methane generation, industrial waste and composting, and wastewater management.

The total mitigation potential of the prioritised action in the waste sector is summarised in Table 3.6.3 below.

Table 3.6.3: Proposed Priority Mitigation Actions in the Waste Sector for the Period 2018-2022

Action	GHG Emission Reductions (tCO_2e)	
	Action up to 2022	Action up to 2030
Implementation of the Solid Waste NAMA		
With composting	0.10	0.13
With land fill gas capture and electricity generation	0.62	0.79
Incineration with electricity generation	0.36	0.46
Total Emission Reduction Potential (NAMA)	**0.72**	**0.82**
Total Emission Reduction Potential (Incineration with electricity generation)	**0.36**	**0.46**

From Table 3.6.3, it is evident that the NAMA implemented with land fill gas capture and electricity generation has a higher mitigation potential than incineration with electricity use. The two options are mutually exclusive as they apply to the same solid waste. With either of the options fully implemented, the waste sector would be able to deliver the 0.4 $MtCO_2e$ high range of emission reductions target by 2030.

Other Mitigation Options in the Waste sector not considered in the Emissions Reduction Analysis.

According to the NDC Sector Analysis Report 2017, and during the recent consultation meetings for the NCCAP 2018-2022, a number of other mitigation options were proposed. The options are summarised in Table 3.6.4. These options have not been further analysed mostly due to lack of adequate data and other relevant information. There is need to capture data on the various wastes to facilitate future analysis.

Table 3.6.4: Summary of Additional Mitigation Options for the Waste Sector for the Period 2018-2022

Additional Mitigation Options	Details/Preliminary Estimates of Emission Reduction Potential
Landfill gas flaring	This is similar to the landfill gas methane capture option, but the captured methane is simply burnt to avoid its release to the atmosphere. It is a second-best option because no electricity is produced and is not considered further in the mitigation scenario. Its mitigation potential would be similar to that calculated for landfill gas generation if modern high efficiency flare technology were used. With older candle flares, up to 10% of the methane might be released un-burnt.
Wastewater treatment	A potentially feasible solution that could be considered in a future analysis. A 2010 study on agro-industrial wastewater suggested that the potential for methane capture and utilisation is relatively low because the methane potentials per cubic metre of wastewater are much lower than solid substrates due to the low content in organic material and high-water content.[cxlii]
Waste-to-energy generation	Better suited to areas with a scarcity of space for landfill (because of the lower costs of using landfill) and waste with a lower moisture and higher energy content (less likely in Kenya because of a high organic waste content).[cxliii] Although incineration can still prove beneficial under these conditions, there is a significant overlap with the option of electricity generation from landfill gas without appropriate waste separation practices, which are not currently found in Kenya. Bamburi cement operates a waste to energy incinerator in Mombasa. Geocycle collects, segregates and incinerates waste, including biomass, waste oil and waste tyres in the Bamburi kiln, in place of imported coal. The firm reports that it uses international waste management standards that leave no residue after disposal. Lafarge, Bamburi's parent company, states that scrap tyres used for thermal energy in a cement kiln can reduce GHG emissions by roughly 30% for every tonne of coal replaced, along with an expected 10 to 15% reduction in nitrogen oxide, but work is needed to determine GHG emission reductions in the Kenyan context.[cxliv]
Anaerobic Composting	This involves a two-stage process of anaerobic digestion and composting. It can treat organic waste to recover energy in the form of biogas, and compost in the form of a liquid residual. Both would reduce methane emissions and may produce a soil conditioner. In addition, the biogas can generate electricity via gas engines. However, it needs a feed stream of source-separated organic wastes, typically in the form of animal manure (which is not readily collected in Kenya) or municipal organic wastes (which are not collected in Kenya). Agricultural residues are considered as a cogeneration option in the energy sector.

Source: Adapted from the NDC Sector Analysis Report 2017; Government of Kenya (2017)

3.6. 3 Enablers

Technology

A summary of the key mitigation technologies in the waste sector is provided in Table 3.6.5.

Table 3.6.5: Summary of Key Technologies in the Transport Sector

Mitigation Option	Key Technologies Required
Solid Waste NAMA, incorporating, separation, recycling, composting and landfill gas capture and utilization	• Waste sorting, separation and recycling technologies, incentives for collection and recycling • Landfill gas recovery systems, improved rates of collection and disposal, improved management of landfills including daily cover, leachate systems, compaction, waste depth, regulatory framework for rights to landfill gas, incentives to install methane capture and energy utilization facilities, feed-in tariff, MRV programme

Capacity Building

As a Country, Kenya is faced by limited technical competencies in waste management. This has led to poor management of waste management facilities and equipment and their failure to attain optimal operating capacities.[cxlv]

Implementation of the fast component of the NAMA entails significant sorting of various types of waste from plastics, paper, glass, metal and other electronic components. Awareness and separation at source is required.

Implementation of the landfill gas capture and utilisation (for energy) mitigation option consists of several hard and soft technologies. Hard technologies include landfill gas recovery systems that are employed in recovering/collecting the landfill gas (which consists primarily of methane and carbon dioxide in an almost equal ratio) for combustion; and compaction systems that compact the waste to increase a landfill's carrying capacity.

Other technologies are leachate systems that collect leachate to prevent it from percolating into and polluting ground water resources and energy generation and utilisation facilities. The main soft technology for Kenya is appropriate institutional and regulatory framework.

Finance and Budgets

According to the Solid Waste NAMA proposal, the estimated cost of the NAMA for the pilot phase in Nairobi alone is USD 39 million. The National Waste Management Strategy estimates that about USD 300 million[cxlvi] is required to implement the full strategy which includes the management of both solid and liquid waste in major urban areas of Kenya.

Chapter 4: Implementation

4.1 Introduction

Over the Vision 2030 period, climate change action will be implemented through selected and prioritised measures covering both mitigation and adaptation. The mitigation-related actions, together with their mitigation potential, have been analysed in Chapter 3 of this MTAR, while the adaptation potential and broader benefits have been analysed in the ATAR and other documents related to the NCCAP 2018-2022.

It is the intention that the implementation of each of the priority mitigation actions be developed as part of the early implementation stages. This section therefore defines the implementation approach and initial preparatory steps but provides an effective basis for ongoing planning by entities involved in implementation of the actions. It is also the intention that the implementation will be scalable and flexible. More detail and work will be required before a detailed implementation plan can be developed for each of the mitigation actions. Both 'quick wins' and 'big wins' should be further prioritised for implementation.

It is assumed that the appropriate level of resources required to ensure efficient and effective implementation of each of the priority mitigation actions will be allocated. This includes financial investment, the management of staff and stakeholder time, staff training and development and the application of appropriate organisational management and governance processes and procedures.

In the approach, provision has been made for carrying out Risk Assessment of the actions early in the implementation process. Risk assessment, will reflect adequate consideration of key risks to implementation, throughout the entire implementation process and not just at the beginning. This is particularly important as significant behaviour change is expected for successful implementation.

This chapter covers the implementation of the prioritised mitigation actions in this MTAR, the measurement, reporting and verification of the progress. The MRV indicators are high level and will be developed in detail at the action level. Most of the actions have either started or are ready, awaiting immediate kick-off activities. Detailed plans will be developed at the sectoral and county levels as well.

Implementation approach

To ensure effective implementation of the plan, the priority actions in the MTAR and the NCCAP 2018-2022 have been aligned with the existing National Climate Change Framework Policy (2016), the Climate Change Response Strategy (2010), the Climate Change Act (2016), ongoing programmes such as the Big 4 Agenda 2018, existing structures and the established development planning frame work for Vision 2030, which is implemented through a series of 5-year Medium Term Plan (MTP) at the national level with county governments implementing County Integrated Development Plans (CIDPs), which are aligned to the national MTP.

Throughout the process, appropriate and just-in-time capacity building and awareness creation activities will be carried out. In order to realise Vision 2030 and deliver the NDC mitigation targets for Kenya by 2030, implementation must be an ongoing process. and must respond to changes in climate, demographics, economic development and energy trends (nationally and internationally).

There are a wide range of sectors and stakeholders that will be involved in the implementation of the mitigation actions that have been prioritised in this MTAR. It will be essential for the national government to play a prominent role given the need for leadership and coordination between different layers of government and other stakeholders, including private sector and civil society.

The set of priority mitigation actions identified in the MTAR is not exhaustive but offers a first perspective on a prioritized set of actions that can be implemented. However, the set of measures has the potential to support the country's delivery of the NDC mitigation target by 2030 and have been prioritised for implementation, mostly through integration in the MTP process.

While the prioritised mitigation actions present obvious advantages and benefits once implemented, it is clear that many barriers must be overcome for the NCCAP 2018-2018 to fully deliver on its promise. Implementation will only succeed with harmonised coordination across all sectors. Finance will naturally be required at scale to support implementation of the prioritised actions, as well as broader institutional needs. Leadership, inter-agency coordination, sustainable stakeholder engagement and effective MRV frameworks will also be critical to enable successful and timely implementation of the mitigation actions. Some of these aspects have been discussed under enablers for each of the six sectors in chapter 3. It is envisaged that the NCCAP 2018-2022 MRV system will be integrated into a national Monitoring and Evaluation (M & E) Framework that covers Vision 2030, the NCCAP and the NAP, addressing both Kenya's long-term development goals (Vision 2030) and fulfilling its global obligations towards combating climate change, including Kenya's NDC.

Additionally, capacity building and awareness creation activities will be critical in Kenya at all levels of government and with all stakeholders to ensure adequate public support and human capacity to implement the actions prioritised in the MTAR and NCCAP 2018-2022. To create common and adequate understanding of the benefits of implementation, and to overcome potential resistance to change accompanying the implementation of the actions, effective communication of the benefits of the actions will be required at many levels across government, the private sector as well as within the civil society. Training and awareness creation will therefore be a cross-cutting and ongoing process throughout implementation of the prioritised actions and the NCCAP 2018-2022.

Table 4.1 below shows the Mitigation Implementation Matrix.

Table 4.1: Mitigation Implementation Matrix

Sector	Issue/problem	Strategic Objective	Actions	Expected Output(s)	Expected Outcomes	Key Performance Indicators	Responsible Agency	Time Frame	Estimated Budget
Agriculture	Climate change is negatively impacting agricultural productivity and resilience of value chain actors, including households (farmers, pastoralists and fisher folks)	Reducing GHG emissions from agricultural systems without compromising productivity	• Increase the total area, under agroforestry at farm level by 200,000 acres (81,000 Ha) by 2022. • Increase farm area under sustainable land management by 250,000 acres (101,000 Ha) by 2022. • Implement the Dairy Nationally Appropriate Mitigation Action (NAMA)- 267,000 households involved in the programme leading to Greenhouse Gas emissions reductions.	200,000 acres of farmland agroforested 250,000 acres of farm area under sustainable land management 267,000 households participating the dairy NAMA	Increased tree cover and increased sequestration Improved agricultural production Improved dairy sector productivity with reduced emissions	Acres of farm land agro-forested GHG emissions from Agriculture sector	Ministry of Agriculture and Irrigation (MoAI), KFS, County Governments	5 years	
Energy Supply	Renewable (and affordable) electricity supply with low GHG emissions needs to increase to meet the demands of a growing population and industrializing nation.	Ensure an electricity supply mix based mainly on renewable energy that is resilient to climate change, and promote energy efficiency	• Develop 2,405 MW of new renewables (Geothermal: 913 MW, Solar: 442 MW, Hydro: 93 MW, Wind: 800 MW, Biomass/Biogas: 157 MW and Distributed solar and mini-grids: 30 MW) and retire 300 MW of thermal plants (Kipevu: 120 MW, IberAfrica: 108.5 MM and Tsavo: 74 MW) by 2022	Additional 2,405 MW of renewable electricity in the grid	Adequate and reliable clean electricity with reduced GHG emissions	Additional generation capacity in MW of renewable electricity added to the grid GHG emissions from the energy supply sub-sector	MoE, ERC, KenGen, KP, County Governments, Local NGOs, Private sector, GDC	5 years but phased out specific projects	
Energy demand	80% of Kenyans depend on biomass for primary energy most of which is non-renewable. This leads to	Enhancing energy security and reducing dependence on unsustainable energy resources	• Develop and distribute 4 million improved biomass stoves by 2022 -Charcoal (2 million) -Biomass (2million)	• 4 million stoves distributed and in use in Kenya	• Reduced biomass use for cooking and heating • Reduced GHG emissions from cooking and heating	Number of stoves distributed and in use GHG emissions from cooking and heating	MoE, KFS, ERC, County Governments, Local NGOs, Private sector	Phased out distribution of stoves over 5 years (400,000 stoves per year)	

	indoor air pollution and deforestation		• Develop and distribute 1 million clean energy stoves by 2022 -Develop LPG (500 units), biogas (250 units), and ethanol (units) stoves and related supply chains	• 1 million clean fuel stoves distributed and in use in Kenya (500 LPG, 250 biogas and 250 LPG)			Ministry of Petroleum and Mining (MPM), MoE, KFS, ERC, County Governments, Local NGOs, Private sector		
Forestry	Increasing GHG emissions from deforestation and degradation of forest ecosystems and other landscapes	To increase tree cover to 10% of the total land cover	Reduce deforestation and forest degradation by rehabilitation and protection of additional 100,000 Ha of natural forests (including mangroves) by 2022 -Community/participatory forestry management -Limiting access to forests -Preventing disturbances through improved enforcement and monitoring -Developing alternative technologies to reduce demand for biomass (e.g., clean cooking and efficient charcoal production) -Carbon stock enhancement (tree planting) in existing forests -Financial innovations including payments through REDD+ / carbon markets	100,000 Ha of forest with covered by the REDD+ program by 2022	Increased forest cover and increased GHG sequestration	Area of forest rehabilitated and protected in Ha. GHG emissions from the action	MEF, KFS, KEFRI, CoG, County Governments, Community Forestry Association (CFAs), Private Sector, NGOs	5-year phased out implementation (20,000 Ha per year)	
Forestry			Support afforestation and reforestation in Counties, with the aim of planting one million trees per County per year (additional 100,000 Ha by 2022) -Institute an annual National Tree Planting Day	100,000 Ha of additional reforested/afforested land by 2022	Increased forest cover and GHG sequestration	Area afforested/reforested in Ha. GHG emissions from the action	MEF-KFS, MAI, KEFRI, CoG, County Governments, Farmers, Community Institutions, Private sector	5-year phased out implementation (20,000 Ha per year)	

			-Implement the National Mangrove Ecosystem Management Plan. -Revive Green Schools Programme – 10% of school land areas planted with trees -Increase tree nurseries and production and availability of seedlings -Tree planting -Expand and protect mangrove forest cover (for coastal adaptation and blue carbon sequestration) -Promote trees on farms -Forest management and planning -Silviculture interventions sequestration) -Promote trees on farms -Forest management and planning						
Forestry	Increasing GHG emissions from deforestation and degradation of forest ecosystems and other landscapes	To increase tree cover to 10% of the total land cover	Restoration of up to 200,000 Ha of forest on degraded landscapes (ASALs, rangelands) •GCF Dryland Resilience Project -Enhanced natural generation of degraded lands through conservation and sustainable management -Ecosystem-based Adaptation through rangeland and forest	200,000 Ha of degraded landscapes restored by 2022	Increased forest cover and GHG sequestration	Area of degraded landscapes restored in Ha. GHG emissions from the action	MEF-KFS, MAI, NDMA, KEFRI, National Treasury, Frontier Counties Development Council, 7 ASAL County Governments, IUCN, FAO, UNEP, Greenbelt Movement, Community institutions	5-year phased out implementation (40,000 Ha per year)	

			landscape restoration and sustainable management (sites include rangelands, woodlands/forests, wetlands, and croplands) -Process to initiative restoration processes on 33% of land area in 7 counties. •AFR100 commitment in 2016 to restore 5.1 million Ha -Analysis of priority landscapes, existing restoration successes -Economic analysis of restoration options -Identification of financing options to scale up landscape restoration						
Forestry	Increasing GHG emissions from deforestation and degradation of forest ecosystems and other landscapes	To increase tree cover to 10% of the total land cover	Increase area under private sector-based commercial and industrial plantations from 71,000 ha to at least 121,000 Ha •Standards and regulations for sustainable forestry management (voluntary moving to regulated)	At least 50,000 Ha of additional plantations by 2022	Increased forest cover and increased GHG sequestration	Area of additional private plantations in Ha. GHG emissions from the action	KEPSA, KAM, Private Sector (Tea Industry, Kenya Commercial Bank, Green Pot Timsales, Rai Ply, Kakuzi, LaFarge, East Africa Breweries)	5-year phased out implementation (10,000 Ha per year)	
Industry	Inefficient use of resources	Promote/encourage the growth of green industry to drive jobs in the manufacturing sector	Implement the NAMA for the Charcoal Sector in Kenya. (Linked to the forestry sector mitigation actions)	1.6 million tons of renewable charcoal produced per year by 2030	Reduced depletion of forests and GHG emissions from charcoal production	Amount of sustainable charcoal produced in efficient kilns GHG emissions from charcoal production	KFS, MITC, KEBS, KIRDI, KAM, KEPSA, Farmers, KEFRI, Charcoal producers, County Governments, Police, MEF	5 years with gradual increase in efficient kilns	

Transport	Operational inefficiency, heavy congestion, heavy fuels, and high fuel consumption leading to high levels of GHG and air pollutant emissions	Establishment of efficient, safe, sustainable, world-class transportation system and logistic services	Implementation of the Mass Rapid Transport System (Bus Rapid Transit System with Light Rail) for Greater Nairobi	13 km of BRT system constructed and operational	Efficient low carbon mass transport operational	Length of BRT system installed and operational Passenger-Km travelled by the BRT GHG emissions of the urban transport system	TMOTIHUD, Nairobi Area Transport Metropolitan Authority (NAMATA), County governments, Kenya Railways Corporation (KRC)	5 years with annual incremental increase in passenger Km travelled	
			Transfer of Freight from Road to Rail Between Nairobi and Mombasa	30% of freight transferred from road to rail	Efficient low carbon mass transport operational	Length of BRT system installed and operational GHG emissions of the urban transport system	MOTIHUD, KRC, National Transport Authority (NTSA), ,	1-2 years	
			Improvement of the Heavy-Duty Truck Efficiency		Improved efficiency of the heavy-duty truck population	Average efficiency of the heavy-duty truck population GHG emissions of the urban transport system	MOTIHUD, National Transport Authority (NTSA	5years with annual incremental improvements in efficiency	
			Electrification of the SGR Line Between Nairobi To Mombasa by 2022	Nairobi To Mombasa SGR electrified	Clean rail transport	and passenger-km freight-Km moved by electric trains GHG emissions of the urban transport system	MOTIHUD, KRC, National Transport Authority (NTSA), County governments, KETRACO,)	1-2 years	
Waste	Poor solid waste management system in major urban areas of the country leading to poor sanitation, low waste collection levels and environmental pollution.	Improved Solid Waste Management in Major Urban Areas	Implement the Solid Waste NAMA to achieve 30% waste recovery (recycling, land fill and composting) and 70% controlled dumping (tipping, compacting, and recovery) in at least one urban area in each 20 counties by 2022	30% waste recovery (recycling, land fill and composting) and 70% controlled dumping (tipping, compacting, and recovery) in at least one urban area in each 20 counties by 2022	Improved solid waste management	Proportion of solid waste that is recycled GHG emissions in the waste sector	MEF-NAMA, CoG County Governments, private sector, NGOs		

The Enablers

Besides the specific enablers identified for each sector in Chapter 3, the prioritised mitigation actions outlined in Chapters 3 would not be possible without the on-going processes that support the implementation of the actions; the enablers. The enablers provide a foundation for current and future actions and will be continuously reviewed and improved. The broad but key enablers are institutional infrastructure, legal and regulatory framework, fund mobilisation (finance and budgets) and, capacity building and knowledge management and integrated planning and data management. These enablers have been discussed in detail below.

Institutional Infrastructure

Enabling Leadership and Responsibility

Kenya has consistently demonstrated its commitment to tackling climate change both domestically and internationally and has taken steps to comply with international commitments to tackle climate change. Kenya ratified the UNFCCC in 1994 and has been a party to the Kyoto Protocol since 2005. Since then, Kenya has been building up technical and institutional capacities in climate change policy. Kenya has taken steps to comply with its national pledges, including the Paris Agreement which it ratified in 2016 having developed the country's NDC.

In line with the Climate Change Act 2016, the development NCCAP 2018-2022, together with the supporting MTAR and ATAR, which define Kenya's low carbon climate resilient pathway towards the realisation of vision 2030, has been led by the Cabinet Secretary for Environment and Forestry. While the Vision 2030 will be spearheaded by the president, the Vision implementation will be the responsibility of every citizen of Kenya in government, private sector, civil society, political organisations and other institutions.

The NCCAP 2018-2022 and the annexed MTAR are aligned with Kenya's development aspirations as presented in Vision 2030, the Big 4 Agenda 2018 and other national development goals. The NCCAP 2018-2022 requires transformation of core systems necessary for the effective functioning of the economy, such as the energy, transport and food systems. Such transformation often involves messy and conflicted process requiring navigation and engagement by high-level leaders, as well as broader coalitions of support. Inspirational, high-level leadership will play a crucial role in initiating and sustaining the implementation of this ambitious plan. However, the critical role played by individual leaders in driving the plan processes means that long-term implementation is potentially vulnerable to political transitions and shifting priorities of leadership. Strategies to effectively manage political transitions, such as institutionalisation of the implementation process, are therefore essential for the long-term viability of delivering the NDC and Vision 2030.

Broadly, the National Government will provide overall leadership, play a facilitative role and provide an enabling environment (institutional, legal, infrastructure etc.) upon which the plan will be based.

Supporting Inter-Agency Coordination and Roles

To implement the plan, it is critical for Kenya to create an institutional arrangement that allows for transparent and effective flow of information, knowledge and financial resources. Given the highly multi-sectoral nature of the plan which focuses on the mainstreaming of a crosscutting issue (issue-based), the institutional and resource mobilisation set-up to support its implementation must inherently involve multiple structures and mechanisms.

Counties will align their Strategic Plans and County Integrated Development Plans (CIDPs) to the Vision 2030 national development blue print, the MTP III and the NCCAP 2018-2022 through a consultative process.

For efficiency and effectiveness, and to ensure legal compliance, this will be built upon the institutional structures and responsibilities defined in the Climate Change act 2016.

Although the prioritised mitigation actions can be allocated to specific ministries to lead on implementation, they are cross-cutting and multi-sectoral in nature. They also involve other stakeholders, including the civil society and private sector. Therefore, responsibility for implementation rests with many stakeholders operating at different levels and scales. This makes co-ordination a big challenge. The specific roles of different stakeholders in facilitating, synergising and supporting the transition process are define in the Climate Change Act 2016.

The Climate Change Directorate (CCD) will be the focal climate change institution. All concerned ministries, departments and agencies have a role to play. A similar management arrangement could be mirrored at the county level where:

Through the multi-stakeholder structures, at both the national and county levels, civil society and the private sector will also play crucial roles not only in the coordination but also in the policy implementation process. It is also understood that all individual citizens in Kenya, through their own awareness and voluntary approach to behavioural change and resource use, are the ultimate implementers of a number of the actions. Public awareness and knowledge raising will be an ongoing and continuous component of the implementation.

Each of the various ministries, departments and agencies (MDAs) involved in the implementation of the actions will designate a departmental focal point and will be accountable for the implementation of the prescribed policy responses and actions that concern their department.

Kenya has established a Climate Fund to receive and manage climate funds that flow into the country. The CCD is responsible for UNFCCC engagement and documentation.

Research and innovation is essential in facilitating low carbon development. The Ministry of Education will work on capacity building in schools while universities and research institutions will research on some of the challenges facing the county. To this end, research institutions will be called upon to reorient their research, innovation and training towards activities that target priority mitigation actions. It is especially important to ensure that innovations are actually reaching practitioners to be transformed from research results into something functional.

Banks and financial institutions including insurance companies, savings and credit co-operative organisations (SACCO) and microfinance institutes will be required to develop and provide innovative products and services that support the priority actions. Such facilities will be critical in encouraging entrepreneurs and enterprises. Media and information and communication technology (ICT) will also play a crucial role in awareness raising. This will bring about the much-needed behaviour and attitudes change towards low carbon development and associated

The Kenya National Bureau of Statistics (KNBS) is responsible for the acquisition, documentation, dissemination, and preservation of micro-data and related metadata.

There are many opportunities for mitigation actions at the county level. However, effective coordination between levels of government and required support for implementation actions at the county government level will be a prerequisite for success and for building synergies and avoiding duplications that lead to waste. Private sector will play an important role in implementing this through adoption of the mitigation technologies and practices in a self-sustaining way.

The arrangements represent collaborative mechanisms which bring responsible authorities and stakeholder groups together on a regular basis to discuss, develop and validate policy, strategies and actions.

Participatory planning will continue to be applied at the sub-national level. The structures and roles will be established in a formal way and described in more detail as part of the initial implementation steps for the actions.

The institutional infrastructure will facilitate the mainstreaming of the actions into Vision 2030, the sector policies and strategies, and the annual budgeting and planning process. To ensure that local needs are met, mainstreaming the actions into policy and planning at the sub-national and county levels is also necessary. Participatory planning will continue to be applied at the sub-national level.

Appointing Low Carbon Development Champions

National and sub-national champions will play a crucial role in making the case for change and providing leadership during the change process. It is essential that there should be a champion at the national level to guide the NCCAP 2018-2022 through both the approval process and the initial years of implementation. The national champion will not only drive the process forward but will ensure good communication and coordination between all players involved in implementation. The Cabinet Secretary for Environment and Forestry will appoint the national champion.

In addition, climate change champions or institutional focal points will be appointed from senior ministry levels down to the county level. The role of the champions (focal points) will be to act as the focal points (one-stop shop) for the implementation of actions at their respective levels and within their organisations. Although the government has urged each and every citizen of Kenya to be a champion for the sustainable development goals, especially Goal 13 which challenges the government to "take urgent action to combat climate change and its impacts", the role of coordinating all related efforts is critical and has been assigned to the CCD, working closely with the Climate Change Council.

Ensuring Sustainable Stakeholder Engagement

Stakeholders are the people who will be affected by the actions or who can influence them. Stakeholders' either influence the change or are affected by the change and are uniquely positioned to help or hinder implementation of the change. Through a stakeholder analysis process, the CCD will identify and enlist support from stakeholders. This process will help the team begin to discover ways to influence relationships and strategies to ensure that the project has the appropriate involvement and support from the key stakeholders.

Legal and Regulatory Framework

The Legal and regulatory framework for climate change provides legitimacy, regulates conduct and establishes sanctions that can ensure compliance. Because of the potential impact of climate change on the realisation of Vision 2030, and in furtherance of the UNFCCC principles, the government has put in place the necessary policy, regulatory and institutional framework through the Climate Change Act which was passed into law in 2016. This Act will provide most of the required legal framework of implementation of the priority mitigation actions. However, for some actions, a review of the legal frameworks at the sectoral or county levels will be required.

Fund Mobilisation

Adequate and predictable financial resources are a crucial component for achieving Kenya's ambitious mitigation objectives. To implement the actions, significant fund mobilisation will be required and must be prioritised in the implementation arrangements. It is estimated that Kenya will need more than USD 15 billion to finance the proposed mitigation measures by 2022. Given the extent of projected climate action in Kenya, it is important to ensure that all sources of finance can be mobilised, including international, domestic, public and private and through Public-

Private Partnerships (PPPs). Kenya therefore requires a suitable framework to attract and efficiently utilise climate finance.[147] Therefore, fund mobilisation measures have to be fast-tracked for implementation of the actions.

A good starting point for fund mobilisation is a comprehensive analysis of current and soon to be climate funds, identifying funds by sector, size, mandate, type of finance, project types, decision-making structure, application procedure, status in Kenya, including local contacts, project examples, links and the key contacts. The country has already built a significant internal capacity, including the establishment of the Climate Change Fund, that will allow Kenya to access climate finance. In addition, the overall investment climate of Kenya has been, and should continue to be, strengthened through targeted policy reviews and implementation, while at the same time building mechanisms to facilitate the use of public finance to leverage private investment. Implementation will also include targeting specific Public Private Sector Partnerships (PPPs).

The Cancun Agreements at COP16 made significant progress on areas related to climate finance, including the establishment of a Green Climate Fund, securing USD 100 billion per year in long-term financing for developing countries by 2020, from a mix of public and private sources, establishment of the Adaptation Committee and establishment of a Nationally Appropriate Mitigation Actions (NAMAs) registry.

Kenya has developed a number of NAMAs which need to source climate financing as part of the implementation of the NCCAP 2018-2022. Any emissions reduction commitments made by Kenya in the future will need to be against the business-as-usual (BAU) baselines already established in the NCCAP 2013-2017, and elsewhere, and the economic impacts must first be analysed.

Initially, the early implementation activities will be funded through the national budget.

Sources of Funds

Climate Finance

Up to now most funds dedicated to climate related expenses have come from international funders. To raise the amount needed for Kenya to pursue a low carbon development, current levels of international funding will need to increase significantly and be complemented with national and private sector financing.

Developed nations have set a goal of mobilising USD 100 billion per year by 2020 to support mitigation and adaptation activities in developing countries. To ensure that Kenya is effectively positioned to access this financing on its climate and development priorities, Kenya has established a national climate change fund that will effectively manage and implement the projects and track climate finance, therefore improve transparency and accountability. A number of counties are also at different stages of establishing their own climate change funds.

Climate finance remains central to achieving low-carbon, climate resilient development. The global climate finance architecture is complex and always evolving. Funds flow through multilateral channels, both within and outside of the UNFCCC Financial Mechanism, and increasingly through bilateral, as well as through regional and national climate change channels and funds. In 2014 alone, it is estimated that that USD 62 billion in public and private sources were directed to developing countries from developed countries.[148] There are more than forty multilateral and bilateral climate funds and programmes that are active in the sub-Saharan region.[149] Therefore, there are numerous international sources that could help fund Kenya's prioritised mitigation actions. Monitoring the flows of climate finance is difficult, as there is no agreed definition of what constitutes climate finance or consistent accounting rules. The wide range of climate finance mechanisms continues to challenge coordination. But efforts to increase inclusiveness and complementarity as well as to simplify access continue.

> Climate finance refers to additional or incremental investment made in activities aimed to climate proof programs and projects against climate change impacts including deliberately reducing greenhouse gas (GHG) emissions.
>
> *Source: GoK (2016); Climate Public Expenditure and Budget Review (CPEBR)*

Kenya has great potential to attract the financial resources it needs to develop in a low-carbon way but to develop at the implied rate in Vision 2030, Kenya will need to leverage much more funds from both multilateral and other bilateral sources, including the new donor countries such as China, Saudi Arabia, Brazil and India.[150] Vision 2030 already highlights the need for significant resources to move Kenya to a newly industrialising, middle-income country by 2030. If the country is to follow a low carbon pathway to reach its goal, this will on the one hand lead to specific financing needs, either substituting or adding to the already established requirements. At the same time, such a pathway would allow Kenya to attract substantial external funding.

Between 2005 and 2015, the GoK had committed approximately USD 370 million while development partners had committed USD 1.94 billion to programmes that they classified as having a 'significant' or 'principal' climate change component[151].

With a focus particularly on public climate financing mechanisms, there are a number of channels through which climate finance flows, including multilateral climate funds that are dedicated to addressing climate change. Several developed countries have also established climate finance initiatives or are channelling climate finance through their bilateral development assistance institutions. Many developing countries, including Kenya, have also set up regional and national funds and channels to receive climate finance.

The types of climate finance available vary from grants and concessional loans, to guarantees and private equity. The architecture has differing structures of governance, modalities and objectives. While the transparency of climate finance programmed through multilateral initiatives is increasing, detailed information on bilateral initiatives, regional and national funds are often less readily available.

Multilateral Channels for Climate Finance

Established in 1991, the Global Environment Facility (GEF) is an operating entity of the Financial Mechanism of the UNFCCC, serving in the same function for the Paris Agreement, with a long track record in environmental funding. As of March 2017, the GEF's cumulative funding approval amounted to USD 4.7 billion, making the GEF the largest single source of cumulative multilateral funding for climate change actions.

The GEF also administers the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF) under the guidance of the UNFCCC Conference of Parties (COP). As of October 2017, the LDCF and SCCF had made cash transfers to projects of USD 493 million and USD 201 million, respectively. Also, formally linked to the UNFCCC, is the Adaptation Fund (AF), with total cash transfers to projects of USD 237 million by end 2017.

The Green Climate Fund (GCF) of the UNFCCC was agreed at the Durban COP and became fully operational with its first projects approved at the end of 2015. By October 2017, the implementing partner network of the GCF had grown to 59 Accredited Entities and the GCF had approved a total of 54 projects with USD 2.6 billion in GCF funding commitments.

At COP 16, the Standing Committee on Finance was established under the UNFCCC to assist the COP in meeting the objectives of the Financial Mechanism of the Convention. The Standing Committee on Finance1 has been tasked with, among other things, preparing a biennial assessment of climate finance flows, the second of which was published in 2016 and detailed flows from 2013-2014 (UNFCCC, 2016).

A substantial volume of climate finance has been channelled through institutions that are not directly under the guidance of the UNFCCC COP. The Climate Investment Funds (CIFs) established in 2008 are administered by the World Bank but operate in partnership with regional development banks including the African Development Bank (AfDB). The CIFs include a Clean Technology Fund with USD 2.75 billion in cash transfers by October 2017, and a Strategic Climate Fund (SCF**)**, with USD 856 million in cash transfers to projects as of October 2017. The SCF is composed of the Pilot Program for Climate Resilience (PPCR), the Forest Investment Program (FIP), and the Scaling-Up Renewable Energy Program for Low Income Countries (SREP).

Multilateral Development Banks (MDBs) play a prominent role in delivering multilateral climate finance, with climate finance commitments of USD 27.4 billion made in 2016 alone[152]. Many have incorporated climate change considerations into their core lending and operations, and most MDBs now also administer climate finance initiatives with a regional or thematic scope. The World Bank's carbon finance unit has established the Forest Carbon Partnership Facility (FCPF) to explore how carbon market revenues could be harnessed to reduce emissions from deforestation and forest degradation, forest conservation, sustainable forest management and the enhancement of forest carbon stocks (REDD+). It also manages the Partnership for Market Readiness and the Bio Carbon Fund. The European Investment Bank administers the EU Global Energy Efficiency and Renewable Energy Fund (GEEREF). The African Development Bank also finances enhanced climate finance readiness in African countries through the German funded Africa Climate Change Fund (ACCF), whose first projects were approved in 2015. The African Development Bank is also the Trustee for the Africa Renewable Energy Initiative (AREI) and will house the AREI Trust Fund with expected USD 10 billion in resources.

Both MDBs and UN Agencies act as implementing entities for the GEF, SCCF, LDCF, AF and the GCF. The UN-REDD Programme, made operational in 2008, brings together UNDP, UNEP and the FAO to support REDD+ activities. The International Fund for Agriculture and Development (IFAD) administers the Adaptation for Smallholder Agriculture Programme (ASAP) that supports smallholder farmers in scaling up climate change adaptation in rural development prorammes.

Bilateral Channels for Climate Finance

A significant share of public climate finance is spent bilaterally, administered largely through existing development agencies although a number of countries have also set up special bilateral climate funds. The Climate and Policy

Initiative estimated that USD 12-19 billion was directed through governments, ministries and bilateral agencies in 2014 in addition to that spent through climate funds and development finance institutions, including climate related ODA[153].

As of April 2017, Germany's International Climate Initiative had provided USD 2.7 billion for more than 500 mitigation, adaptation, REDD+ projects since its establishment in 2008. The UK government has committed USD 12.7 billion to its International Climate Fund through to 2021, and so far, has channelled a substantial share of ICF money through dedicated multilateral funds, including the CIFs and the GCF. Together with Germany, Denmark and the EC, the UK also contributes to the NAMA Facility. Germany, the UK and Denmark also support the Global Climate Partnership Fund (GCPF). Germany and the UK also support the USD 141 million REDD+ Early Movers Programme (REM). Norway's International Forest Climate Initiative has pledged USD 377 million each year since 2008 through bilateral partnerships, multilateral channels and Civil Society.

Regional and National Channels and Climate Change Funds

Several developing countries have established regional and national channels and funds with a variety of forms and functions, resourced through international finance and/or domestic budget allocations and the domestic private sector.

National Financing and Private Sector Investment

The challenges to accurately estimate funding for climate change activities are even stronger on the national front. However, Kenya has developed significant capacity in this area with appropriate codes and accounting systems, which are yet to be used effectively for tracking public, and even, climate funds.

The key actor in Kenya is the National Treasury. The main role of the MEF should be to facilitate linking the policy formulation processes with the institutional architecture and the national budgetary system. The effectiveness of climate finance, particularly in the long term, "depends critically on the strength of the public finance management system." This echoes the challenges identified in the National Development Plan I which mentioned the challenges to implement actions due to a lack of prioritization, and most significantly, insufficient alignment of planning and budget instruments.

Private Sector investment

Despite the potential sources of international finance and the prospects of increasing investments from the national government, these funds will fall short of the financial requirements of the Kenya's low carbon climate resilient pathway actions in the NCCAP 2018-222. Private foreign direct investment (FDI) will play a critical role in placing Kenya on the low carbon development path. In the past, emerging markets experienced a boom in foreign direct investment. FDI represented 39% of external financial flows, increasingly exceeding ODA in the African continent.[154] Despite a global decrease of FDI in 2014, Africa was the continent least affected and its "FDI project numbers remain substantially above pre-2008 levels".[155] FDI will continue to flow to the region, which will not only focus on projects to tap the continent's vast natural resources but to a large extent the focus will be shared with consumer products and retail as well as technology, media and telecommunications.[156]

Mobilising private finance at scale requires equating or reducing the risks of low carbon investments to the same level as those faced by alternative, conventional investments. Particular attention should be given to delivering market-based signals, conducive macroeconomic policies, providing basic infrastructure and security.[157]

To leverage international funds and private foreign direct investment for low carbon development, the government of Kenya will need to align policies and institutions around a budget making process that uses its public resources strategically. International funds and public finance should be used to leverage private investment.

Capacity Building and Knowledge Management (Training and Awareness Creation)

To effectively implement the NCCAP 2018-2022, significant awareness has to be created regarding the plan at all levels of government and among the public, non-governmental organisations and the private sector. Awareness creation programmes will therefore be initiated early as part of the plan implementation and will be sustained throughout the implementation process. In addition, financial and technical capacities will have to be built among the stakeholders, especially government planners at all levels. The capacity building will be in the form of just-in-time training followed by immediate practical application of the concepts and tools which will be developed by the CCD.

Training is necessary on key aspects of implementation as a way of preparing key implementers and stakeholders for implementing the plan. In addition, further technical training will be required for various stakeholders on sectoral and technical aspects of implementing the strategy in specific sectors and counties.

Many of the prioritised mitigation actions are knowledge intensive and require new skills across sectors and management levels. Capacity building efforts create the foundations of adaptive management and stakeholders' ability to implement the plan. With strengthened coordination CCD at the national, sectoral and county government levels and appropriate technical support, the CCD, with the support from the National Climate Change Council and the Council of Governors will develop a comprehensive capacity building plan as one of the first steps of implementation. The plan will target government sectors, county governments and ministries, departments and agencies.

The capacity building component encompasses codifying and integrating knowledge, and transferring knowledge and tools developed during the project to the local partners and stakeholders. In the short term, key government staff from all government ministries and key institutions will undergo capacity building in the plan. To build capacity in specific areas, Kenya will bring in international experts to work with and train national and county government employees. Kenya will also send government employees to other countries to receive high quality on-the-job experience and training. Scholarships will be provided for graduate study on international courses in the fields of related to various priority actions.

Significant capacity building is required for the Kenya National Bureau of Statistics (KNBS) to provide good quality and timely data. Capacity and training needs include good observational network, efficient telecommunications system, data processing facilities for product generation and data archival, trained human resources, and effective dissemination system. Further training and capacity building for sectoral staff is required in sectoral greenhouse gas emission baselines and emission factors.

All actions to create awareness and build capacity will build on exiting efforts.

Integrated Planning and Data Management

Climate change is a cross-cutting issue with long-term impacts on the economy of Kenya. Due to the multi-sector constraints facing the country, integrated planning of multiple sector measures is necessary. Such planning systems will enable the GoK to invest in the most efficient way, producing the maximum return on investment while accommodating different sector needs during the implementation of the NCCAP 2018-2022.

To facilitate data and facts-based decisions and scenario planning, the collection, analysis and application of robust data across sectors will be required. An integrated set of analyses is required to understand the feedbacks and interconnections between various climate-sensitive systems under future scenarios. The institutional arrangements in the Climate Change Act 2016, together with the application of the MTP and CIDP process, will provide the framework for integrated planning and data management.

With regard to mitigation measures, the most critical data sets required currently are those required to generate emission baselines and business-as-usual scenarios for the various sectors. Key variables are ongoing activity data and greenhouse gas emission factors. There are significant data gaps in the forestry sector and biomass energy subsector. Additional manpower is needed to address these gaps in data collection, measurement and analysis, along with additional training and associated costs.

Monitoring, Reporting and Verification (MRV) system

Introduction

The principal objective of the Monitoring, Reporting, and Verification (MRV) system is to measure, report, and verify accomplishments of an action in terms of achieving its stated specific goals and objectives. The "burden of proof" that an action is effective and is making a difference falls upon the efforts and reporting undertaken by the MRV system. The MRV system will address critical information from the proposed action activities, and monitors, reports and verifies outcomes using commonly accepted methodologies and practices that meet the high standards and expectations of both national and international stakeholders and donors.

For Kenya, an MRV system is necessary to ensure effectiveness and accountability of climate change actions, including the implementation of the NCCAP 2018-2022 actions, for the realisation of a low carbon climate-resilient growth and sustainable development. NCCAP 2018-2022 (MTAR Component) aims to assist the country in realising the following broad objectives:

- Achieve sustainable development goals as envisaged in Vision 2030
- Realise climate change mitigation[158]

The MRV system will enhance transparency in tracking the progress towards the realisation of the above objectives. The goals and measures for tracking performance with regard to the NCCAP 2018-2022 (MTAR Component) therefore inherently arise from these objectives. The focus of the MRV effort will therefore be the two intrinsic goals for all sectors of the Kenyan economy. The areas of focus for the MRV system are summarised in the table below.

Table 4.2: MTAR MRV Focus Areas

MTAR Objectives	Intrinsic UGGDS Goals
Objective 1 – To mitigate climate change and attract climate financing.	Mitigate GHG Emissions Attract climate financing
Objective 3 – Achieve development goal as per Vision 2030 and attract development financing	Sustainable Development Goals (SDGs) and Socio-Economic Co-benefits Attract development financing

Three key aspects of MRV system are of particular relevance to the implementation of the MTAR in Kenya.

First, planning, implementation and decision-making on effective use of resources all require monitoring and evaluation, with baseline data and indicators. In general, a set of tools is used before the intervention takes place, or after the intervention, tracking expected or realized outcomes. For MTAR implementation, the baseline data and indicators have already been determined for most of the actions but there are gaps that need to be filled before implementation of the various mitigation actions begin. In most cases, determination of the baseline scenario and indicators will be part of the detailed project proposal. This helps to ensure that resources for sustainable development and low carbon development are well spent and that the results are communicated back to decision makers and stakeholders for any appropriate actions or decision.

Climate change interventions will be linked to the delivery of sectoral development objectives and are consistent with national priorities. However, monitoring, reporting and verification on these mitigation actions will require the strengthening of existing information systems that also integrate the MRV requirements of the MTAR. As part of the plan implementation, and through the ongoing Capacity-building Initiative for Transparency (CBIT) and Initiative for Climate Action Transparency (ICAT) projects, the MRV system will be therefore be reviewed to integrate the MRV requirements of the MTAR. While the ICAT will focus on the energy sector, the CBIT will support the development of an MRV system for all the six UNFCCC mitigation sectors in Kenya.

Secondly, for Kenya to receive international support for its voluntary contributions to tackle climate change, the MRV system will be necessary. The MRV system will include a registry to keep track of whether the international support promised is really being provided, and the sustainable development benefits realised as well as monitoring, reporting and verifying whether climate change actions are in operation, how successful they are and to what extent they reduce emissions and create effective adaptation. The development of relevant gender sensitive indicators as part of Kenya's monitoring and reporting system is also crucial.

An effective MRV system for Kenya's REDD+ activities will enable the country to access larger scale international support and has received international support for building the required institutional and technical capacity. In addition, a REDD+ system needs to link to a wider national system for MRV to avoid duplication and increase coherence, especially with changes in reporting needs for all stakeholders.

For both the voluntary contributions and REDD+ activities, the MRV system will also provide the required information for the purpose of sharing benefits (carbon credits) with communities involved in the implementation of certain measures. Such a system also includes a definition of benefit sharing arrangements.

Third, Kenya has reporting obligations to the UNFCCC. The biennial update reports (BURs) containing updates of national greenhouse gas inventories, including a national inventory report and information on mitigation actions, needs and support received is to be prepared every two years while the national communication containing the same information, among others, is to be prepared every four years. The MRV system and the associated data will be used as the basis for preparing the reports.

This section covers the MRV system that would be integrated into a national framework to realise the above key aspects of the MRV system.

The Proposed Monitoring and Evaluation (M&E) Framework for the National Climate Change Policy Implementation

Effective implementation of the MTAR and hence the NCCAP 2018-2022 is highly dependent on the internal "feedback" generated through monitoring, reporting and verification (MRV) processes. Without an MRV system, it will be impossible for the GoK to assess the effectiveness of investment in mitigation, or to determine whether the funds are being spent well.

The MRV framework is underpinned by the need to promote efficiency and effectiveness in service delivery to achieve results as well as transparency and accountability in the use of available resources. In addition, the continuance of international funding for climate change activities depends on effective MRV.

Bilateral aid agencies, multilateral development banks and other providers of finance need the results of MRV systems to validate the effectiveness of funds they provide. Therefore, securing further financial support for the implementation of the mitigation actions will be dependent on the successful establishment of the MRV framework.

To assist in the process of effective and efficient implementation of the mitigation actions, as well as to promote the lesson-learning through this process, it is paramount to develop a clear set of building blocks to organise the monitoring, reporting and verification of the implementation process.

Monitoring, Reporting and Verification (MRV) System

A key component of the proposed M&E Framework for the implementation of the NCCP is an overarching MRV system that can deliver both MRV of greenhouse gas (GHG) emissions and mitigation activities and monitoring and reporting of the adaptation activities. The MRV system will assist by:

- Providing guidance on the implementation of climate change response actions (both adaptation and mitigation actions), whether in the form of policies, projects, programmes or business ventures
- Helping fulfil Kenya's international reporting obligations: for example, by assisting in developing its GHG inventory and tracking mitigation and adaptation actions ready to report to the UNFCCC through National Communications (NCs) process. The MRV system will formalise and institutionalize the process for producing the GHG inventory and NCs
- Demonstrating the country's climate finance readiness and providing a strong platform for attracting international climate finance flows from multilateral and bilateral development partners.

The proposed MRV system involve the following three broad activities:

- **Measurement and monitoring:** Data and information will be gathered, quality checked and fed into the system. Monitoring will be a continuous process capturing all the data in real time. The formats and procedures, together with the instruments, for data collection are to be predetermined.
- **Data analysis and reporting:** The data is analysed and used to calculate other parameters and/or get information in prescribed formats. The results are then used to prepare a monitoring report in an appropriate but predetermined format.
- **Verification (and evaluation):** The report is then used by a third-party verifier to verify that all activities have been carried out as planned and that the expected results have been realised. Usually, a verification process includes a site visit by the verifier. After a verification activity, a verification report is produced by the verifier. The report can be positive or negative depending on the findings.

The MRV system will be built on existing institutions, capacities and skills. The agreed structure for implementation of the NCCAP will be used for data collection and internal data quality checks and reporting. Existing M&E systems within the Ministries, Departments and Agencies (MDAs) and M&E related governance structures will be used to collect and analyse data before reporting for the MRV system. The actual data to be collected will be determined within the sectors and mitigation actions.

However, arrangements required by the MRV system and the additional functions of the various participants in the M&E Framework require a significant capacity. This capacity will be built over time in different sectors of the Kenyan economy and capacity building activities will be identified and planned as part of the implementation of the NCCAP 2018-2022. Different aspects and components of the MRV system will be built in a phased-out manner.

As part of the implementation of the NCCAP2018-2022, the MRV system will be integrated into and made part of the M&E Framework for the implementation of the NCCAP 2018-2022. As part of the integration, the sustainable development goals (SDGs) indicators will be reviewed to sharpen and align the indicators with Kenya's SDG targets. The final M&E Framework will be appropriate as a basis for ensuring the full implementation of the NCCAP 2018-2022 and for the development of specific performance indicators and targets for each mitigation action by sector. The framework also proposes accountabilities for the actors that are tasked to implement them.

However, to meet international reporting obligations to the UNFCCC through National Communications, GHG inventories will need to be produced on a regular basis. Therefore, there is need for a clear methodology and team in place to continually improve the transparency, accuracy, completeness, comparability, consistency of the GHG inventory each time it is produced. This will be set up through the CBIT project.

Monitoring

Each lead ministry, department and agency for which accountabilities have been identified under the costed implementation strategy will have a role to play in monitoring and reporting. It is expected that as each partner in the NCCAP 2018-2022 implementation process tailors the indicative strategy guidance to its own work planning, specific performance measurement frameworks (PMFs) to organise the monitoring and reporting function for each partner will also have to be developed as part of the planning process, with guidance from the CCD, to ensure a common format that can easily be consolidated.

Such individual PMFs, as well as the overarching PMF, will present, for each category of results (outcomes and outputs in particular), performance indicators and targets, as well as methods and data sources to be used to streamline the monitoring and reporting responsibilities.

In addition to monitoring and enforcement against the M&E Framework, the implementation of the NCCAP will undergo an independent external evaluation in 5 years' time, while some specific mitigation actions will undergo annual third-party verification reviews. The recommendations resulting from this evaluation will then feed into the revision process for future action. This revision is to be carried out based on a thorough public consultation process and review of the results at that point in time.

To this end, it will have a team of experts working on each of the six mitigation sectors to monitor projects so as to ensure their effectiveness, measure, report, and verify (MRV) project outcomes, and provide appropriate access to information on projects and outcomes to the public. This will be done in a manner that is transparent, cost-efficient, utilizes a sound institutional framework, and provides transparent, consistent, comparable, complete and accurate data. Preferably, such efforts will be internationally comparable with the efforts of other parties to the UNFCCC, especially in terms of determining an appropriate baseline approach and identifying the methodologies pursued in

the estimations of the GHG emission reductions. The MRV system should establish the environmental integrity of mitigation actions and ensure that no double-counting occurs. Finally, the MRV system must recognize the unique set of circumstances, requirements, and limitations of Kenya and those of involved stakeholders, and will therefore be developed by the local stakeholders with appropriate international support.

Reporting

The various ministries, departments and agencies (MDAs) concerned with implementation of the NCCAP 2018-2022 are expected to report on a quarterly and semi-annual basis on their progress in the implementation of their respective tasks and in the attainment of their expected results under the NCCAP 2018-2022. This information will be reported to the CCD and copied to the National Treasury and the Ministry of Devolution and Planning. Monitoring reports generated through the MRV system will also follow the same reporting hierarchy and frequency. However, the data and information reported will be different and will be in accordance with the MRV system requirements.

The National Climate Change Commission (NCCC) under the Ministry of Water and Environment (MWE): The reporting from the various ministries, departments and agencies will be consolidated as relevant at the national level by the CCD. The CCD will be tasked with preparing a consolidated annual progress report on the overall implementation of the NCCAP, for consideration by the Climate Change Council. The CCD will also be responsible for the development of the MRV system and its integration into the M&E Framework for implementing the NCCAP. The CCD will provide guidance to the various MDAs as they develop their PMFs and reporting formats, to ensure consistency and focus on result-based management in the implementation of the NCCAP 2018-2022.

The Ministry of Devolution and Planning and will review development plans and budgets of county governments to ensure they mainstream climate change and low-carbon development issues. It will in addition review relevant reports from the county governments to ensure the quality of the reporting and consolidate reporting on county-level actions towards the implementation of the NCCAP 2018-2022 on a semi-annual basis. This information will be reported to the National Treasury and the CCD.

The National Treasury and the Ministry of Devolution and Planning will be responsible for resource mobilization, formulation of national budgets, and disbursement of NCCAP 2018-2022 budgetary resources, financial accountability, and budget monitoring and reporting. It will also review quarterly and semi-annual reports from the ministries, departments and agencies concerned, to ensure that resource use is in line with expected and actual progress in implementing the NCCAP.

Development Partners will support the M&E framework and in particular the development of an MRV system by providing financial and technical assistance for the integration of the MRV system into the M&E Framework, the operationalization of the M&E system; the refinement of indicators, tools and processes; and the implementation of M&E activities, capacity building for M&E, and use of M&E products.

Civil society and private sector organisations, through their representation on the multi-stakeholder frameworks, will also play a key role in the monitoring function.

This will be done, for instance, through their review of the consolidated progress reports on the implementation of the NCCAP. They will also provide feedback from civil society and the private sector to present their own evidence on the pace of progress of the implementation and their own reporting on their actions towards the implementation of the NCCAP.

Due to the importance of quality reports for the proposed M&E framework and the setting of appropriate performance targets, particular attention should be paid to the equal application of criteria and standards, as well as the comparable use of formats in reporting. To assume their roles, the various M&E actors therefore need certain capacities, both in terms of human resources and technical know-how. In addition, the CCD, given its key role in consolidated reporting at the national level, will require adequate capacity to perform this function effectively. Care should be taken, as part of the early activities in operationalizing the institutional framework for the implementation of the policy, to provide adequate resources for this monitoring function, in both the CCD and the line and cross-cutting ministries that have to report on their actions.

Communication of the NCCAP and priorities for the current MTP, together with regular engagement with all stakeholders and partner organisations is critical to its success.

Evaluation and Verification

The first independent evaluation of the NCCAP should take place in 2020 and should ideally be commissioned by the Climate Change Council. A steering committee under the CCD will be set up to develop the terms of reference and to provide guidance to the independent evaluation team contracted to conduct this evaluation. This steering committee will constitute a balanced representation of the various ministries, departments and agencies involved in the implementation of the policy, donors supporting the policy implementation process, civil society and private sector representatives involved in policy implementation. Ideally, this steering committee should be chaired by a representative with strong credentials in evaluation.

For mitigation related measures and activities, and for which emission reductions will be determined, annual third-party verification will be carried out in accordance with the established standards such as the Clean Development Mechanism (CDM) and the Gold Standard. The verification requirements, which are part of the MRV system, will be incorporated in the M&E Framework for the national NCCAP 2018-2022 implementation.

Implementation of Monitoring

A starting point for all monitoring activities will be the determination of the key indicators that best give a quantitative or qualitative indication of performance or achievement relative to the goals identified above.

The baseline scenario is the scenario for a given measure that reasonably represents the status before implementation of the measure. For each action, and for the baseline scenario, the baseline anthropogenic emissions by GHG sources, climate resilience as well as sustainable development indicators will be determined before implementation of the NCCAP 2018-2022 action.

Implementation results will then be tracked and monitored relative to the baseline indicators.

For each action, a monitoring plan will be prepared before the action is implemented. Each monitoring plan will define the parameters to be monitored for GHG emission reductions determination with the following details:

- Type of parameter
- The data unit
- Description of the parameter
- Measurement criteria/means of measurement
- Source of the data

- Frequency of data collection
- Quality assurance/quality control arrangements for the data
- Other remarks or comments.
- Appropriate data collection tools will be designed for use before implementation to ensure completeness and consistency.

Monitoring procedures will also include corresponding indicators for sustainable development benefits, financial management, and the implementation status.

The data will be analysed to obtain performance indicators that provide signals for action. Data gathering is a costly and time-consuming exercise and will be well targeted. The need for collecting and utilising information has been stressed and large amounts of data will be collected and processed into useable information. But it has to be kept in mind that information per se is only valuable when it is focused and used to a specific end.

Low Carbon Development Reports

As part of the plan implementation, the GoK will be preparing a State of the Low Carbon Development Report on a regular basis. This report will inform the public about the status of progress in the implementation of the mitigation actions and help the country take the right course and make solid advances towards a low carbon development through monitoring and reporting its progress.

The report will provide the public with a clear overview of the government's plan for low carbon development, diverse public and private efforts and their achievements, as well as an international benchmarking of the country's current standing based on objective performance indicators. The first edition of the report, the report also includes a substantial amount of background information to help domestic and global readers to understand Kenya's national context and prospect for low carbon development transition.

This report will be compiled by CCD, using information from various sectors of the economy.

Delivery of Low Carbon Development Training and Knowledge Sharing Workshops for Stakeholders

The first workshop for the public and private sector will be held in the first quarter of 2019, introducing an overview of low carbon development pathway in the areas of policy and technology.

Subsequent Workshops in the Climate Change Knowledge Sharing Program will be held on need-basis and as determined and scheduled by the CCD in consultation with the Climate Change Council.

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[158] The international development partners are looking for results-based GHG mitigation. They wish to see rigidly developed and quantified GHG baselines and GHG mitigation reductions. These must be rigidly defined, monitored, reported, and independently verified on an annual basis.