Republic of Kenya

Ministry of Environment, Climate Change and Forestry





NATIONAL CLIMATE CHANGE ACTION PLAN (NCCAP) III 2023-2027 - VOLUME II

MITIGATION TECHNICAL ANALYSIS REPORT (MTAR)

Towards Low Carbon Climate Resilient Development

www.environment.go.ke





Correct citation:

Government of Kenya. (2023). *Mitigation Technical Analysis Report (MTAR) 2023–2027*. Ministry of Environment, Climate Change and Forestry, Nairobi, Kenya.

Copyright © 2023 Government of Kenya

Reproduction of this publication for educational or non-commercial purposes is authorised without written permission from the copyright holder, provided that the source is fully acknowledged. Reproduction of the publication for resale or other commercial purposes is, however, strictly prohibited, except with prior written permission from the copyright holder.

Cover Design and Layout: Boniface Gor, *@digimattsol*, *www.digimatt.co.ke*

Photo Credits:

For further information, please contact:

Principal Secretary

Ministry of Environment, Climate Change and Forestry

State Department of Environment and Climate Change

Email: psoffice@environment.go.ke

Website: www.environment.go.ke

Please consider the environment before printing this publication. If you have to print it, please use recycled paper, and print on both sides of the paper.



NCCAP 2023–2027 Secretariat / Climate Change Directorate

Pacifica Ogola
Thomas Lerenten Lelekoitien
Augustine Kenduiywo
Samuel Muchiri
Michael Okumu
James Thonjo
Brian Mounde
Ressa Kombi
Josephine Ofula
Ruth Nyamasege
Yvonne Nyokabi

MTAR 2023–2027 Process Coordinator

Agustine Kenduiwo

Youth and Children Consultation Coordination Team

James Thonjo
Sheila Ngare
Bob Aston
Passy Ogolla
Patricia Kombo
Julius Mbatia
Sammy Sikinyi
Joanita Mudambo
Victor Kirwa
Duncan Mueke
Leah Kanunka
Amina Mohamed

NCCAP 2023–2027 Consulting Team

Dr Robert Kibugi	NCCAP Consultant and Team Leader
Dr Aggrey Adimo	ATAR Consultant
Calvince Mbeo	MTAR Consultant
Deborah Murphy	ATAR, NCCAP Reviewer

TABLE OF Contents

List of Tables vii
List of Figures xi
List of Boxes xiii
List of Abbreviations xxiii
Definition of Terms xiv
Executive Summary xxiv

p01 CHAPTER 01 Introduction

1.1. Projected Climate Change 4
1.2. Kenya's Commitments to Climate Change 10
1.3. The Kenya Development Agenda and Alignment to NCCAP 11
1.3.1. Progress of Implementation of Mitigation Actions During MTP II and III 16
1.3.2. Mainstreaming Climate Change in Development Planning 17

p21 CHAPTER 02 Methodology for NCCAP 2023–2027

2.1. Documents Review 22
2.2. Stakeholder Engagements 23
2.3. Modelling NCCAP III 25
2.3.1. Low Emission Analysis Platform tool 25
2.3.2. LEAP Data Structure. 26
2.3.3. LEAP Scenarios 27
2.3.4. Drivers of Energy and Non-Energy GHG Emissions 28

TABLE OF Contents

p31 CHAPTER 03 **Kenya's GHG Emissions Baseline and Mitigation Potential Projection**

3.1.	Baseline GHG Emission Projection	32
3.2.	Updated NDC Greenhouse Gas Emission Projections and Mitigation Targets	37

p41 CHAPTER 04 **GHG Mitigation Implementation Status as of 2022**

4.1.	**Energy Sector (Demand and Supply) Mitigation Actions Implementation Status**	**42**
4.1.1.	*Energy Demand*	*42*
4.1.2.	*Electricity Supply*	*78*
4.2.	**Transport Sector**	**89**
4.2.1.	*Overview of the Sector and GHG Emission Profile by Source*	*89*
4.2.2.	*Transport Sector Data Inputs and Assumptions.*	*94*
4.2.3.	*Transport Sector GHG Emission Mitigation Targets and Achievements in 2018–2022*	*70*
4.2.4.	*Challenges Faced and Lessons Learnt in Implementation of NCCAP II*	*99*
4.3.	**Agriculture Sector**	**101**
4.3.1.	*Overview of Agriculture Sector*	*101*
4.3.2.	*Agriculture Sector Data Inputs and Assumptions*	*103*
4.3.3.	*Agriculture Sector Mitigation Targets and Achievements in NCCAP II*	*105*
4.3.4.	*Challenges Faced and Lesson Learnt in the Implementation of NCCAP II*	*112*

TABLE OF Contents

4.4.	**Industrial Processes and Product Use**	**114**
4.4.1.	*Overview Industrial Processing and Product Use*	*114*
4.4.2.	*IPPU Sector Data Inputs and Assumptions*	*122*
4.4.3.	*IPPU Sector Mitigation Targets and Achievements*	*123*
4.4.4.	*Challenges Faced and Lessons Learnt in the Implementation of NCCAP II*	*128*
4.5.	**Waste**	**129**
4.5.1.	*Overview of the Waste Sector*	*129*
4.5.2.	*Waste Sector Data Inputs and Assumptions.*	*130*
4.5.3.	*Waste Sector Mitigation Targets and Achievements*	*135*
4.5.4.	*Challenges Faced and Lessons Learnt in the Implementation Period*	*138*
4.6.	**Forestry**	**139**
4.6.1.	*Overview of the Forestry Sector*	*139*
4.6.2.	*Data Inputs and Assumptions*	*144*
4.6.3.	*Mitigation Targets and Achievement in NCCAP II*	*149*
4.6.4.	*Challenges Faced in the Implementation of NCCAP II*	*153*
4.7.	**Summary Progress on Emission Reduction in 2022**	**154**

p157 **CHAPTER 05** **Mitigation Actions for 2023–2027**

5.1.	**Energy**	**159**
5.2.	**Transport**	**170**
5.3.	**Industrial Process and Product Use**	**173**
5.4.	**Agriculture**	**176**
5.5.	**Waste**	**183**
5.6.	**Forestry**	**186**

TABLE OF Contents

p191 CHAPTER 06 **Implementation Plan**

6.1.	Overview of Implementation Plan	192
6.2.	Implementation Approach	193
6.3.	Enablers	205
6.4.	Monitoring, Reporting and Verification (MRV) System	211

p213 CHAPTER 07 **Cross-cutting Issues/Actions**

7.1.	Carbon Markets	214
7.2.	Gender, Youth, Children and Persons with Disabilities Inclusion in Climate Change Mitigation in Kenya	217
7.3.	Non-Market Approaches	220

p223 **References**

List of Tables

Table 0 1.	Summary of emission reduction potential by sector in NCCAP III	xxvi
Table 1-1.	Summary of development priorities in MTPs with GHG emission/abatement contribution potential	12
Table 2-1.	High-level demographic and macroeconomic assumptions	28
Table 2-2.	GDP growth model for the period 2023–2027 - Medium Term Plan IV	29
Table 3-1.	BAU Scenario and Baseline Emissions for First NDC (GoK, 2013)	34
Table 3-2.	GHG emission abatement potential	38
Table 3-3.	GHG emission reduction projections, potentials, and targets relative to BAU in NDC, NCCAP	39
Table 4-1.	The evolution of residential cooking energy source in percent share	51
Table 4-2.	Status of residential fuel and fuel conversion technology use in 2019	53
Table 4-3.	Data for residential cooking derived from KIHBS 2015/2016	55
Table 4-4.	Energy intensity for various cooking fuels	57
Table 4-5.	The evolution of proportion of households lighting by fuel source	59
Table 4-6.	Residential lighting	60
Table 4-7.	Commercial and industrial sector value add to total GDP (Drivers of commercial and industrial demand)	62
Table 4-8.	Fossil fuel demand and supply	62
Table 4-9.	Petroleum and electricity sales by sector	64
Table 4-10.	Balancing final energy demand by sector	65
Table 4-11.	Energy demand balance in commercial and industrial sectors	66
Table 4-12.	Summary of NCCAP 2018–2022 priority actions, targets, and achievement in the residential sector	68
Table 4-13.	Change in number of households adopting modern fuels	69
Table 4-14.	Adoption of improved and efficient cookstoves and decline in over dependence on traditional cookstove	70
Table 4-15.	Energy demand sector emission time series as of 2022 against the baseline scenario	74
Table 4-16.	Emission factors for burning wood and charcoal.	75

List of Tables

Table 4-17.	Illustration of modelled GHG emissions based on historic data in LEAP tool and areas of significant difference with updated NDC	77
Table 4-18.	Historic electricity generation and installed capacity as of 2022	83
Table 4-19.	Captive and mini-grid electricity systems	84
Table 4-20.	GHG emission abatement in the electricity sector	86
Table 4-21.	Cumulative stock of vehicles by category	91
Table 4-22.	Annual mileage and Fuel economy	92
Table 4-23.	Rail transport data	92
Table 4-24.	Summary maritime modelling data	93
Table 4-25.	Achievement status of NCCAP II	94
Table 4-26.	Progress in cargo handling by rail and other sources	96
Table 4-27.	Distribution of fleet of cars on the road by fuel type	97
Table 4-28.	Transport sector GHG emission between 2018–2022	98
Table 4-29.	GHG emission mitigation status in the transport sector in million tonnes of CO2eq	98
Table 4-30.	Livestock population data for enteric fermentation	103
Table 4-31.	Emission factors for livestock enteric fermentation by type	104
Table 4-32.	Activity level data for crop farming of the major crops grown in Kenya.	104
Table 4-33.	Time series of the area under rice production in Kenya categorised by farming practice (in hectares)	105
Table 4-34.	Summary of priority actions and implementation status	106
Table 4-35.	Agricultural sector emission in baseline projection and actual in the planning period	109
Table 4-36.	GHG emissions in the agricultural sector	110
Table 4-37.	Charcoal Kiln types and their efficiencies	116
Table 4-38.	Refrigerant and air conditioning gases used in Kenyan cooling appliances in tons.	121
Table 4-39.	Industrial process data for GHG emission accounting	122
Table 4-40.	HFC imported in the country for cooling in stationary and mobile refrigerants in tonnes	123

List of Tables

Table 4-41.	Priority actions and implementation status under IPPU	124
Table 4-42.	GHG emission status for IPPU	127
Table 4-43.	Solid waste generation and collection status in Kenya's urban areas	132
Table 4-44.	General assumptions for municipal solid waste modelling	133
Table 4-45.	Solid waste characterisation	133
Table 4-46.	Domestic water emission classification	134
Table 4-47.	GHG emission estimation parametres for industrial wastewater from four main agri-food and pulp industries	134
Table 4-48.	IPCC default parameters for Tier 1 emission estimation from wastewater	135
Table 4-49.	Summary of mitigation actions and implementation status in the waste sector	135
Table 4-50.	Status of GHG emission in the waste sector	138
Table 4-51.	Land conversion matrix in the period of 2014 - 2018	141
Table 4-52.	Emission factors used in land conversion GHG emission and sink analysis	144
Table 4-53.	Forest change matrix for the period 2014–2018 in hectares	145
Table 4-54.	Summary action and implementation status for NCCAP 2018–2022	149
Table 4-55.	Forestry sector emission status analysis	151
Table 5-1.	Overall GHG emission and abatement potential in NCCAP 2023–2027	149
Table 5-2.	Residential sector modelling assumptions	159
Table 5-3.	Residential energy sector emission	165
Table 5-4.	Potential emission reduction from the commercial and industrial sector GHG emissions	167
Table 5-5.	Emission reduction potential in electricity generation	169
Table 5-6.	Priority mitigation actions in the transport sector	170
Table 5-7.	GHG emission mitigation potential in the transport sector	172
Table 5-8.	Emission trend in mineral and chemical processes	173
Table 5-9.	Trend in GHG emission in refrigeration and air conditioning	174

List of Tables

Table 5-10.	Priority mitigation actions under IPPU	174
Table 5-11.	GHG emission in IPPU	175
Table 5-12.	Growth projection in key agricultural sectors in accordance with MTP IV	176
Table 5-13.	Agricultural sector mitigation actions	177
Table 5-14.	Summary of emission reduction	182
Table 5-15.	Summary of priority mitigation actions in waste sector	183
Table 5-16.	Summary emission abatement potential	185
Table 5-17.	Priority actions for NCCAP III	186
Table 5-18.	Summary forest sector GHG abatement	189
Table 5-19.	Risks and mitigation measures in implementing forestry sector actions.	189

List of Figures

Figure 0-1.	GHG emission projection for Kenya in the adjusted BAU emission scenario	xxv
Figure 1-1.	Rainfall climatological zones for Kenya based on annual total rainfall	3
Figure 1-2.	Absolute change in air temperature in RCP 2.6 and 8.5	4
Figure 1-3.	Annual average temperature anomaly for 2022 relative to the reference period of 1991–2022	5
Figure 1-4.	Relative change in precipitation in Kenya	6
Figure 1-5.	Average annual precipitation trends and projections for the period 1986–2099	7
Figure 1-6.	Figure 1-6. Spatial distribution of rainfall anomalies for 2022 at annual (a), and seasonal; March–April–May (MAM) (b) and October–November–December (OND) (c) time scales	8
Figure 1-7.	MAM 2022 rainfall totals compared to Long-Term Mean (LTM) for MAM (1991–2020)	9
Figure 1-8.	Delivery of development and climate action at national and devolved levels	18
Figure 2-1.	NCCAP development process and stakeholders' engagement framework	24
Figure 2-2.	General computation approach	25
Figure 2-3.	LEAP tree branches	26
Figure 2-4.	NCCAP III scenarios modelling	27
Figure 3-1.	Baseline Scenarios projection	34
Figure 3-2.	National GHG Emissions Trends (BAU Scenario and NIR 3) (MtCO2e)	36
Figure 3-3.	NCCAP 2013–2017 BAU Scenario and Baseline Emissions for First NDC (GoK, 2013)	37
Figure 4-1.	The evolution of energy demand in Kenya	43
Figure 4-2.	Historic trend in residential energy consumption	44
Figure 4-3.	Residential energy demand by source	45
Figure 4-4.	Final energy demand in urban households by source	45
Figure 4-5.	Final energy demand in rural households in 2022	45
Figure 4-6.	Energy demand in industrial and commercial sectors	46
Figure 4-7.	Energy demand in service, manufacturing, and construction sectors	47
Figure 4-8.	Section of tree structure in a bottom-up approach in residential energy sector scenario modelling	49
Figure 4-9.	Demographic trend disaggregated in rural and urban areas	50

List of Figures

Figure 4-10.	Evolution of residential cooking energy by proportion of households using energy sources	52
Figure 4-11.	Kerosene consumption trend	58
Figure 4-12.	Evolution of residential lighting by fuel source	59
Figure 4-13.	Residential sector GHG emissions in the planning period (2018–2022)	71
Figure 4-14.	Commercial and Industrial energy demand emission in the planning period (2018–2022)	72
Figure 4-15.	Overall energy demand sector emission in the planning period against projected baseline emission at AR5 and AR3	73
Figure 4-16.	Illustration of biogenic methane and nitrous oxide consideration in LEAP tool	75
Figure 4-17.	Demand emission from stationary biomass combustion	76
Figure 4-18.	Additional capacities (MW) achieved between 2016 and 2022	79
Figure 4-19.	Total national installed capacity and electricity grid mix for Kenya.	80
Figure 4-20.	Typical daily load curve	81
Figure 4-21.	Evolution of technical and commercial system losses	82
Figure 4-22.	Electricity generation by source in the planning period	85
Figure 4-23.	GHG emissions by power plant	86
Figure 4-24.	Cumulative growth of road transport vehicles by type	89
Figure 4-25.	Fuel consumption in the aviation sector	90
Figure 4-26.	Population growth of livestock in NCCAP II period	108
Figure 4-27.	Agriculture sector emission relating to reference scenario projection, updated NDC computation, and LEAP modelling using two GWP of methane (AR3–21 times GWP and AR5–28 times GWP)	109
Figure 4-28.	Cement production in Kenya	115
Figure 4-29.	Common brands of refrigerators in Kenya	119
Figure 4-30.	Capacity distribution of registered brands of air conditioning	120
Figure 4-31.	GHG emissions from the cement industry	125
Figure 4-32.	Emission avoidance resulting from charcoal production	126
Figure 4-33.	Industrial Process and Product Use GHG emission between 2018–2022	127

List of Figures

Figure 4-34.	Changing population between urban and rural areas	131
Figure 4-35.	GHG emission from different waste streams	137
Figure 4-36.	Kenya Forest Cover Trend for the period between 1990–2018	140
Figure 4-37.	Percent change in emission resulting from different land conversion types	142
Figure 4-38.	Total emission and sink from different land conversion types.	143
Figure 4-39.	Summary of GHG emission evolution until 2022 against the reference projections	154
Figure 4-40.	Progress towards achievement of NDC in 2022	155
Figure 5-1.	Overall GHG emission and abatement potential in NCCAP 2023–2027	158
Figure 5-2.	Evolution of electricity access in 2027	162
Figure 5-3.	NCCAP 2023–2027 residential sector emission projection	164
Figure 5-4.	Emission abatement projection in residential sector with 2023 as the reference year.	165
Figure 5-5.	Commercial sector energy efficiency benefits and GHG emission abatement co-benefits	167
Figure 5-6.	Projected Emission reduction from electricity generation	168
Figure 5-7.	Evolution of rice production in the intensified rice production scenario	179
Figure 5-8.	GHG emission in different modelled scenarios against the BAU	182
Figure 5-9.	Summary emission projection in different scenarios	185

List of Boxes

Box 1	Kenya's adaptation goal	77
Box 2	IPCC concepts: Components of climate risk	110
Box 3	Kenya's nationally determined contribution	137
Box4	Kenya declaration at Africa Climate Week and Summit 2023	152

Acronyms and Abbreviations

AAK-GROW	Agrochemicals Association of Kenya
ABC	Africa Biogas Component
ABG	Aboveground Biomass
ADPs	Annual Development Plans
ANSP	Air Navigation Service Providers
AR	Assessment Report
ASAL	Arid and Semi-Arid Land
ASCU	Agricultural Sector Coordination Unit
ASDSP	Agricultural Sector Development Support Programme
ATAR	Adaptation Technical Analysis Report
BAU	Business as Usual
BETA	Bottom-up Economic Transformation Agenda
BGB	Belowground Biomass
BRT	Bus Rapid Transit
CA	Conservation Agriculture
CAIDI	Customer Average Interruption Duration Index
CAIPs	County Aggregated Industrial Parks
CBOs	Community-Based Organisations
CCCF	Climate Change Challenge Fund
CCD	Climate Change Directorate
CCF	Climate Change Fund
CCPC	County Climate Change Planning Committees
CDAs	County Departments and Agencies
CDM	Clean Development Mechanism
CFA	Community Forest Association

Acronyms and Abbreviations

CFCs	Chlorofluorocarbons
CFL	Compact Fluorescent Light
CIDP	County Integrated Development Plan
CNG	Compressed natural gas
CO_2eq	Carbon dioxide equivalent
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CSA	Climate-smart agriculture
CSA-MSP	Climate Smart Agriculture-Multi-Stakeholder Platform
CSOs	Civil Society Organisations
DMUs	Diesel Multiple Units
DOC	Dissolved Organic Carbon
EAC	East African Community
E-GK	Electric Government of Kenya (GK) vans
EPR	Extended Producer Responsibility
EPRA	Energy and Petroleum Regulatory Authority
EPPs	Embedded Power Producers
ESCOs	Energy Service Companies
ESG	Environmental, Social, and Governance
ESMAP	Energy Sector Management Assistance Program
EVs	Electric vehicles
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FiT	Feed-in Tariff
FLLoCA	Financing Locally-Led Climate Action Program

Acronyms and Abbreviations

FOLAREP	Forest and Landscape Restoration Implementation Plan
FRL	Forest reference level
FSC	Forest Stewardship Council
GCF	Green Climate Fund
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GECCO	Global e-Cooking Coalition
GESIP	Green Economy Strategy and Implementation Plan
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GJ	Gigajoule
GoK	Government of Kenya
GWh	Gigawatt hours
GWP	Global Warming Potential
HCFCs	Hydrochlorofluorocarbons
HCW	Healthcare Waste
HDVs	Heavy-Duty Vehicles
HFCs	Hydrofluorocarbons
Hhd	household
HV	High-voltage
ICAO	International Civil Aviation Organization
ICDs	Inland Container Depots
IGAD	Intergovernmental Authority on Development
IKI	International Climate Initiative
IOC	International Oil Company

Acronyms and Abbreviations

IPs	Industrial Parks
IPCC	Intergovernmental Panel on Climate Change
IPPs	Independent Power Producers
IPPU	Industrial Process and Product Use
ITS	Intelligent Transport Systems
IUCN	International Union for Conservation of Nature
JKIA	Jomo Kenyatta International Airport
KAA	Kenya Airports Authority
KABDP	Kenya Agricultural Business Development Project
KAM	Kenya Association of Manufacturers
KCAA	Kenya Civil Aviation Authority
KCARs	Kenya Civil Aviation Regulations
KCB	Kenya Commercial Bank
KCC	Kenya Co-operative Creameries
KPC	Kenya Pipeline Company
KDHS	Kenya Demographic and Health Survey
KEFRI	Kenya Forestry Research Institute
KenGen	Kenya Electricity Generating Company
KeNHA	Kenya National Highways Authority
KEPHIS	Kenya Plant Health Inspectorate Service
KEPSA	Kenya Private Sector Alliance
KeRRA	Kenya Rural Roads Authority
KES	Kenyan Shilling
KFS	Kenya Forest Service
KIHBS	Kenya Integrated Household Budget Survey

Acronyms and Abbreviations

KIRDI	Kenya Industrial Research and Development Institute
KNBS	Kenya National Bureau of Statistics
KNCPC	Kenya National Cleaner Production Centre
KNEECS	Kenya National Energy Efficiency and Conservation Strategy
KOSAP	Kenya Off-Grid Solar Access Project
KPA	Kenya Ports Authority
KQ	Kenya Airways
KRC	Kenya Railways Corporation
KURA	Kenya Urban Roads Authority
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hour
KWTA	Kenya Water Towers Agency
LAPSSET	Lamu Port-South Sudan-Ethiopia Transport
LCPDP	Least Cost Power Development Plan
LEAP	Low Emission Analysis Platform
LITS	Livestock Identification and Traceability System
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
LTM	Long-Term Mean
LTS	Long-Term Strategy
LULUCF	Land Use, Land-Use Change and Forestry
MAM	March–April–May
MARPOL	International Convention for the Prevention of Pollution from Ships
MDAs	Ministries, Departments and Agencies

Acronyms and Abbreviations

MECCF	Ministry of Environment, Climate Change, and Forestry
MEPS	Minimum Energy Performance Standards
MGR	Metre Gauge Railway
MITI	Ministry of Investment, Trade and Industry
MOECCF	Ministry of Environment, Climate Change and Forestry
MoEF	Ministry of Environment and Forests
MoEP	Ministry of Energy and Petroleum
MoEWN	Ministry of Environment Water and Natural Resources
MOH	Ministry of Health
MoRT	Ministry of Roads and Transport
MRF	Material Recovery Facility
MRT	Mass Rapid Transit
MRV	Monitoring, Reporting, and Verification
MSMEs	Micro, Small, and Medium Enterprises
MSW	Municipal Solid Waste
MTAR	Mitigation Technical Analysis Report
MTPs	Medium-Term Plans
MV	Medium-voltage
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NaMATA	Nairobi Metropolitan Area Transport Authority
NARIGP	National Agricultural and Rural Inclusive Growth Project
NAP	National Adaptation Plan
NCAAP	National Climate Change Action Plan
NCCC	National Climate Change Council

Acronyms and Abbreviations

NCTIP	Northern Corridor Transport Improvement Project
NCTTCA	Northern Corridor Transit and Transport Coordination Authority
NDAs	National Designated Authorities
NDC	Nationally Determined Contribution
NEMA	National Environment Management Authority
NFI	National Forest Inventory
NFP	National Forest Programme
NGEC	National Gender and Equality Commission
NGOs	Non-governmental organizations
NIR	National Inventory Report
NLG	Natural Liquid Gas
NMT	Non-Motorised Transport
NTSA	National Transport and Safety Authority
NWMS	National Waste Management Strategy
OMCs	Oil Marketing Companies
OND	October–November–December
OPC	Ordinary Portland Cement
PAYG	Pay As You Go
PJ	Petajoules
PLC	Portland Limestone Cement
PoAs	Programme of Activities
PPA	Power Purchase Agreement
PPC	Portland Pozzolana Cement
PPPs	Public-Private Partnerships
PRG	Partial Risk Guarantee

Acronyms and Abbreviations

PROs	Producer Responsibility Organisations
RACHP	Refrigeration, Air Conditioning and Heat Pumps
RCP	Representative Concentration Pathway
RE	Renewable Energy
REDD+	Reducing Emissions from Deforestation and Forest Degradation plus the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
REREC	Rural Electrification and Renewable Energy Corporation
RWE	Round Wood Equivalent
SAF	Sustainable Aviation Fuel
SAIFI	System Average Interruption Frequency Index
SDGs	Sustainable Development Goals
SDoT	State Department for Transport
SEforALL	Sustainable Energy for All
SERC	Strathmore Energy Research and Centre
SEZ	Special Economic Zone
SF6	Sulfur hexafluoride
SGR	Standard Gauge Railway
SHS	Solar homes System
SLEEK	System for Land-Based Emissions Estimation in Kenya
SMRs	Small Modular Reactors
SNC	Second National Communication
SSA	Sub-Saharan Africa
SSMT	Site Species Matching Tools
SWH	Solar Water Heater
TCF	Trillion Cubic Feet

Acronyms and Abbreviations

TLUs	Tropical Livestock Units
TMC	Traffic Management Centre
TWh	Terawatt-hour
UNDP	United National Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

Definition of Terms

Scenario—This is a consistent story or a set of statements that describe how the future is expected to look like. It can be based on statistical models to predict future outcomes using past events as a reference, or be based on a descriptive explanation of what people expect or project might happen or change.

Baseline Scenario—These are the assumptions that formed the basis for the first Nationally Determined Contributions (NDC) projection until 2030 for all greenhouse gas (GHG) emission sectors. It is the starting point established in the initial National Climate Change Action Plan (NCCAP).

Business as Usual scenario—This refers to the assumptions that guided the first reference scenario emissions, which have been adjusted to incorporate changes resulting from the IPCC's (Intergovernmental Panel on Climate Change) 5th Assessment Report (AR5) on the Global Warming Potential (GWP) for methane and nitrous oxide, updates in forestry sector data, and Business as Usual (BAU) projections in Agriculture based on historical trends.

Executive Summary

Kenya has continued to lead the climate change debates across the region despite its shares of adverse climate change impacts including droughts, unpredictable rainfall patterns affecting agriculture and food security, flooding that have caused migrations, internally displaced persons, and loss of property. These extreme events are happening more often. Kenya's temperature patterns vary widely across different regions and times of the year (GIZ et al., n.d.). The latest climate report for Kenya showed that the Northwestern and Northeastern regions experienced the highest temperatures, reaching 35 °C to 40 °C from January to March in 2022. In contrast, most of the countries have cooler temperatures from June to August. On the other hand, future projections of precipitation are less certain (GoK, 2022). However, average rainfall is expected to increase by mid-century, particularly during the 'short rains', which occur between October and December. Even so, further analysis by the World bank indicates that extreme rainfall events are expected to increase in frequency, duration and intensity (World Bank, 2021).

Even though Kenya does not significantly contribute to global emissions, the country has continued to promote low-carbon development. Kenya became a signatory to the Paris Agreement in 2016 and committed to an ambitious emission reduction target of 30% against the BAU by 2030, with interventions targeted for key sectors like energy, forestry and agriculture, transport, industry, and waste. In 2020, the country did its first NDC update and raised the commitment to 32% compared to the baseline (Ministry of Environment and Forestry, 2020). Achieving these targets involves, among other things, transitioning to low-carbon electrification, promoting residential energy efficiency, intensifying the adoption of improved cookstoves, enhancing energy efficiency in commercial and industrial sectors, and implementing low-carbon transportation solutions such as e-mobility, bus rapid transit, and efficient heavy-duty trucks.

Forestry is one of the leading sources of GHG emissions of the country, and the government has set ambitious goals for restoring degraded land, reafforestation, and agroforestry. In line with this, Kenya signed the Bonn Challenge that aims to restore 350 million hectares of degraded and deforested land globally by 2030. The country also pledged to restore 5.1 million hectares of degraded landscape by 2030. On ozone-depleting substances, the country has to implement measures to reduce their use in accordance with the Montreal Protocol and the Kigali Amendment.

National Climate Change Action Plan (NCCAP) is the key instrument identified by the Climate Change Act, 2016 (Rev.2023), for implementing the NDC. Kenya's GHG emission baseline scenario was forecasted to be 143 $MtCO_2eq$ by 2030. The sectors with the highest emissions are Land Use, Land-Use Change and Forestry (LULUCF), electricity generation, transport, and agriculture, which account for 15%, 29%, 15%, and 27%, respectively. Energy demand accounts for 7%, industrial processes 6%, and waste 3% (Ministry of Environment, Water and Natural Resources, 2015).

Key assumptions regarding baseline scenario emissions included a high reliance on fossil fuels in the electricity sector, including coal and gas being used to meet the rapidly rising energy demand, emissions from the agriculture and forestry sectors mainly due to uncontrolled deforestation, and emissions from livestock enteric fermentation. The NCCAP II (2018–2022) mitigation actions therefore included transitioning to clean cooking, improving energy efficiency, and continued expansion of renewable electricity generation for grid electricity, low-carbon transportation (including a shift of freight from road to rail, efficient heavy commercial vehicles, and mass rapid transportation), climate-smart agriculture, increasing afforestation efforts, and solid waste management at its source. These actions would result in a total reduction of 26.1 MtCO2eq (Government of

Kenya, 2018). Modelling the GHG sector's emission status as of 2022 and comparing it against the baseline scenario revealed that 26.4 MtCO2eq of GHG emissions were abated during the planning period (2018–2022).

However, waste, agriculture, and forestry sector data, along with related IPCC emission factors, have significantly changed affecting direct comparisons between mitigation scenario analysis in 2023 to the baseline scenario projections. Specifically, in the baseline scenario, the global warming potential for methane over a 100-year time horizon was based on the IPCC-AR3 report, which was 21 times CO_2eq, while the nitrous oxide GWP potential was 310 times CO_2eq. In the implementation of NCCAP 2018–2022, the GWP potentials for methane were updated in the IPCC-AR5 report, revising methane GWP to 28 times and nitrous oxide to 265 times CO_2eq. Additionally, in 2018, the government commissioned a study to estimate Kenya's forest cover using the Forest Reference Level (FRL) for the implementation of Reducing Emissions from Deforestation and Forest Degradation plus the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+). The results showed significant deviations from the projections made in the national forest inventory between 1990 and 2015. Finally, the agriculture sector adopted a Tier 2 enteric fermentation emission factor of 41 kgCO_2eq per animal, compared to the Tier 1 emission factor of 46 kgCO_2eq.

To accurately assess Kenya's emission reduction contributions, NCCAP III (2022–2027) incorporates these adjustments to the modelling by reinterpreting the baseline scenario and estimating expected emission reductions based on the mitigation priorities of different sectors. Figure 01 illustrates GHG emissions in the adjusted business-as-usual scenario, taking into consideration the new changes in data, i.e., updated IPCC global warming potentials and updated data like the forestry FRL. The recalculated baseline indicated that in the absence of mitigation actions, Kenya's emissions would be 177 MtCO_2eq in 2027 and 203 MtCO_2eq in 2030, as illustrated in Figure 01.

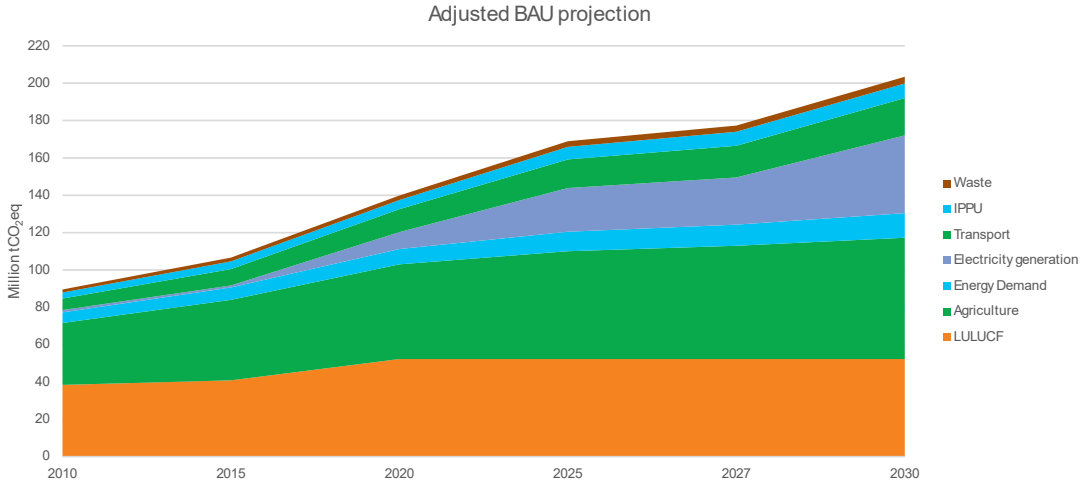


Figure 0-1. GHG emission projection for Kenya in the adjusted BAU emission scenario

In the energy sector, mitigation actions in NCCAP III aim to promote clean and affordable energy, universal access to electricity, and the expansion of renewable electricity in the grid. In the transportation sector, priority actions include enhancing e-mobility, alternative transport modes and fuels, shifting more freight from roads to railways, mass rapid transportation, decongestion of the cities, and encouraging non-motorised transport options like walking and cycling. The Industrial Process and Product Use (IPPU) is among the hard-to-decarbonise sectors, but some of the key priority interventions include adopting sustainable cooling practices and using low-carbon refrigerants, exploring alternative construction materials, and piloting state-of-the-art technologies like carbon capture and storage. In the agriculture sector, priorities include scaling up sustainable land management practices, promoting agroforestry, adopting intermittent irrigated rice production methods, implementing climate-smart animal husbandry practices and, improving on-farm manure management. The waste sector's major action is to minimise refuse disposed of in dumpsites by 90%, while the forestry sector targets to expand forest cover to above 10% from the 5.9% recorded in 2018. Implementing these priority actions is projected to reduce GHG emissions by 79 $MtCO_2eq$ compared to the baseline scenario. A summary of potential emission abatement is illustrated in Table 0-1.

Table 0-1. Summary of emission reduction potential by sector in NCCAP III

Mitigation Potential (MtCO2eq)	2025	2027
Forestry	**24.2**	**37.3**
Reduce emissions from deforestation, forest degradation, and land degradation. Key targets include: rehabilitating and protecting an additional 100,000 hectares of natural forests (including mangroves) by 2028, ensuring a high proportion of renewable biomass is used to produce charcoal (between 90% and 95% of charcoal produced to come from renewable biomass), restoring up to 1,000,000 hectares of forest on degraded landscapes, establishing 5 million acres (20,000 km2) of agroforestry woodlots in drylands, and planting 75,000 hectares in private commercial plantation forests.		
Agriculture	**4.88**	**6.34**
Reduce livestock emissions through climate-smart animal husbandry and on-farm manure management, including intensifying waste-to-biogas recovery for residential use.	5.29	7.01
Promote and adopt sustainable land management practices on a larger scale.	0.28	0.41
Increase the acreage of rice production under intermittent irrigation.	0.32	0.48
Intensify fertiliser application according to the high agricultural productivity scenario outlined in the MTP IV projection for fertiliser use.	-0.64	-0.97
Intensify rice production in accordance with the MTP IV.	-0.37	-0.55

Mitigation Potential (MtCO2eq)	2025	2027
Waste	**1.39**	**2.51**
Implement a 90% reduction of solid waste at its source and compost 80% of organic waste.	1.37	2.48
Conversion of waste to energy.	0.02	0.03
IPPU	**1.14**	**1.41**
Promote alternative construction materials to reduce overdependency on cement for use in residential and commercial building. These materials include interlocking blocks, compressed laminated timbers, etc.	0.67	0.56
Implement good operational practices in handling HFCs and achieve a 10% transition to low GWP cooling technologies.	0.11	0.25
Transition to modern and clean cooking technologies and increase the adoption of efficient charcoal technologies.	0.36	0.6
Transport	**1.11**	**2.05**
Commercialisation of e-mobility.	0.52	0.99
Implementation of Bus Rapid Transit (BRT) buses in the city of Nairobi.	0.03	0.06
Achieving 30% shift of cargo from road to rail transportation.	0.00	0.05
Enhancing the efficiency of Heavy-Duty Vehicles (HDVs) engines.	0.25	0.47
Increasing the number of passengers transported by rail through the expansion of the SGR and the meter gauge rail networks.	0.24	0.38
Implement alternative energy sources such as LPG for use in vehicles.	0.12	0.23
Electrification of the SGR from Mombasa to Nairobi.	0.06	0.09
Energy Demand	**2.74**	**3.04**
Promote energy efficiency and conservation in the industrial sector, aiming for 75% of manufacturing and commercial sectors to have undergone audits, with a 50% implementation rate to achieve a 15% increase in energy efficiency levels.	1.64	2.01
Increased access to electricity, achieving 100% urban electrification, with rural grid coverage increasing to 43% and off-grid contributing to 40% of total electrified households by 2027.	0.04	0.06
Transition to modern and clean cooking technologies such as LPG, biogas, ethanol, and electric cooking, with the aim of having 75% of total households adopting clean cooking fuels.	0.36	0.51

Mitigation Potential (MtCO2eq)	2025	2027
Increased adoption of improved cooking technologies to achieve 60% of the population using firewood to adopt efficient cookstoves, and 75% of charcoal users to adopt modern efficient charcoal stoves, with the remainder using Kenya Ceramic *Jiko*.	0.09	0.16
The overall potential for GHG emission abatement from electricity generation against the baseline	**23.1**	**24.9**



Chapter 01

Introduction

Kenya, located in East Africa, boasts a coastline of over 500 km along the Indian Ocean (GIZ et al., n.d.). The country relies heavily on its natural resources for livelihoods and economic growth, including agriculture, tourism, fisheries, and the blue economy. According to the 2023 Economic Survey, the Real Gross Domestic Product (GDP) shrank by 4.8% in 2022, compared to a revised growth of 7.6% in 2021.

The growth was spread across all sectors of the economy, with service-oriented activities experiencing more pronounced impacts. Agriculture, forestry, and fishing sectors contracted by 1.6% in 2022 compared to a contraction of 0.4% in 2021. This was attributed to prolonged drought conditions that characterised the period under review. Historically, Kenya has experienced unprecedented droughts cycles, notably in 2010–2011, 2016–2017, and the longest from 2020 to 2022, with the recent drought being the most severe (KIPPRA, 2023). The reports noted that this drought claimed about 2.6 million heads of cattle and over 4.4 million people needed assistance in the 23 Arid and Semi-Arid Land (ASAL) counties[1]. Nominal GDP increased from KES 12,027.7 billion in 2021 to KES 13,368.3 billion in 2022. Despite noticeable slowdown in volume terms in 2022, agriculture remained the dominant sector, accounting for about 21.2% of the overall GDP in 2022 (KNBS, 2023). Agriculture continues to be the backbone of the country's economy, with approximately 70% of the population being at least partially employed in farming or livestock rearing (GIZ et al., n.d.)**.** Kenya's vulnerability to climate extremes such as floods, landslides, and droughts poses significant challenges to sustainable development.

Kenya's climate is diverse, largely influenced by altitude. The highlands maintain a mean annual temperature of 15 °C, while lowland areas in northern and eastern Kenya can reach temperatures of up to 29 °C. The coastal area and the shores of Lake Victoria in the far west have a tropical climate, with temperatures ranging from 23 °C to 27 °C. Annual precipitation volumes in northern and eastern Kenya, which are characterised by steppe, range from 200 mm, to over 1,600 mm in western Kenya. The highlands typically have a moderate climate, with annual precipitation sums between 800 and 1,000 mm (GIZ et al., n.d.).

The country's climate seasonal pattern is described in four categories:

1. Generally sunny and dry months between January and March
2. Long rains seasons in the months of March to May
3. Cold seasons between June through to September
4. Short rains seasons between October and December (GoK, 2022).

Kenya's weather and climate conditions are primarily influenced by the semi-annual northward and southward migration of the sun across the equator. In accordance with the yearly distribution patterns of rainfall, Kenya's climatology can be broadly characterised, as depicted in Figure 11.

Counties located in the highlands to the west of the Rift Valley experience the most substantial annual precipitation, exceeding 1,800 mm. Similarly, a handful of counties situated in the central highlands to the east of the Rift Valley also encounter considerable yearly rainfall. On the contrary, counties experiencing lower annual precipitation are primarily those classified as arid or semi-arid, covering areas in the Northwest and Northeast regions of Kenya.

[1]The 23 ASAL counties include: Turkana, Marsabit, Mandera, Wajir, Isiolo, Samburu, West Pokot, Baringo, Laikipia, Meru, Nyeri, Tharaka Nithi, Embu, Kitui, Makueni, Tana River, Garissa, Lamu, Kilifi, Taita Taveta, Kwale, Kajiado, and Narok. Among these, Marsabit, Kajiado, Isiolo, Samburu, Turkana, Wajir, and Mandera were the hardest hit, recording above-normal livestock mortality rates.

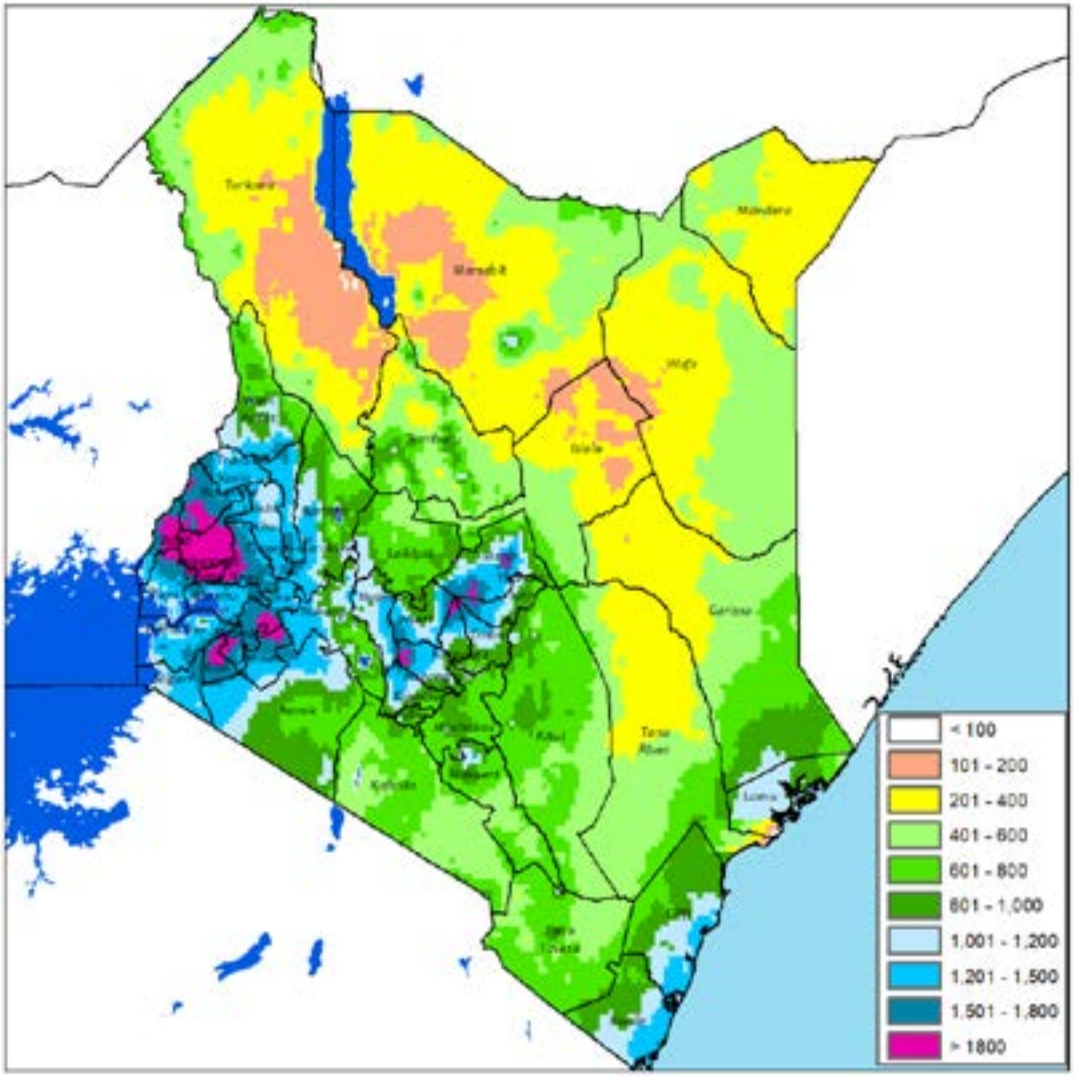


Figure 1-1. Rainfall climatological zones for Kenya based on annual total rainfall

Source: GoK, state of the climate for Kenya

1.1 Projected Climate Change

Kenya has had its share of adverse climate change impacts, including droughts, unpredictable rainfall patterns affecting agriculture and food security, and flooding that has led to migrations, internally displaced persons, and loss of property. These extreme events are becoming more common.

Temperature

Kenya's temperature patterns vary widely across different regions and seasons. According to the latest climate report for Kenya, the Northwestern and Northeastern regions experience the highest temperatures, ranging from 35 °C to 40 °C from January to March. In contrast, most of the country experiences cooler temperatures from June to August. The Central regions have the lowest temperatures, ranging from 3 °C to 6 °C. Wind patterns also differ, with favorable wind speeds observed in the Northwest (Marsabit and Turkana counties), Rift Valley borders, and the Coastal area, presenting opportunities for energy generation. Examination of station data indicates moderate to strong southeasterly winds, mainly over the Eastern and Northern parts between May and August. The other months typically have relatively calm winds that bring moisture or dry air depending on the season (Kazimierczuk, 2019).

Kenya's climate change models continue to show that high temperatures are likely to persist with high variability. According to climate risk projections, the country's average air temperature is projected to rise by 1.2 °C to 3.2 °C by 2080 under RCP 6.0 (GIZ et al., n.d.). Climate analytics models show a median rise to 2.2 °C by 2080 under RCP 6.0 with a possible upper limit of 3.7 °C, as illustrated in Figure 1-2. During the current action plan period (2023–2027), the mean temperature change in Kenya is expected to remain below 1.0 °C compared to the baseline temperature of 24.96 °C under both RCP 2.6 and RCP 6.0 scenarios.



Figure 1-2. Absolute change in air temperature in RCP 2.6 and 8.5

Source: Climate Analytics; Climate impact explorer

Figure 1-3 illustrates spatial analysis of temperature anomalies for 2022 compared to the average climatological period between 1991–2022. According to the report, above-normal temperatures were observed in Northern, Northeastern, Central highlands, and southeast lowlands, while slightly below-normal temperatures were experienced along the coastal strip and the inland regions of Garissa, as well as around the Lake Victoria Basin (GoK, 2022). Moreover, an analysis of the monthly distribution of temperatures shows that March was the hottest month in 2022, with an average of 23.3 °C, while August was the coolest, with an average temperature of 19.7 °C, and July 19.8 °C. The climate risk profile further indicates that there is likely to be realised increase in hotter days throughout the year in 2022, with Northeastern regions likely to experience about 200 hotter days annually by 2080 under RCP 6.0 (GoK, 2022).

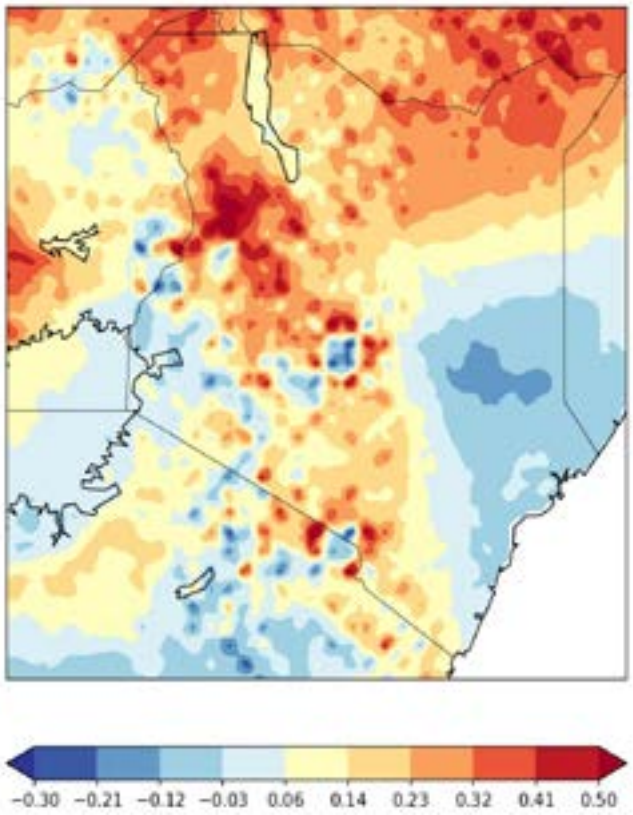


Figure 1-3. Annual average temperature anomaly for 2022 relative to the reference period of 1991–2022

Source; GoK, 2022, state of climate

Precipitation

According to the Kenya climate risk profile, future projections of precipitation are less certain (GIZ et al., n.d.). However, average rainfall is expected to increase by mid-century, particularly during the 'short rains', which occur between October and December (World Bank, 2021). Three models' assessments depict no change to a slight decrease in mean annual precipitation over Kenya under RCP 6.0 in the first model, while the other two models depict an increase under the same scenario. The same models, under RCP 2.6, median model projections indicate a slight increase towards the year 2030 but an overall decrease towards the end of the century. Under RCP 6.0, the projected precipitation increase is likely to intensify after 2050, reaching 53 mm per year at the end of the century compared to the year 2000. Higher concentration pathways suggest an overall wetter future for Kenya (GIZ et al., n.d.).

Figure 1-4 shows how relative changes in precipitation (expressed in percent) will unfold over time in Kenya at various global warming levels compared to the reference period 1986–2006, based on the RCP 2.6 and RCP 6.0 scenarios using the spatial aggregation method, area-weighted average. This statistical technique combines data from different regions to determine the average value for the entire area.

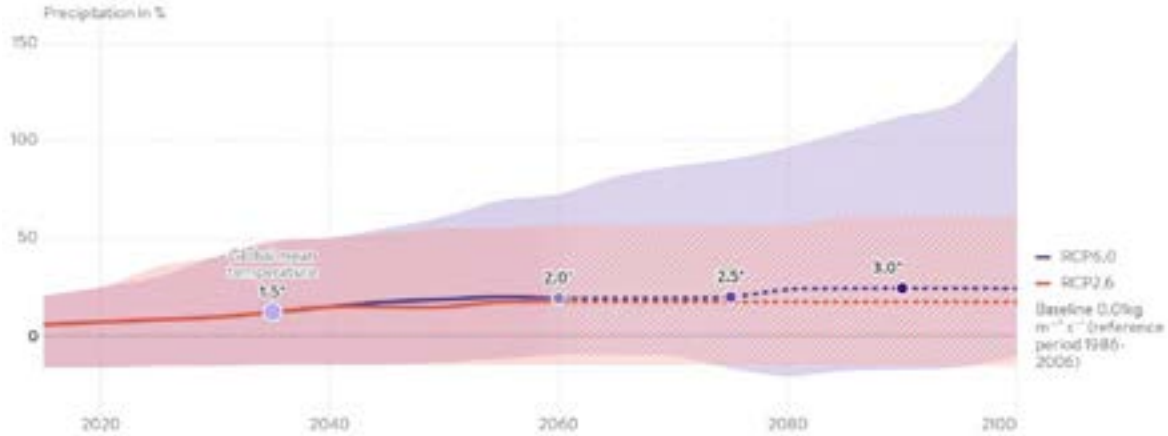


Figure 1-4. Relative change in precipitation in Kenya

Source: Climate Analytics; Climate impact explorer

Indeed, further analysis by the World bank indicates that extreme rainfall events are expected to increase in frequency, duration, and intensity, and the proportion of heavy rainfall that occurs in heavy events will increase. However, the period between heavy rainfall events may also increase, as illustrated in Figure 1-5. It is important to note that rainfall in the arid zones is generally projected to decrease.

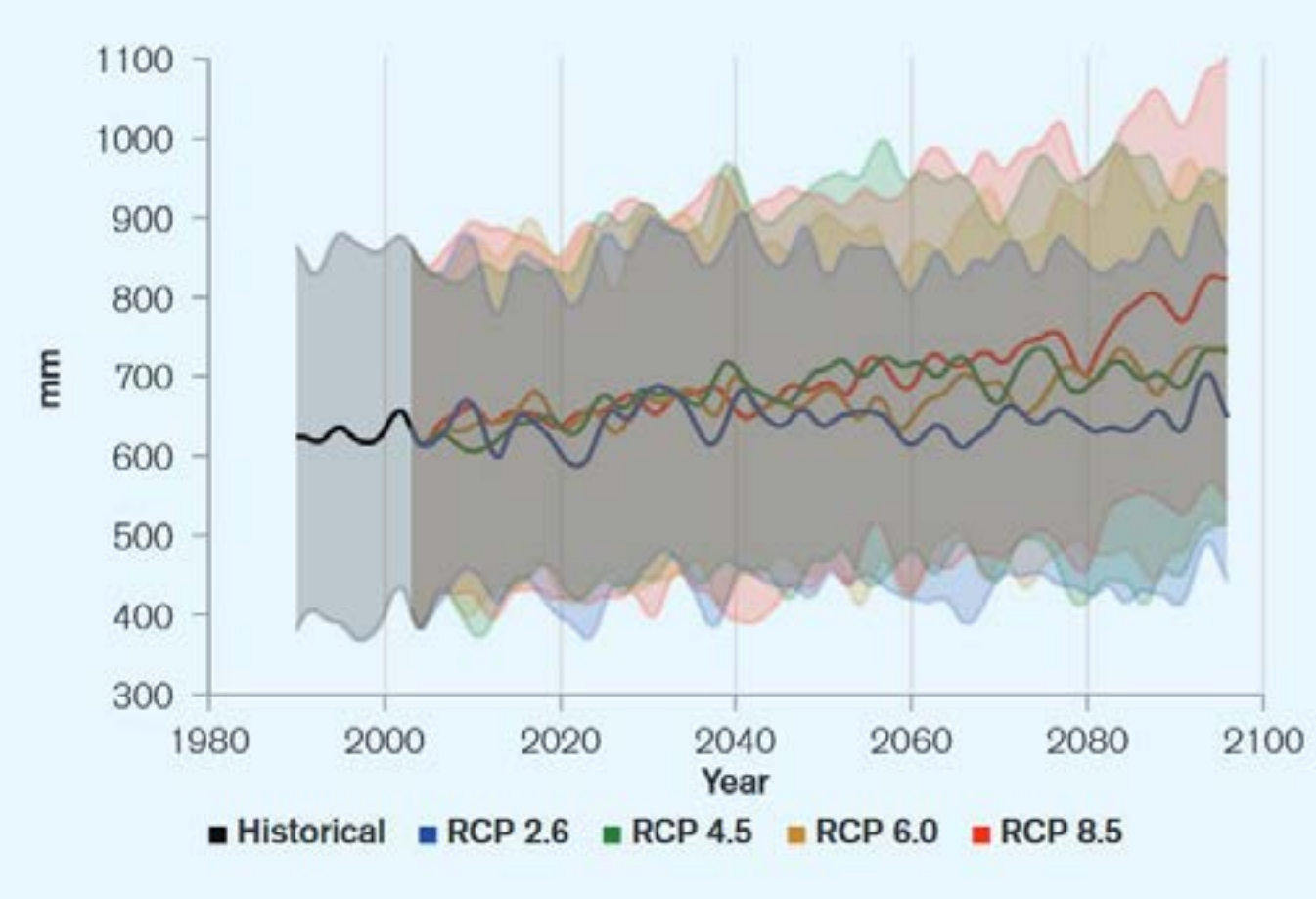


Figure 1-5. Average annual precipitation trends and projections for the period 1986–2099

Source: World Bank, 2021

Even so, according to the "State of Climate in Kenya" report, most parts of the country experienced below-average rainfall across the country during all seasons in the year 2022 (GoK, 2022), as illustrated in Figure 1-6.

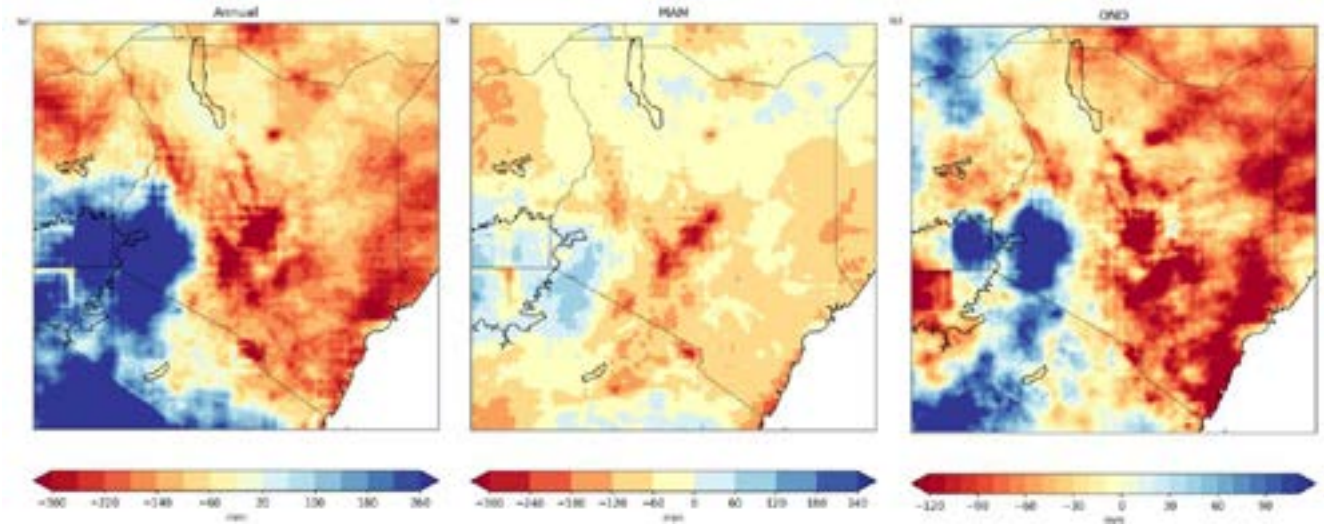


Figure 1-6. Spatial distribution of rainfall anomalies for 2022 at annual (a), and seasonal; March–April–May (MAM) (b) and October–November–December (OND) (c) time scales

(Source GOK State of Climate 2022)

Further investigation into the period of long rains, an evaluation of the rainfall data collected between March 1st and May 31st, 2022, reveals a notable decline in rainfall performance across the country as shown in Figure 1-7. The distribution of rainfall, both temporally and spatially, exhibited overall inadequacy across most regions. In March, rainfall levels were notably diminished in most areas, except for Moyale, Kisumu, Voi, and Laikipia, which experienced near-average precipitation amounts.

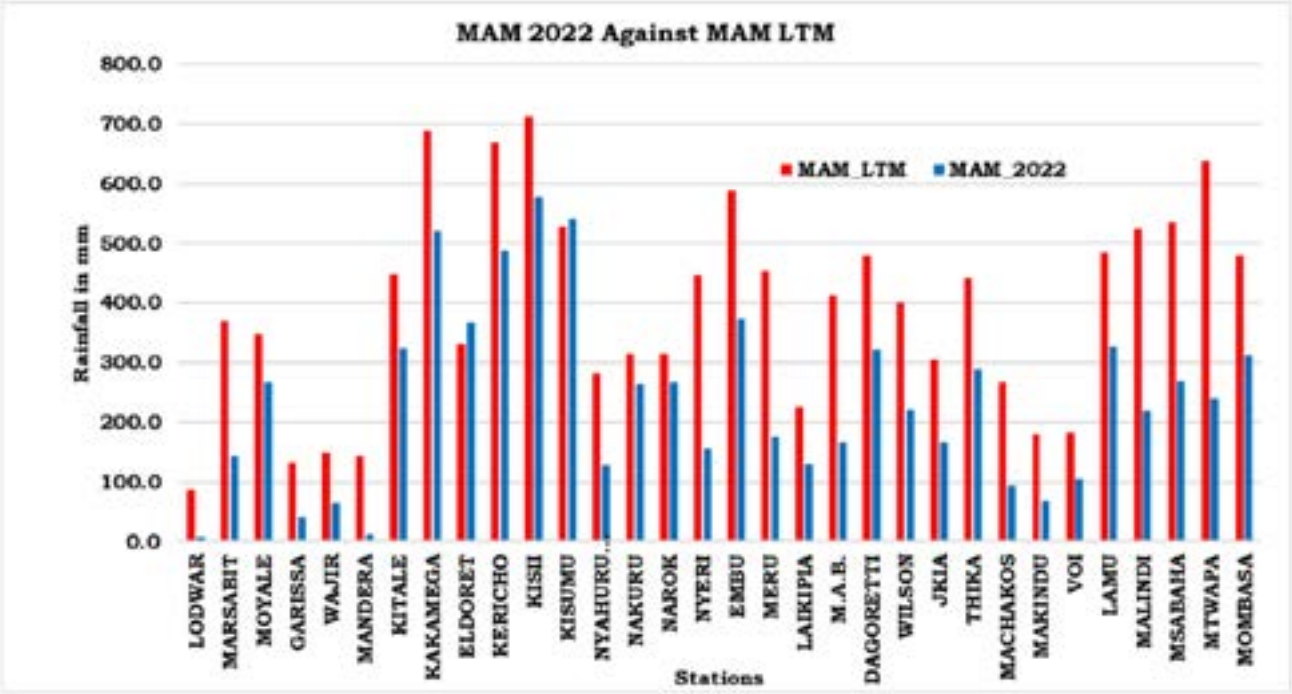


Figure 1-7. MAM 2022 rainfall totals compared to Long-Term Mean (LTM) for MAM (1991–2020)

Source: GoK; State of Climate 2022

Thus, in the NCCAP 2023–2027, given the changing climate conditions, there is a concerted effort to build resilience and pursue measures aimed at limiting the rise in temperature to 1.5 °C, while climate-proofing investments in various mitigation actions.

1.2 Kenya's Commitments to Climate Change

Similar to other countries in Sub-Saharan Africa (SSA), Kenya has been at the forefront of advocating for the reduction and potential reversal of GHG emissions. Kenya demonstrated its commitment to climate change mitigation as far back as 1996 by signing the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), which sought to establish a common agenda while acknowledging the differing responsibilities between developed and developing countries.

In its own capacity, the country has made deliberate efforts towards greening the energy sector and increasing forest cover while reducing further degradation of forest lands. Kenya has also actively participated in Clean Development Mechanism (CDM) projects and other carbon market mechanisms. By the end of the CDM's first crediting period in 2012, the country had 35 registered projects mitigating 4.6 million tonnes of CO2eq emissions (UNEP Copenhagen, n.d.).

Currently, Kenya boasts the largest CDM portfolio in Eastern Africa, with a total of 210 registered activities, including 20 Project Activities as well as 190 Component Project Activities (CPAs) within 29 Programmes of Activities (PoAs). The country also hosts a significant number of voluntary carbon standards portfolio totaling 72 activities, with a large number of registered Gold Standard activities (51), Voluntary Carbon Standard (19), and (2) Plan Vivo projects. In terms of metric tonnes, Kenya has issued over 12.3 million Certified Emission Reductions (CERs), with the top three sub-sectors being grid-connected renewable power (with geothermal and wind comprising over 39% share), improved cookstoves (40%), and water purification (20%).

The power projects have been implemented by the national power producer Kenya Electricity Generating Company (KenGen) and Lake Turkana Wind Power Project, generating over 6.2 million issued CERs. Geothermal activities have the highest issuances, with approximately 4.7 million CERs (41%), followed by improved cookstoves with about 4.5 million CERs (31%), and water purification activities with about 1.6 million CERs (14%).

Kenya became a signatory to the Paris Agreement in 2016 and set an ambitious emission reduction target. The country revised its NDC in 2020, adjusting the reduction target to 46 MtCO2e (32% of the baseline emissions by 2030), with key interventions targeted for the six GHG emission sectors (energy, forestry, agriculture, IPPU, transport, and waste sectors). Moreover, Kenya signed the Bonn Challenge, which aims to restore 350 million hectares of degraded and deforested landscape globally by 2030 (IUCN & IKI, 2020). The country pledged to restore 5.1 million hectares of degraded landscapes by 2030 (IUCN & IKI, 2016). A myriad of actions is ongoing, including the innovative digital promotion and monitoring tool on trees grown, known as "15 billion Jaza Miti".

On ozone-depleting substances, the country is implementing initiatives to reduce the use of ozone-depleting substances in accordance with the Montreal Protocol and the Kigali Amendment. The Kigali Amendment refers to an international agreement that aims to phase down the production and consumption of hydrofluorocarbons (HFCs), a type of potent greenhouse gas used in various applications such as refrigeration, air conditioning, and the production of insulation. It is an amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer.

The Kigali Amendment was adopted on October 15, 2016, during a Meeting of the Parties to the Montreal Protocol in Kigali, Rwanda. It addresses the issue of HFCs, which are known to have a significant impact on global warming. HFCs were developed and widely used as replacements for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), which were phased out under the original Montreal Protocol due to their ozone-depleting properties.

Kenya has developed a National Cooling Action Plan, aiming to achieve increased access to and improve the efficiency of cooling

appliances available in Kenya, transitioning the cooling sector to refrigerants with low global warming potential in general, and to natural refrigerants where feasible, while also increasing access to agricultural cold chains (Ministry of Environment, Climate Change and Forestry, 2022).

Kenya has formulated its Long-Term Low Emissions Development Strategy (LT-LEDS) aimed at attaining net-zero greenhouse gas (GHG) emissions by 2050, contingent upon support from development partners. Aligned with the ongoing implementation of its NDCs, the LT-LEDS delineates Kenya's pathway toward realising an equitable and cost-efficient transition to a competitive, resilient, and carbon-neutral economy by 2050. Over the years, Kenya's greenhouse gas emissions have surged from 57 MtCO2eq in 1995 to 94 MtCO2eq in 2015 and further to 128 MtCO2eq in 2022, with projections soaring to 300 MtCO2eq in 2050 in the absence of intervening policies. While the NDC specifies commitments, both unconditional and conditional, the LTS delineates a comprehensive strategy, spotlighting priority interventions, actions, and investments necessary to surpass the NDC's 2030 timeframe. Kenya's overarching goal is to achieve a net-zero economy by 2050, building upon its previous commitment to slash emissions by 32% against BAU levels by 2030, as outlined in the updated NDC of December 2020 (Government of Kenya, 2022).

The Climate Change Directorate, established by the Climate Change Act, 2016 (Rev. 2023), is mandated to coordinate the implementation of climate change mitigation and adaptation actions in accordance with the constitution and development agendas of the country. The Directorate coordinates the implementation of mitigation and adaptation actions outlined in the NCCAPs.

1.3 The Kenya Development Agenda and Alignment to NCCAP

Kenya's development agenda is anchored in the long-term development strategy, the Kenya Vision 2030, which is implemented through 5-year medium-term plans (MTPs). These MTPs are strategically designed to align with the political calendar, underscoring the significance of political manifestos and the implementation of devolution in achieving the objectives of Kenya Vision 2030. The new constitution emphasises grassroots (county-level) development, reflecting a commitment to real national transformation. A key instrument for driving counties' development agendas is the County Integrated Development Plan (CIDP), which is intended to align with the national plan. Both national (MTPs) and county (CIDPs) development instruments are interconnected to facilitate horizontal and vertical integration in the implementation of Vision 2030.

Vision 2030 identifies three pillars—economic, social, and political—as fundamental to achieving its objectives. The economic pillar aims for a 10% annual GDP growth rate. Meanwhile, the social and political pillars aim to create an equitable, cohesive society with people-centred governance. Vision 2030 also identifies key enablers (foundational sectors) like transport, ICT infrastructure, and energy, with flagship projects within the three pillars. These include initiatives to increase agricultural value and improve water supply for both social and productive uses.

The third MTP (2018–2022) was developed to deliver the "Big Four" agenda for 2017–2022, which focuses on food security, universal health coverage, affordable housing, and manufacturing to "fast track" Vision 2030. The fourth MTP (2023–2027) is aligned within the Bottom-up Economic Transformation Agenda (BETA) with a

key focus on agricultural transformation and inclusive growth, support for Micro, Small and Medium Enterprises (MSMEs), housing and settlement, healthcare improvements, and the development of the digital superhighway and creative industry.

In terms of climate change mitigation and adaptation, Kenya has consistently positioned itself within a framework of progressive sustainable development, further aligning its development agenda with a low-carbon development pathway. Table 1-1 summarises how the national development agenda has been aligned with low-carbon development pathways across the four medium-term economic development plans between 2008–2027.

Table 1-1. Summary of development priorities in MTPs with GHG emission/abatement contribution potential

Development Pillars	MTP 1 (2008–2012)	MTP II (2013–2017)	MTP III (2017–2022)	MTP IV (2022–2027)
Foundation	An energy access scale-up programme.	National and county-specific spatial plans to rationalise utilisation of space for economic and social planning.	Main infrastructural targets included the expansion of JKIA, development of a free trade area, and the Lamu port. Also, SGR phase II completion from Nairobi–Malaba.	Development of a 50-year transport master plan entailing preparation of a comprehensive strategy and master plan for transport sector linked to national spatial plan.
	Creation of a national spatial plan to enhance the development of suitable physical infrastructures.	Infrastructure expansion such as building SGR and enhancing port efficiency.	Increasing electricity generation capacity to 5,221 MW by 2022 and construction of 116 primary distribution substations and 1,244 km of lines.	Decongestion of Nairobi city through construction of 28 km of Simba Lane–Rongai–Bomas (Langata Rd)–CBD–Ruiru–Thika–Kenol Road.
		Regional collaboration and establishment of the LAPSSET project.	The national spatial plans to be mainstreamed with the county spatial and sector plans.	Increasing access to power through expansion of the number of inter-country and regional transmission lines. A 2,930 km transmission network and 37 new substations are planned. These will include regional interconnections such as the 132 km of 400 kV Lessos–Tororo interconnection and the 96 km of 400 kV Kenya–Tanzania interconnection.

Source: World Bank, 2021

Development Pillars	MTP 1 (2008–2012)	MTP II (2013–2017)	MTP III (2017–2022)	MTP IV (2022–2027)
		Increase electricity installed capacity to 5,538 MW by 2017.	To mitigate climate change impacts, government to strengthen integrated early warning systems and drought emergency fund.	Power distribution and access targeting 5,800 km HV and MV lines; 2.3 million additional customers and 30,000 public facilities connected; installation of 150 mini-grids; 50,473 standalone solar systems; and 75,000 lanterns for public lighting projects.
		Completed land reforms.	40 km of NMT and implementation of MRT.	Alternative energy sources. The government aims for, additional 4,350 of-grid tie solar systems, 10 small hydro projects, 80 wind mast and data loggers, 2 biofuel plants for value chain addition; 300 biogas systems; 195 energy-efficient charcoal kilns, and promotion of multiple initiatives in clean energy such as e-mobility and e-Cooking, and energy conservation and green buildings, green hydrogen and waste-to-energy projects. About 606 MW is targeted from geothermal, 100 MW wind and 42.5 MW solar across seven focal projects. Additionally, 200 MW is expected from LNG. Lastly, multiple infrastructure projects for LPG expansion targeting 5,000 public boarding schools transitioning to LPG as the primary cooking fuel. Adoption of LPG policy to enhance residential transition to clean cooking solutions through subsidies on LPG cylinders.
			Development of a 50-year transport master plan as a vision for multi-modal transport system.	Rail transport expansion focusing on regional interconnection and upgrading of MGR and interconnection of SGR and MGR.

Development Pillars	MTP 1 (2008–2012)	MTP II (2013–2017)	MTP III (2017–2022)	MTP IV (2022–2027)
			Targeting 5 million new household connections through grid and off-grid solutions and 15, 739 public facilities.	
			It also promotes research and development of RE sources.	
			On LULUCF, the plan aims to implement the National spatial plan with key interest on land use, agriculture, and the blue economy.	
The Economic Pillar	The economic growth target of 7.9%–8.7%.	Sustain growth in manufacturing and agriculture to achieve an overall 10% GDP growth in 2017.	Increase GDP annual growth rate of 7% in 2019.	The overall real GDP growth is projected to increase from 4.8% in 2022 to 6.1% in 2023, 6.3% in 2024, 6.5% in 2025, 6.7% in 2026, and 7.2% by 2027.
	To triple national earnings from tourism during the strategy period, with plans to establish 3 tourist resort cities.	A total of 404,800 hectares of land under irrigation.	Promote 1.2 million acres under irrigation, reduce fertiliser costs and expansion of strategic food reserve trust fund, improve the availability of fodder in Arid and Semi-Arid land.	Market development, the country aims to expand through construction and completion of 6 metropolitan area markets, 47 county-level Aggregation and Industrial Parks (CAIPs), 100 municipal-level retail markets, and 100,000 containerised hawkers' stalls.
	A growth rate of 6%-8% in agriculture and livestock through multiple measures including value addition and input materials and market creation. Also, irrigation of additional 1.2 million hectares of land.	Mechanisation of agriculture and revival of farmers' cooperatives and unions.	Establishment of 3,850 new manufacturing enterprises through industrial financing	Leather and leather product value chain. Targeting 3 million hides and 18 million skins and to expand tannery utilisation from 25% to 100%. Entails development of common effluent treatment plants, tanneries, leather cottage industries, and operationalisation of SEZ in Naivasha, Kisumu, Lamu, and Dongo Kundu.

Development Pillars	MTP 1 (2008–2012)	MTP II (2013–2017)	MTP III (2017–2022)	MTP IV (2022–2027)
	Establishment of two special economic zones in two major cities and at least five MSME industrial parks across Kenya.	Intensify reforms on means of doing business.	Other economic drivers include blue economy expansion, tourism, mineral exploration, and mining.	Dairy value chain. Double animal productivity through appropriate feeding, export up to 1 billion litres of milk, dairy mechanisation including bulk cooling facilities, and modernisation of new KCC. Other livestock interventions with GHG emission abatement include large-scale feed production and commercialisation, anaerobic waste management in meat processing factories and abattoirs.
	Enhancing financial services through savings and capital investments.	Three special economic zones in Kisumu, Mombasa, and Lamu.		Crop value chain targets, 100,000 acres rice plantation irrigated and 75,000 acres under rainfed rice cultivation reducing emissions from rice production.
		Other initiatives on building meat and leather, and stronger dairy sector.		
		Universal access to ICT, development of digital content, and promoting e-government service.		

1.3.1 Progress of Implementation of Mitigation Actions During MTP II and III

During MTP III, both national and county governments implemented several programmes and projects aimed at improving the country's infrastructure and propelling Kenya towards a newly industrialising middle-income economy. Notable achievements in line with national actions toward low-carbon pathways included:

- Expansion and modernisation of aviation facilities at Jomo Kenyatta, Moi, and Kisumu International Airports, as well as selected airstrips countrywide, including the installation of 500 kW of solar PV at Mombasa airport and a 1 MW captive solar generation system at Jomo Kenyatta International Airport (JKIA).
- Improvement of shipping and maritime facilities to handle Panamax and Post Panamax container ships thereby enhancing efficiency; completion of Berth No. 19 in Mombasa; construction of the first three berths at Lamu Port was ongoing; and acquisition of two ferries with a capacity of 1,500 seated passengers.
- The first phase of Standard Gauge Rail completed, between Mombasa to Nairobi and Nairobi to Naivasha, reducing transport-related emissions; construction of commuter railway stations at Makadara and Imara Daima were also completed, while others such as Ruiru, Kikuyu, Kahawa, Dandora, Githurai, and Embakasi Village, were ongoing freeing traffic congestion in Nairobi city.
- Under the Road Expansion Programme, 3,250 km of roads were constructed or rehabilitated, with 2,779 km undertaken by the National Government and 471 km by county governments; Under the Northern Corridor Transport Improvement Project (NCTIP), 576 km of road networks were constructed.
- Decongestion of cities, urban areas, and municipalities involved the construction of bypasses, missing links and improvement of roads in Nairobi and other cities and municipalities further improving city transport and traffic congestion instigated emissions.
- Policy, legal, and institutional framework for development of Mass Rapid Transit (MRT) System was put in place. A pilot MRT project was proposed for the Thika superhighway and is still under construction.
- On electricity production saw an increase in power generation capacity from 1,768 MW in 2013 to 2,339.9 MW by December 31, 2017, and further to 3,088 MW by 2022. By December 2022, the electricity grid mix comprised 88% from renewable sources, 11% from fossil fuels, and 1% from imports.
- Increased electricity access through the upgrading and expansion of the national power transmission network from 4,250 km to 5,676 km; about 98% of urban households (Kenya Power, 2022) have access to grid electricity and 30% rural connectivity was achieved by 2021. This is a significant contribution reducing the reliance on kerosene for household lighting in the rural areas.
- In addition, a total of 15,134 schools were connected to grid electricity, bringing the total number of primary schools connected to 23,496 by 2018.
- The electricity reliability indicators, Customer Average Interruption Duration Index (CAIDI) and System Average Interruption Frequency Index (SAIFI), were 5.66 and 45.32 respectively as of June 30, 2017; these figures have since improved by 2.6 and 4.5 respectively in 2020, reducing the operation time for standby generators and further contributing to emission abatement from backup generators (Kenya Power, 2020).

- According to the MTP 2023–2027 review, the share of manufacturing contribution to GDP steadily declined from 8.4% in 2018 to 7.4% in 2021, before increasing to 7.8% in 2022. On the other hand, contribution of crop production to GDP steadily increased from 14.5% in 2018 to 16.7% in 2020, then declined to 15.2% in 2022, leading to an increase in GHG emissions from the mineralisation of soil organic carbon.
- The rail cargo handling at the port steadily increased from 4.6 million tonnes in 2018/2019 to 6.23 million tonnes in 2021/2022, against a target of 1.6 million tonnes and 7.12 million tonnes respectively, achieving a 20% cargo transfer from road to rail.
- Finally, regarding universal electricity connectivity, 7.2 million households were connected against a target of 6.8 million households in 2018/2019. By 2021/2022, the number of households connected to grid electricity had increased to 8.9 million, with about 2.8 million households connected to off-grid electricity.

1.3.2 Mainstreaming Climate Change in Development Planning

The Kenya Climate Change Act, 2016 (Revised 2023) is the principal act that establishes a framework for addressing climate change and achieving low-carbon development. The 2023 revision of the Act introduces provisions for legislation on carbon markets in Kenya in addition to other amendments in the Act. Thus, the Climate Change (Amendment) Act, 2023 amends, among other things, Section 3 of the 2016 Act to provide guidance for the development and implementation of carbon markets (GoK, 2023).

Thus, key policies in climate change management include the NCCAP, NDCs, NAP, and Green Economy Strategy and Implementation Plan (GESIP). The Act facilitates the management of both international and national climate finance, as well as streamlining the roles of various actors in addressing climate change. Additionally, climate change considerations are to be integrated into the national mid-term development plans (MTPs) and the CIDPs, which are 5-year plans that subsequently inform annual budgets and sectoral plans.

Figure 1-8 maps out the institutional arrangement for climate change plan implementation. Grey boxes represent national and county development blueprints. Kenya's development agenda is anchored in the overall development blueprint of Vision 2030, consisting of three broad pillars—economic, political, and social pillars. The overarching objective is to transform the country into a middle-income economy by 2030 (GoK, 2007). Vision 2030 is implemented through five-year MTPs, which are often aligned with political manifestos. The NCCAP 2023–2027 aligns with MTP 2023–2027, streamlining climate mitigation and adaptation into the national development blueprint. At the county level, the CIDPs outline the top priority county development plans implemented through Annual Development Plans (ADPs).

National Climate Change Council (NCCC), chaired by the president, is the top most decision-making organ, providing a comprehensive coordination mechanism. It is charged with the responsibilities to, among other things, ensure the mainstreaming of climate change functions into both the national and county governments, approve and oversee the NCCAP implementation, advise the national and county governments on legislative, policy, and other measures necessary for climate change response, and attaining low-carbon, climate change resilient development. The cabinet secretary in charge of environment and climate affairs acts as the council's secretary, with the Climate Change Directorate (CCD) acting as the secretariat and lead agency for NCCAP implementation. It carries out its mandates through climate change units within Ministries, Departments and Agencies (MDAs) at the national level and County Departments and Agencies (CDAs) at the county level. The County Climate Change Planning Committees (CCPCs) at the county and sub-county level are charged with the implementation of climate change planning and operate through the ward climate change planning committees.

Both national and internal climate finance flows are consolidated at the national treasury but administered by the Council and managed by the Principal Secretary responsible for climate change affairs. At the county level, a climate change fund shall be established to implement climate change activities at the county level. Unlike the public climate finance, international climate finance, including grants, green bonds, and carbon finance, are administered through various funding mechanisms and directly channeled through national implementing entities.

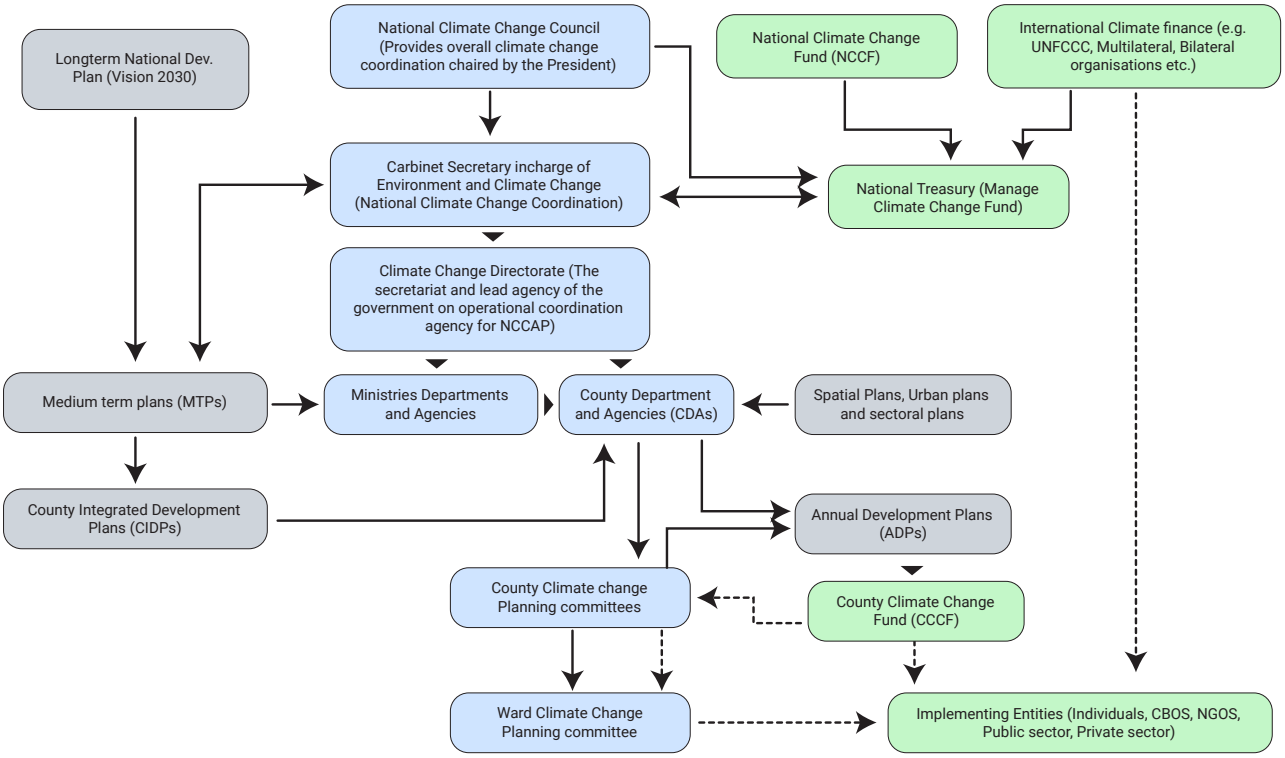


Figure 1-8. Delivery of development and climate action at national and devolved levels

Source: Author's own, based on the Climate Change Act, 2016

Legend: Grey boxes represent development planning processes at the national and county levels. Blue boxes represent the public sector structure mandated to develop and deliver climate and development policies and strategies. Green boxes represent the structural arrangements for managing and implementing climate finance (domestic and international). Solid arrows represent information and responsibility flows between national and county levels, while dashed arrows represent the flows of climate finance.





Chapter 02

Methodology for NCCAP 2023–2027

This chapter describes the approach that was used to develop NCCAP 2023–2027. It details the process in three sub-chapters: document review, stakeholders' engagement, and mitigation actions modelling.

2.1 Documents Review

In the development of the NCCAP for Kenya from 2023 to 2027, a comprehensive review of several crucial documents took place to inform the strategic framework. Among the key documents considered were the Mitigation Technical Analysis Report (MTAR) plan for the years 2018 to 2022, which provided valuable insights into the country's agricultural, energy, forestry, waste, transport, and IPPU sectors along with their potential impact on climate change. Additionally, the reference scenario and mitigation actions were examined to assess their effectiveness in curbing emissions and promoting sustainable practices.

Another vital source of information was the first NCCAP implemented from 2013 to 2017, which outlined nine essential mitigation actions that laid the groundwork for climate change adaptation and mitigation efforts in the country. Building upon this previous plan allowed for a more nuanced and effective approach in shaping the current NCCAP.

Furthermore, Kenya's updated NDC in 2020 was considered, which demonstrated the country's commitment to reducing greenhouse gas emissions and enhancing climate resilience on a global scale. The NDC acted as a guiding document, aligning national efforts with international climate goals.

To align with the long-term climate vision, the review also considered the Kenya Long Term Low Emission Development Strategy (LT-LEDS) aiming to achieve net-zero emissions by mid-century. This forward-thinking strategy emphasised the government's ambition to shift towards a low-carbon economy and to play a leading role in the global effort against climate change.

Finally, the NCCAP Implementation Status Reports were assessed to gauge the progress and challenges faced in previous initiatives. Learning from the implementation of earlier plans allowed for a more practical and efficient approach in setting actions and targets for the 2023–2027 NCCAP.

The combination of insights from these diverse documents enabled the formulation of a strong and comprehensive NCCAP III that aims to address climate change challenges holistically, with concrete strategies for mitigation, adaptation, and sustainable development across various sectors in Kenya. Several other peer-reviewed and grey literature sources were also reviewed to build on the scenario modelling and narratives, providing real-world evidence for the development of the updated NCCAP 2023–2027.

2.2 Stakeholder Engagements

The NCCAP III was developed through consultative and collaborative processes to reflect a whole of government and whole of society participation approach. A linear approach was used in developing NCCAP III which entailed pre-NCCAP activities including mobilisation of required resources, seeking collaborations and to gain buy-in from relevant sectors and developing the methodology. This included, literature reviews, consultative meetings, data analysis of trends and reviewing the status of NCCAP II (2018–2022) implementation, modelling GHG emission status from NCCAP II and developing scenarios for NCCAP III. A validation and technical steering committee meeting identified and documented implementation and investment plans in line with national, sectoral, and county development plans.

Stakeholder engagements were classified into four categories: development partners working group, sectoral leads and experts' consultations, county-level consultations, and political (Senate and Parliament committee on climate change) groups, with final approval sought from the executive. An oversighting and quality control technical committee, comprising of representatives from the Ministries, Departments, and Agencies representing the key mitigation and adaptation sectors, was established through nomination by the respective Principal Secretaries. The committee set the agenda and offered high-level steering and control of the process. They engaged with the development partners at a high level and sought for collaboration and support while also ensuring the quality of the NCCAP process at every stage. Sectoral leads were involved in the literature review process, assessing progress, and defining future scenarios for NCCAP III. Further consultations were also made with various groups, including the youth, children, marginalised communities, and the private sector.

Counties were also actively involved in reviewing the draft NCCAP III, as well as the MTAR and Adaptation Technical Analysis Report (ATAR), to ensure mainstreaming of counties' priorities. The final drafts were then validated by the steering committee. Figure 2-1 summarises the processes of NCCAP delivery and stakeholders' engagement.

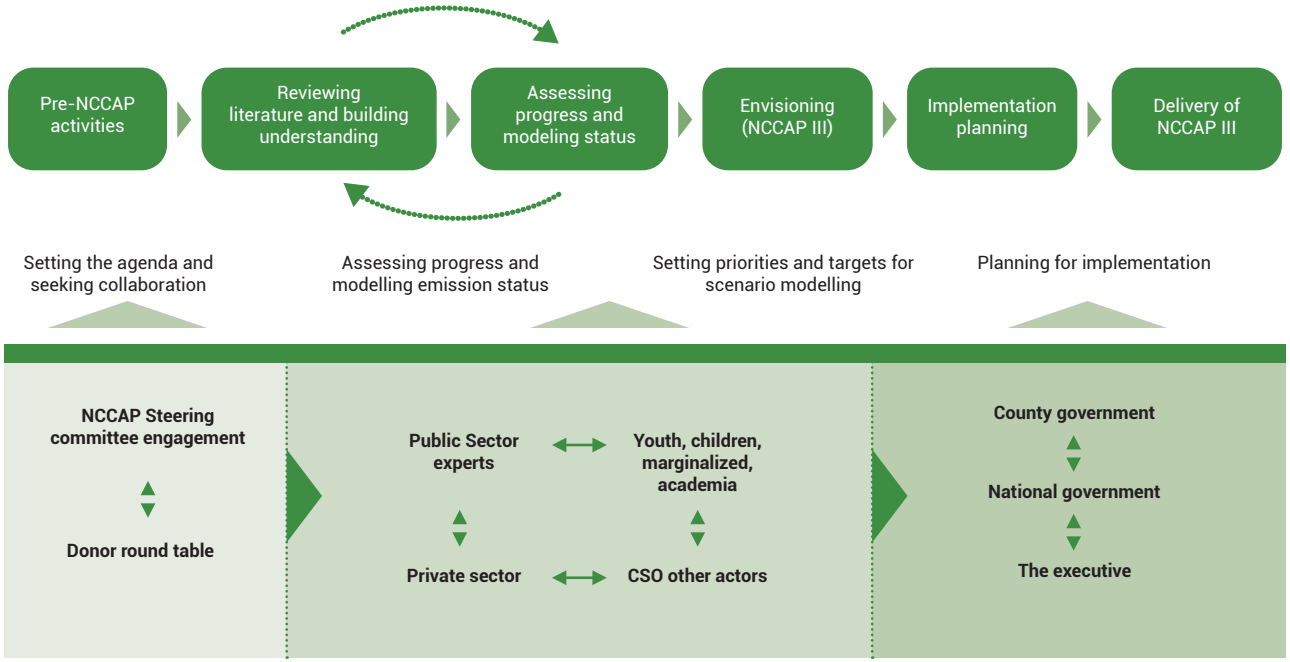


Figure 2-1. NCCAP development process and stakeholders' engagement framework

Source: Authors own, mapped out based on the process that was used to develop NCCAP III

2.3 Modelling NCCAP III

This section describes in detail the approach used to model GHG emissions and the corresponding mitigation scenarios in energy, transport, waste, agriculture, and IPPU. It describes the tool used, data structure and data input for modelling and the various assumptions made.

2.3.1 Low Emission Analysis Platform tool

Kenya has used the Low Emissions Analysis Platform (LEAP) for modelling mitigation actions outlined in the Long-Term Strategy (LTS). LEAP is an integrated scenario modelling tool that is used to analyze energy and non-energy emissions and mitigation scenarios. The tool has a flexibility of applying top-down and bottom-up approaches to emission analysis, making it adaptable in areas with low data access. The tool uses activity-level parameters such as number of households, vehicle kilometres travelled, GDP contributions, livestock populations, and respective energy and emission intensities (GJ/household, litres of gasoline per vehicle kilometre, tCO_2/GJ, tCO_2eq/Tonne of cement produced etc.) for analysing emissions from final energy demand. Typically, it applies the IPCC methodology in building emission inventories and assesses mitigation pathways scenarios, making it suitable for national planning and policy development.

In line with the IPCC methodology, LEAP uses activity data, such as national, regional, or local population figures, as the main driver of sectoral emissions. The activity-level data is multiplied by consumption intensity metrics (per capita, per household, per vehicle) and emission factors (e.g., tCO_2eq/GJ) to give the final emissions (n) in tCO_2eq. The difference between the baseline emissions (n) and mitigation emissions (m) is the avoided emissions estimates. Figure 2-2 illustrates the general approach to computing emissions.

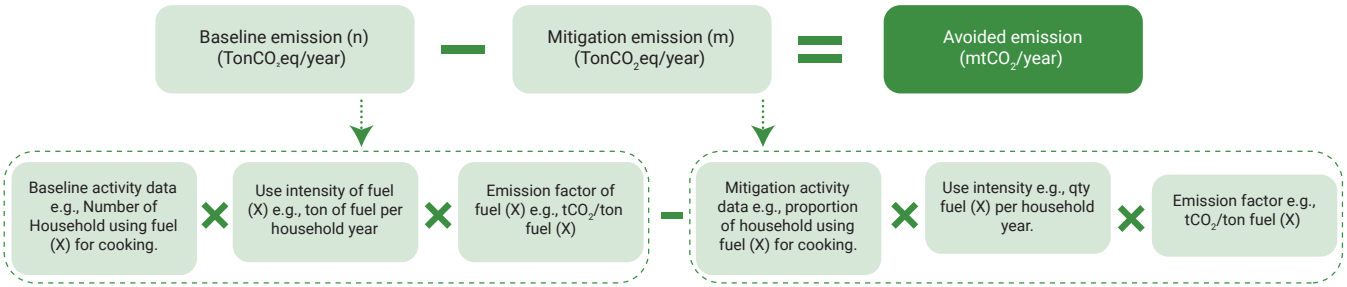


Figure 2-2. General computation approach

Source: GoK, 2023., Fourth Medium Term Plan, 2023 - 2027

2.3.2 LEAP Data Structure

In LEAP, the "current account" refers to GHG emissions in the current year (defined as the year of the most available data in the inventory) and historical emissions. For the Kenya NCCAP 2023–2027, the current year is proposed to be 2022, with a historical emission inventory spanning 12 years up to 2010. The first scenario year would hence be 2023, assuming that mitigation actions have been implemented on a continuous basis since NCCAP I. The LEAP model for NCCAP III adopts the LTS structure, consisting of four main module categories: Key Assumption, Energy Demand, Transformation, and Non-Energy, as illustrated in Figure 2-3. Within the Key Assumption branch category, we express in detail the demographic and economic drivers for growth and changes in consumption and activity data. Specifically, we enter real GDP (Agricultural and Non-agricultural GDP[2]), GDP growth rates, national population categorised into urban and rural, and population growth rates. Energy demand emissions account for both electricity and non-electricity usage in residential, agricultural activities, commercial and manufacturing sectors. In LEAP, emissions from the transport sector are also analyzed within the energy demand module but are reported separately as the transport sector. The transformation module in LEAP analyses direct and indirect emissions associated with power and charcoal production. The non-energy emissions, such as those from IPPU, Agriculture, and Waste sectors, are modelled under non-energy modules, as illustrated in Figure 2-3

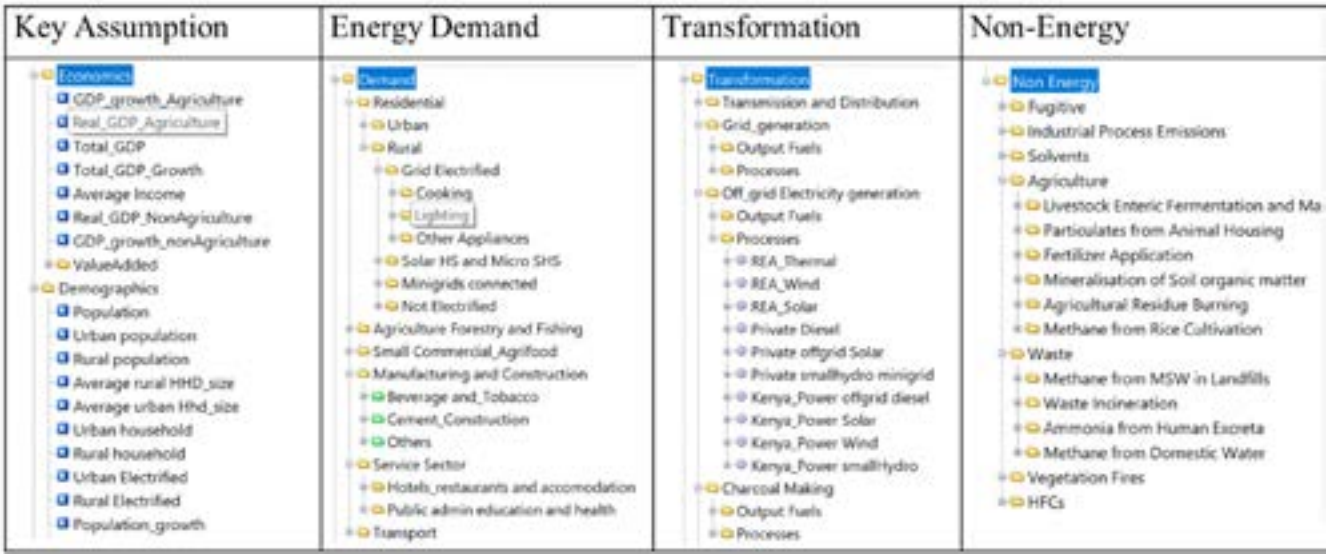


Figure 2-3. LEAP tree branches

Source: Authors own, screen shot from LEAP tool

[2] The distinction between agriculture and non-agriculture was adopted from the LT-LEDS economic projection

2.3.3 LEAP Scenarios

Scenarios are self-consistent storylines of potential developments within a particular socio-economic setting and under a particular set of policy conditions. Using LEAP, scenarios can be built and then compared to assess their societal costs, benefits, and environmental impacts. In scenarios, we input desired mitigation action targets and run results to establish the impacts, whether positive or negative.

The MTAR for NCCAP III creates two broad scenarios, as summarised in Figure 2-4. These scenarios include: the Baseline Scenario adopting assumptions from the first NCCAP (2013–2017) based on intensive energy demand, high dependence on fossil fuels, and extensive agriculture, and the Mitigation Action Scenario are mainly mitigation activities targeted for updated NDC and LTS goals in the short term. LEAP provides for the inheritance of assumptions from BAU to mitigation, and further ambition for carbon trading. Thus, it systematically analyses emissions and compares them against mitigation actions and ambitions.

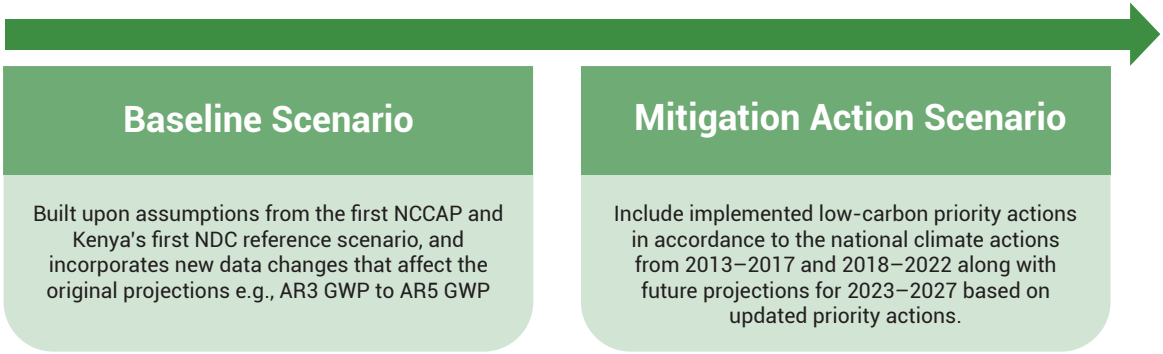


Figure 2-4. NCCAP III scenarios modelling

Source: Authors Own

2.3.4 Drivers of Energy and Non-Energy GHG Emissions

Economic and Demographic Drivers of Energy and Non-Energy Emissions

LEAP is a demand-driven tool and assumes that supply is driven by demand. Thus, the main demand drivers are demographic and micro-economic providing high-level growth and forecasting parameters, as outlined in Table 2-1.

Table 2-1. High-level demographic and macroeconomic assumptions

Key assumption description	2010	2019	2022
Demographic			
Population	38.5 million	47.56 million	50.6 million
Urban Population	12.7 million	19.52 million	21.6 million
Average Rural household size	4.6 people		
Average Urban household size	3.6 people		
Rural households	5.6 million	6.1 million	6.3 million
Urban households	3.5 million	5.4 million	6.0 million
Economic			
Total GDP (Billion USD)	31 billion	50 billion	57 billion
GDP growth	5.30%	6.30%	3.8%
Value Added percentage Share			
Agriculture, Forestry, and Fisheries	24%	21%	21%
Small commercial and service	33%	38%	39%
Manufacturing and Construction	28%	26%	26%
Public administration, Education, and health	13%	13%	13%
Hotels, restaurants, and local eateries	2%	1%	1%

GDP growth projection was based on the MTP IV beta modelling, as illustrated in Table 2-2, according to the MTP IV report. The performance in the sectors is expected to be supported by the implementation of crops and livestock value chains, promotion of agroprocessing, establishment of Special Economic Zones (SEZ) and Industrial Parks (IPs), product improvement and diversification of export markets, and an increase in credit to Micro, Small, and Medium Enterprises for business start-ups and expansion.

Table 2-2. GDP growth model for the period 2023–2027 - Medium Term Plan IV

BETA Sector	2022	2023	2024	2025	2026	2027
Overall GDP	**4.8**	**6.1**	**6.3**	**6.5**	**6.7**	**7.2**
Finance and Production	3.4	7.1	7.3	7.5	7.7	8.2
Infrastructure	5.5	4.9	5.1	5.3	5.5	5.9
Social	5.0	5.9	6.1	6.3	6.5	7.0
Environment and Natural Resources	10.3	7.9	8.1	8.3	8.5	8.9
Governance and Public Administration	4.6	4.8	5.0	5.2	5.3	5.8
Taxes on Products	7.0	6.0	6.2	6.4	6.6	7.1





Chapter 03

Kenya's GHG Emissions Baseline and Mitigation Potential Projection

This chapter describes in detail the progress made in implementing mitigation actions outlined in the NCCAP 2018–2022 period and the status of GHG emissions as of 2022. The chapter is organised by first building an understanding of the GHG baseline scenarios as was projected in the first NDC and then in the NDC update in 2020. It starts by illustrating the reference points from where NCCAP I and the NDC commitments were based, then summarily presents the achievements outlined in the updated report of the first NDC in 2020. It then follows by describing the achievements made in the period 2018–2022. Finally, the section presents modelling results of the emission reductions that resulted from the mitigation actions outlined in the NCCAP 2018–2022, based on updated activity data and empirical evidence based on recent surveys and reports.

3.1 Baseline GHG Emission Projection

In the first NCCAP (2013-2017), Kenya's total GHG baseline emissions across all sectors were forecasted to reach143 $MtCO_2eq$ by 2030. In 2015, the second NCCAP (2013-2017) was validated and adjusted based on the data available during the preparation of the Second National Communication report to the UNFCCC. Kenya's NDC, was based on emission projections made from the base year 2010.

In the baseline projections six sectors of the economy, namely Forestry or LULUCF, Energy (both electricity generation and energy demand), Transportation, Agriculture, Industry, and Waste, were analyzed. Kenya's total GHG emissions from all the six sectors combined were anticipated to consistently increase from 80 $MtCO_2e$ in 2015 to about 98 $MtCO_2e$ by 2020 and 143 $MtCO_2e$ by 2030, mostly due to the growing population and expanding economy. While the livestock sub-sector of agriculture and the forestry sector were the largest emitters in Kenya before 2015, the largest absolute increase in emissions was expected from the energy sector, particularly from electricity generation and transportation. By 2030, the highest amount of emissions was projected to come from electricity generation (energy supply) at 35.7%, followed by agriculture at 27.3%, and forestry through LULUCF at 15.4%.

The drivers for emissions in the baseline scenario assumed a high carbon driven electricity sector due to the implementation of ambitious coal and natural gas power plants, transport and industrial process baseline projections based on historical growth trends, while waste and residential energy demand growth were determined by population growth projections. In the agricultural sector, the projection assumptions considered a 3% annual growth in agricultural GDP. This growth trend was applied across all sub-sectors, including crop and animal farming. However, for large ruminants (cattle, sheep, goats, camels, and donkeys), a growth rate of 1.3% was considered. The baseline emission projections under LULUCF showed more of an increase in plantation sizes than withdrawal, resulting in insignificant changes by 2030 (Government of Kenya, 2015).

In the baseline scenario for the energy supply sector, emissions forecasting was primarily driven by high fossil-fuelled electricity generation, including the then newly found coal and gas resources coming online to meet the rapidly rising electricity demand. The coal resources were 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 ranked coal as the fourth-largest contributor to the generation capacity after geothermal, hydro, and imports, in that order, starting from 2020 onwards. Lamu and Kitui coal plants were therefore included in the baseline projection. Nuclear was also expected to play a role in electricity generation by 2030.

In the baseline projections, agriculture was the largest contributor (40%) to Kenya's GHG emissions in 2015. Methane emissions from enteric fermentation in the livestock sector accounted for over half of the emissions from agriculture. Activities such as

conventional tilling, burning of savannah and crop residues, and rice cultivation in the crops sub-sector contributed carbon dioxide, methane, and nitrous oxide emissions. However, the agriculture sector's contribution was expected to decrease to 27% by 2030, as emissions from energy-related activities were projected to grow at a considerably faster rate than the agricultural sector emissions. A key driver in the slower increase in emissions in the sector was the lower economic growth rates expected in agriculture compared to other sectors of the economy as a result of climate change and weather-dependent agricultural practices, which would negatively affect both livestock and crop production.

The LULUCF sector includes estimates of GHG emissions and removals associated with increases or decreases in carbon stored in living biomass due to land-use changes occurring over time. Such land-use changes include actions like converting forest areas to cropland or establishing new forest lands through reforestation or afforestation. According to the baseline scenario, the forestry (LULUCF) sector was the second-largest contributor to Kenya's greenhouse gas emissions after agriculture in 2015, accounting for 33% of emissions, largely as a result of deforestation. The forestry sector is also vulnerable to climate change impacts, which are expected to have significant effects on the composition, growth rates, and regenerative capacities of forests. The first NCCAP reported that climatic changes are expected to increase desertification and forest degradation, with negative impacts on economic benefits and livelihoods derived from the forestry sector. By 2013, the government had initiated actions to address climate change in the forestry sector, including through tree planting initiatives and preparatory activities to enable participation in REDD+ as a climate change mitigation process. Under the Bonn Challenge, Kenya had established a restoration target of 4,210,000 hectares by 2030. The Bonn Challenge is a global initiative aiming to restore 150 million hectares of the world's degraded and deforested lands by 2020 and 350 million hectares by 2030. All these government efforts were expected to slow down and possibly reverse deforestation trends leading to a 15% reduction in GHG emissions from the forestry sector by 2030.

However, during the NDC Sectoral Analysis in 2017, it was observed that the estimates of carbon stocks in forests (referred to as Remaining Forest Land in the LULUCF sector) had the highest uncertainty of emission estimates because of uncertainty in activity data and emission factors. The uncertainties regarding the actual extent of total forest cover still remain. A review of biomass literature generated through the System for Land-Based Emissions Estimation in Kenya (SLEEK) project indicated that it was likely that total biomass stocks of forests may have been underestimated in the modelling work conducted for Kenya's Second National Communication (SNC), which was one of the primary data sources for estimating the baseline emissions for the NCCAP 2013-2017. During the update of the NDC in 2020, the available data from the REDD+ FRL development was reviewed and used to update the sectoral GHG emissions.

The baseline established in 2030 also projected that emissions from the transport sector would triple between 2010 and 2030, while those from the waste sector would double over the same period mostly as a result of the increasing population and economic growth (Government of Kenya, 2015). Table 3-1 and Figure 31 illustrate the baseline emission projections in the main GHG emission sectors.

Table 3-1. BAU Scenario and Baseline Emissions for First NDC (GoK, 2013)

Sector	Baseline GHG Emissions ($MtCO_2e$)							
	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**	**56**	**57**	**69**	**80**	**98**	**116**	**143**

Source: Second Biannual Communication; 2015

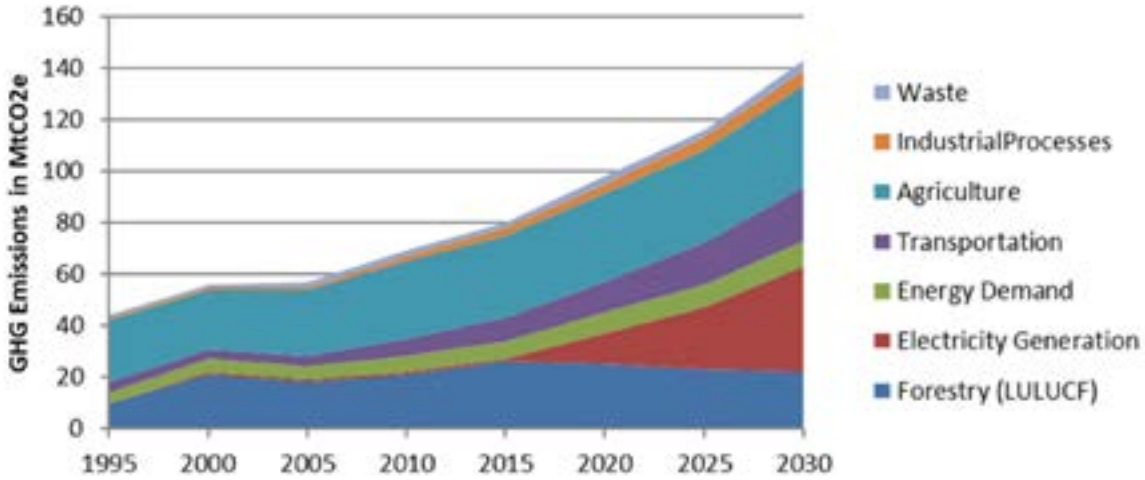


Figure 3-1. Baseline Scenarios projection

Source: Second Biannual Communication

In 2020, Kenya's 3rd GHG Inventory Draft Report (NIR 3) reported the revised GHG emissions and removals by sinks for the period 1995 to 2015, following the 2006 IPCC Guidelines and applied updated data.

For the dairy sector and some LULUCF sub-sectors, Tier 2 estimations were applied. According to NIR 3, the total national emissions in 2015 were 93.6 $MtCO_2e$ against a baseline projection of 80.0 $MtCO_2e$, implying that the baseline had been underestimated.

The largest variances were from the following sectors:

- LULUCF sector (9.3 $MtCO_2e$ increase in the NIR): Generally, experience to date has shown that the assumptions made in the baseline projections for the LULUCF sector were too optimistic, and the policies, laws, and regulations in place have not delivered the impacts that were forecasted during the NCCAP 2013–2017 process. The use of data sourced from different approaches has also contributed to the variance. The use of FRL in forest cover assessment is considered more accurate based on the detailed satellite imagery providing evidence to afforestation, forest degradation, and agroforestry. It demonstrates that National Forest Inventory (NFI) overestimated the carbon stock.
- Agriculture (5.3 $MtCO_2e$ increase in the NIR): The projected livestock population in the baseline, and corresponding enteric emissions (15.5 $MtCO_2e$), were lower in the NCCAP 2013–2017 than the actuals reported in the NIR 3 (22.3 $MtCO_2e$). During the NCCAP 2013–2017 process, the livestock population was capped based on expert opinion and the perceived livestock carrying capacity of the ASALs.
- Transport (2.3 $MtCO_2e$ increase): The average rate of increase of road vehicles has been higher than was projected in the baseline. This resulted in the observed variance between the NIR 3 and the baseline emissions from the transport sector. According to NIR 3, a comparison of the method used in the baseline (top-down approach) and the inventory of vehicle population (bottom-up approach) totals for the period 1995 to 2015 shows that the baseline totals of CO_2 emissions in the sector are more than 12% of the estimation based on vehicle inventory total emissions. Therefore, Kenya needs to enhance data collection on sectoral fuel allocation.
- A decrease in the 2015 emissions from the energy sector of 2.5 $MtCO_2e$ was observed in the NIR 3 relative to the baseline. This was mostly due to the increased generation of electricity from renewable sources relative to the baseline projections. The shutdown of the only petroleum oil refinery in 2013 was also not projected in the baseline.

Figure 3-2 illustrate effect of the deviation in projected emissions in Kenya. Since the NDC baseline is fixed up to 2030, it is important that the discrepancy between the NIR 3 and the NDC baseline is clearly explained in the NIR 3. Kenya's NDC, was based on emission projections made in the year 2010, as the base year. There is an opportunity to validate the NIR 3 data through NIR 4 which will also inform future NDC updates and NCCAPs.

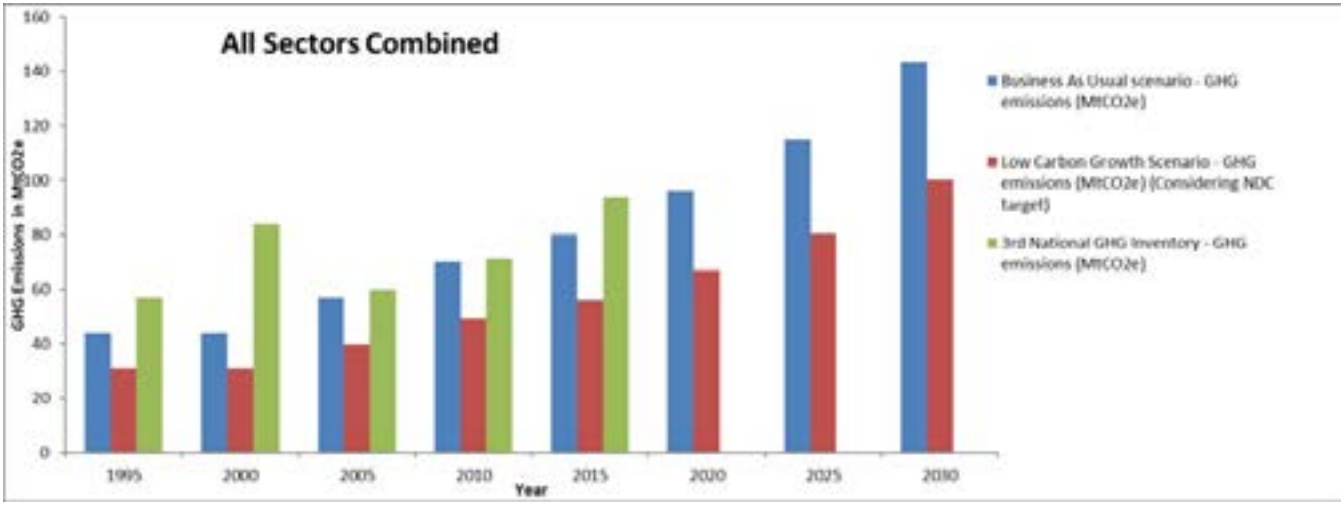


Figure 3-2. National GHG Emissions Trends (BAU Scenario and NIR 3) ($MtCO_2e$)

Source: Updated NDC, Technical Report

Both the Draft NIR 3 and the current NDC baseline, as expected, showed the same trends in terms of the sectoral shares of GHG emissions. In both cases, about 96% of the total emissions are from the agriculture, LULUCF, and energy sectors (including transportation).

3.2 Updated NDC Greenhouse Gas Emission Projections and Mitigation Targets

Kenya has been at the forefront of climate change mitigation and adaptation efforts. Upon the ratification of the Paris Agreement, the country committed to reduce its contribution to greenhouse gas emissions by 30% compared to the baseline emissions by 2030. Both the NCCAP 2013–2017 and the second national communication (SNC) identified and examined various mitigation options in the six sectors to determine priority mitigation actions and their associated mitigation potentials. The analysis established that out of the projected baseline BAU baseline GHG emissions total of 143 $MtCO_2e$, Kenya had the technical potential to reduce 60%, or 85.8 $MtCO_2e$, of these projected baseline emissions by 2030. These findings, which were applied in the MTAR 2018–2022, formed the basis of Kenya's mitigation NDC target that was set at 50% of the technical emissions reduction potential, equivalent to 42.9 $MtCO_2e$ by 2030. This technical potential provided the basis for determining the overall 30% emission reduction target for Kenya, with each sector being considered for its widely unique potential and costs. The technical emission reduction potential is illustrated in relation to the baseline emissions by 2030 in Figure 3-3, and Table 3-2. GHG emission abatement potential.

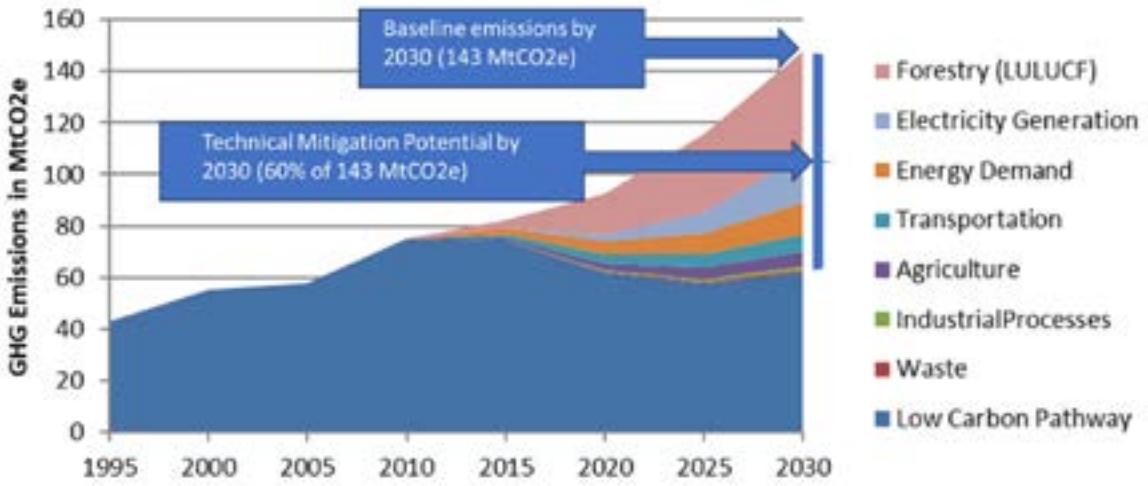


Figure 3-3. NCCAP 2013–2017 BAU Scenario and Baseline Emissions for First NDC (GoK, 2013)

Source: NCCAP 2013–2017

Table 3-2. GHG emission abatement potential

Sector	GHG Emission Reduction Potential ($MtCO_2e$)								First NDC Target ($MtCO_2e$)
	1995	2000	2005	2010	2015	2020	2025	2030	2030
Forestry (LULUCF)	0	0	0	0	2.71	16.24	29.76	40.2	20.1
Electricity Generation	0	0	0	0	0.28	2.24	8.61	18.63	9.32
Energy Demand	0	0	0	0	2.74	5.16	7.92	12.17	6.09
Transportation	0	0	0	0	1.54	3.52	5.13	6.92	3.46
Agriculture	0	0	0	0	0.63	2.57	4.41	5.53	2.77
Industrial Processes	0	0	0	0	0.26	0.69	1.03	1.56	0.78
Waste	0	0	0	0	0.05	0.33	0.5	0.78	0.39
Total Emissions Reduction Potential	**0**	**0**	**0**	**0**	**8.21**	**30.75**	**57.36**	**85.79**	**42.91**
Total BAU Emissions	**44**	**56**	**57**	**69**	**80**	**98**	**116**	**143**	**143**
% Emission Reduction Potential	**0%**	**0%**	**0%**	**0%**	**10%**	**31%**	**49%**	**60%**	**30%**

Source: NDC sector analysis report, 2017

In the analysis, it was assumed that each sector would make proportional (50%) contribution to the sector's technical mitigation potential by 2030.

However, during the NDC Sectoral Analysis, it was established that different sectors would make different contributions proportionally towards the achievement of the Initial NDC target of 30%. As illustrated in Table 3-2 (NDC Sectoral Analysis Report), 47% of the NDC contributions would come from the forestry sector, with electricity generation and energy demand contributing 22% and 14%, respectively. The transport sector's contribution was estimated at 8%, while agriculture, IPPU, and waste would contribute 6%, 2%, and 1%, respectively. By achieving the NCCAP 2018–2022, it was estimated that the country could potentially reduce up to 39.7 million tonnes of CO_2eq by 2022 as per the MTAR 2018–2022.

In the process of updating the NDC, mitigation actions were identified and prioritised, and their mitigation potential determined, as summarised in Table 3-3.

The third NCCAP (2023–2027) aims to review the progress made and identify smart and actionable targets towards achieving Kenya's NDC while aligning with the long-term vision of achieving net-zero GHG emissions by 2030.

Table 3-3. GHG emission reduction projections, potentials, and targets relative to BAU in NDC, NCCAP

Sector	First NDC Emissions projections and targets		NCCAP I & II Targets		Updated NDC greenhouse gas emission projection and mitigation potential		
	2030 BAU Emissions projection	2030 Emission reduction commitment	NCCAP I (2013–2017) emission reduction potential by 2017	NCCAP II (2018–2022) Emission reduction Potential by 2022	2022 emission reduction potential	2030 emission reduction potential	2030 emission reduction potential in updated NDC
Forestry	22	20.1	8.1	10.4	10.4	20.8	11.9
Electricity Generation	41	9.32	1.1	9.2	19.2	40.7	24.1
Energy Demand	10	6.09	3.7	7.1	4	7.4	
Transportation	21	3.46	2.3	1.9	1.9	4.7	2.4
Agriculture	39	2.77	1.4	2.61	2.7	9.7	5.8
Industrial processes and product use	6	0.78	0.4	0.45	0.8	2.4	1.4
Waste	4	0.39	0.2	0.36	0.7	0.8	0.5
Total	**143**	**42.9**	**17.2**	**32.02**	**39.7**	**86.5**	**46.0**

Source: NDC Sectoral Analysis Report (GoK, 2015); NCCAP 2013–2017 (GOK, 2013); NCCAP 2018–2022 (GOK, 2018); Updated NDC, 2020 (GOK, 2020)



Chapter 04

GHG Mitigation Implementation Status as of 2022

4.1 Energy Sector (Demand and Supply) Mitigation Actions Implementation Status

Energy is pivotal in the economic development of a country and has been recognised as a key infrastructure enabler for the achievement of the Kenya Vision 2030 (GoK, 2007). The level and intensity of commercial energy use in a country are key indicators of economic growth and development (MoE, 2004). Over the short-term development plans, energy has been emphasised, making it an indisputable factor in moving Kenya towards a middle-income economy. MTP I sought to scale up energy access for social and economic gains. In MTP II the government demonstrated ambition and sought to more than double the installed grid-connected capacity from just above 2,155 MW in 2015 to about 5,538 MW by 2017. In MTP III, the focus was on the delivery of sustainable energy development through the provision of mostly renewable electricity in the Kenya's electricity grid and increased adoption of clean and modern energy services towards the achievement of Sustainable Development Goal (SDG) 7.

Energy sector GHG emissions come from both the demand and supply sides. Energy demand emissions consist of direct emissions from the combustion and use of primary and secondary biomass and fossil fuels to support productive or social services in residential, commercial, and industrial sectors. On the other hand, supply-side energy emissions account for direct GHG emissions resulting from electricity generation conversion.

4.1.1 Energy Demand

4.1.1.1 Drivers of Energy and Non-Energy GHG Emissions

Energy demand sectors broadly include residential, commercial, industrial, and transport. The evolution of Kenya's final energy demand has shown a growing trend driven by demographic and economic growth. Kenya's final energy demand in 2018, as modelled in the LEAP tool, was estimated at 445 Petajoules (PJ) and has risen to 463 PJ in 2022.

As can be observed in Figure 4-1a, the residential sector exhibited the highest demand in 2018, accounting. for 37%, which gradually decreased to 36% in 2020 and further to 34% in 2022. The contribution of the commercial and industrial subsectors to the final energy demand was 31% between 2018 and 2022 while the transport sector's contribution (elaborated in the following chapter) increased from 32% in 2018 to 35% in 2022.

Similarly, the evolution of energy demand by source is illustrated in Figure 4-1b, based on the LEAP bottom-up and top-down modelling approaches. In 2018, biomass was observed as the highest contributor to energy demand, accounting for 48%. However, the share of biomass contribution has gradually decreased from 48% in 2018 to 44% in 2022, while fossil fuel use increased from 46% in 2018, to 48% in 2020, and further to 50% in 2022 of the final national energy demand over the same period. This shift could be attributed to residential energy transition from traditional biomass to modern and clean energy sources such as LPG, as well as the rapidly rising number of vehicles in the road. The contribution of electricity to the final energy demand has remained at around 6% of the total national energy demand over the same period.

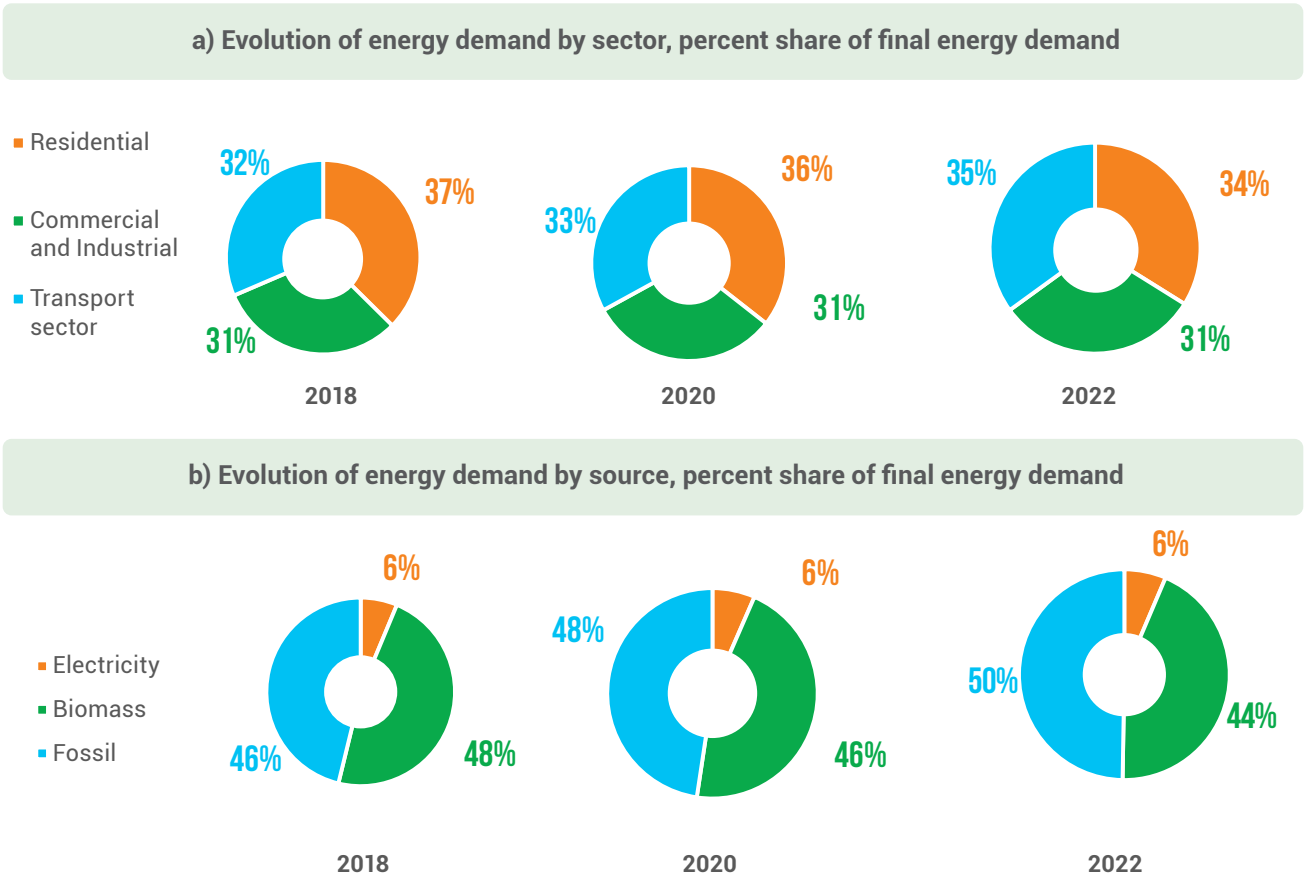


Figure 4-1. The evolution of energy demand in Kenya

Source: Author's own; LEAP modelling

Energy demand emissions have been attributed to the use of biomass and fossil fuels in the residential, commercial, institutional, and industrial sectors. The transport sector emissions are reported separately from energy demand emissions.

a) The evolution of energy demand in the residential sector

As mentioned earlier, energy demand is influenced by demographic changes. While it might be argued that energy demand would grow proportionally with population growth, the user and consumer dynamics in growing economies such as changing rural-urban populations, energy transition, social-cultural behaviour changes, and the implementation of national policies result in a nonlinear rise in energy demand. Therefore, modelling historical trends in residential energy demand from 2010 showed that in 2010, final energy demand was 156 PJ, which rose to 170 PJ in 2017 before declining to 157 PJ in 2022, as illustrated in Figure 4-2. Biomass usage remained the dominant source of final energy demand for the residential sector, with firewood contributing 71% of the total final energy demand in 2022, followed by LPG (10%), charcoal (9%), and electricity (5%), as illustrated in Figure 4-3. Kerosene use has reduced substantially in both urban and rural households. In urban households, energy demand reached 42 PJ in 2022, with LPG, firewood, charcoal, and electricity dominating the final energy demand, accounting for 29%, 24%, 21%, and 16% respectively, (see Figure 4-4). In rural areas, biomass accounted for 88% of the final energy demand, while charcoal and kerosene contributed 5% and 3% respectively. LPG accounted for only 2% of the final energy demand in rural areas as shown in Figure 4-5. Even so, there has been a significant transition from traditional to modern energy sources, especially in urban areas, as illustrated in Figure 4-2. The use of LPG has increased nearly 8 times since 2010, with ethanol emerging as a cooking fuel, particularly in urban areas. Additionally, there has been a rise in the use of electricity for cooking.

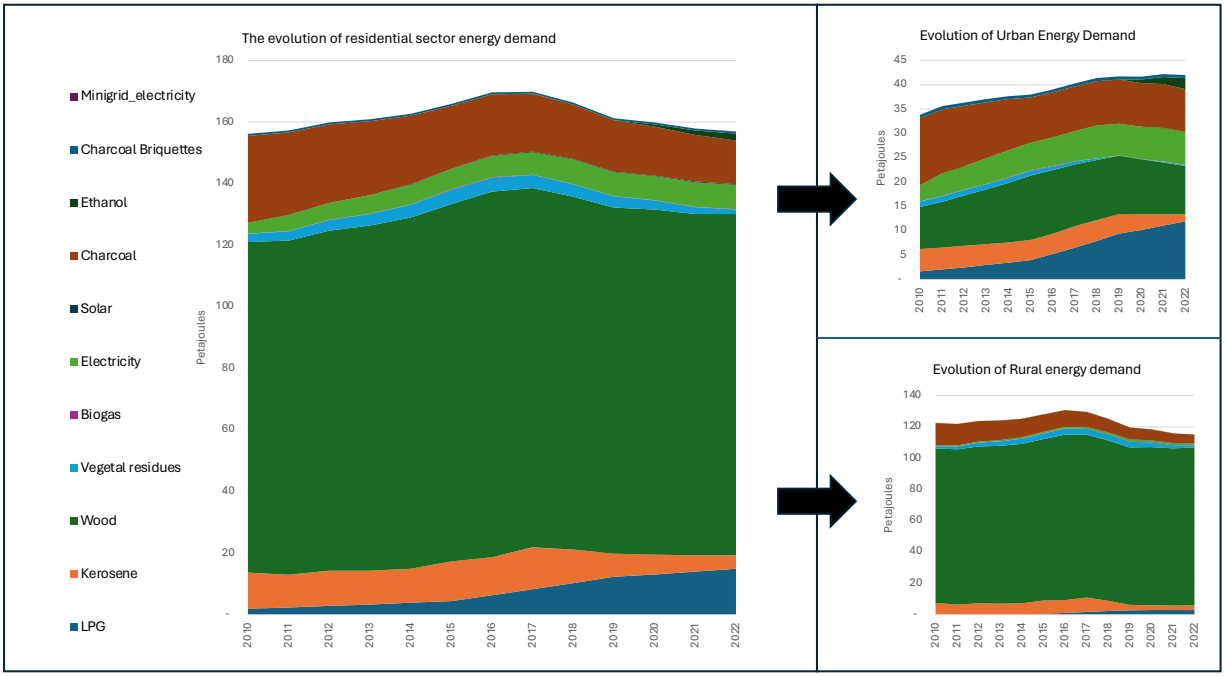


Figure 4-2. Historic trend in residential energy consumption
Source: Author's own, LEAP modelling

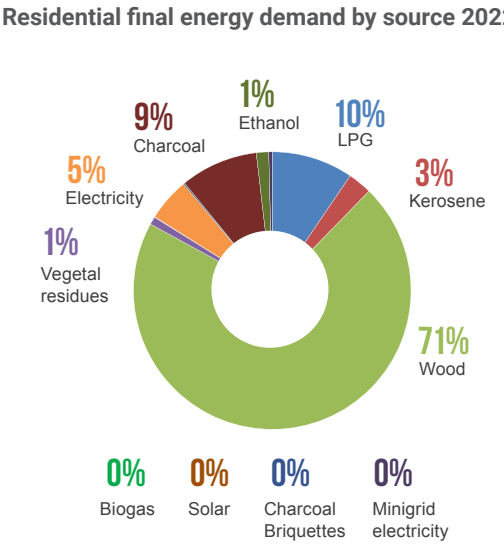


Figure 4-3. Residential energy demand by source
Source: Author's own

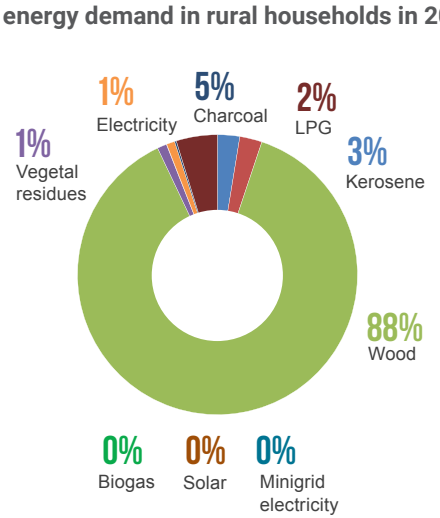


Figure 4-4. Final energy demand in urban households by source

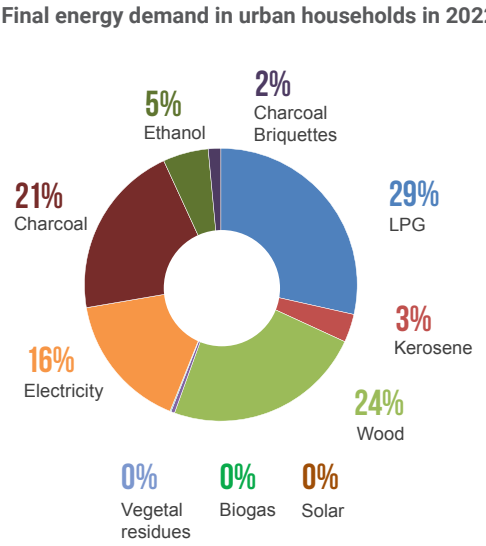


Figure 4-5. Final energy demand in rural households in 2022

b) The evolution of energy demand in the commercial and industrial sectors by 2022

Direct emissions from the commercial and industrial sector are associated with energy use for process heating. Figure 4-6 shows time series growth of energy demand in the industrial sector from 116 PJ in 2010 to 144 PJ in 2022. The service and manufacturing sectors contribute to about 94% of the total energy demand in the industrial and commercial sectors, with the manufacturing and construction sub-sector contributing to 52% of the final energy demand in the commercial and industrial sectors, while the service sub-sector contributes to 42% of the final energy demand in the commercial and industrial sector in 2022. The manufacturing and construction sector includes beverage (tea and coffee) and tobacco industries, cement production, and other manufacturing industries. In manufacturing and construction, heavy fuel oil, firewood, diesel, electricity, and coal are the main energy sources. A steady slow rise in energy demand is observed between 2010 and 2018, and a sudden tilt resulting from coal demand is evident as illustrated in Figure 4-7a. The tilt in coal demand between 2018–2022 could be attributed to a sudden increase in cement production (see further discussion in IPPU–chapter 4.4). Coal is assumed to be used entirely in cement manufacturing.

Service sectors include institutions such as hotels, restaurants, hospitals, and learning institutions. As such, energy demand in this sub-sector is mainly for heating and cooking, with firewood and charcoal accounting for over 90% of the total energy demand. Figure 4-7b illustrates a slow increase in energy demand from 51 PJ in 2010 to 60 PJ in 2022, almost flattening between 2018 and 2022.

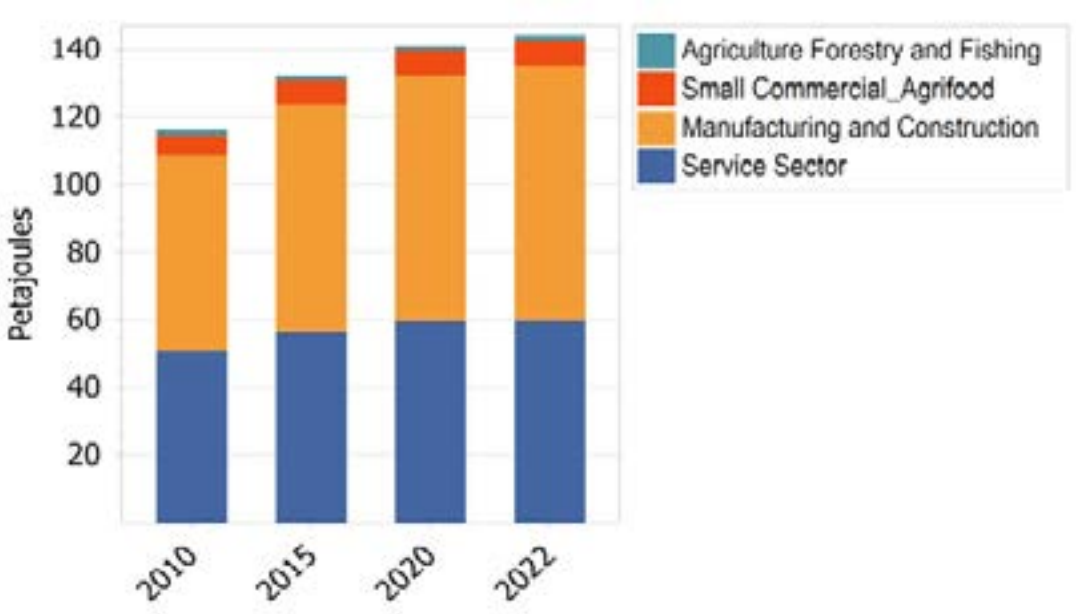


Figure 4-6. Energy demand in industrial and commercial sectors

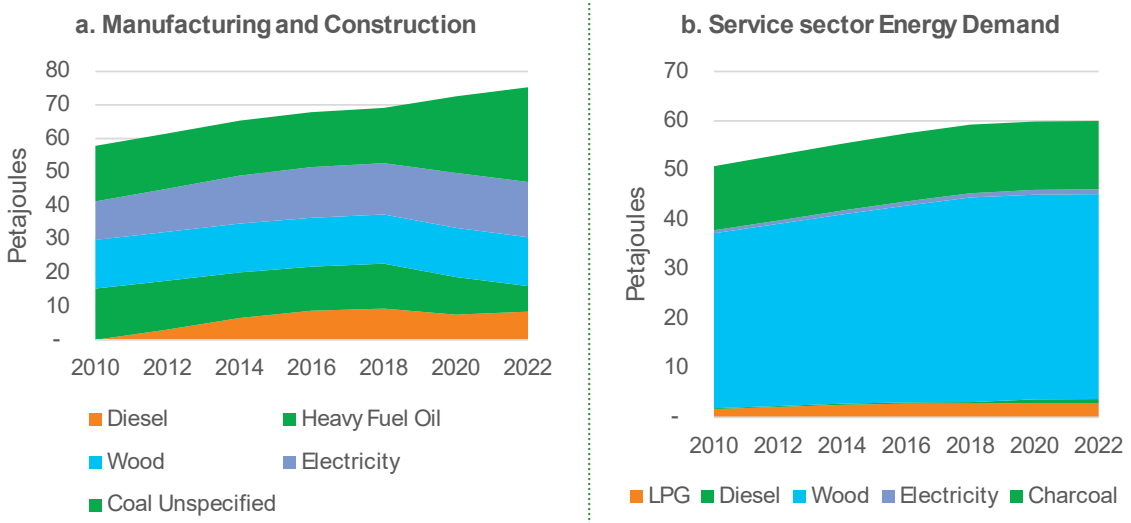


Figure 4-7. Energy demand in service, manufacturing, and construction sectors

4.1.1.2 Residential Sector Data Input and Assumptions

The residential sector in Kenya adopts a bottom-up approach, aiming to assess and implement strategies targeting the adoption of clean cooking technologies as well as the switch to modern and cleaner fuels in the medium term. This bottom-up analysis approach disaggregates energy usage to the level of technology, as illustrated in Figure 4-8. The figure illustrates categorization of activity level data, first by the number of households in rural and urban areas, and then by the proportion of these households electrified or not electrified. This disaggregation enables a comprehensive assessment of energy consumption while capturing the dynamics brought about by different user categories, whether urban or rural, and whether the household has access to electricity or not. The modelling also considers the proportion of these households using specific fuels and preferred technologies for fuel conversion to useful energy. This approach is significant for assessing fuel transitions, such as from traditional biomass to clean fuels such as LPG, while also accounting for efforts to enhance energy efficiency through the adoption of efficient technologies for biomass conversion. The calculation of final energy demand and emissions follows the following formula.

Final Energy Analysis: $e_f = (\text{summation})_{h,s,j}\ a \,.\, I$ .....*(i)*

Where: *e* =energy demand,

a =activity level,

I = energy intensity (energy consumed per unit of activity)

$_{h,s,j}$ = *household type, energy service sort, and fuel type*

Thus

Total GHG emission $C\text{tCO}_2\text{eq} = (summation)_{h,s,j} e_f \,.\, EF_j$ .....*(ii)*

Where: $C\text{tCO}_2\text{eq}$ = Total GHG emissions in tCO2eq

EF = Emission Factor by type of fuel

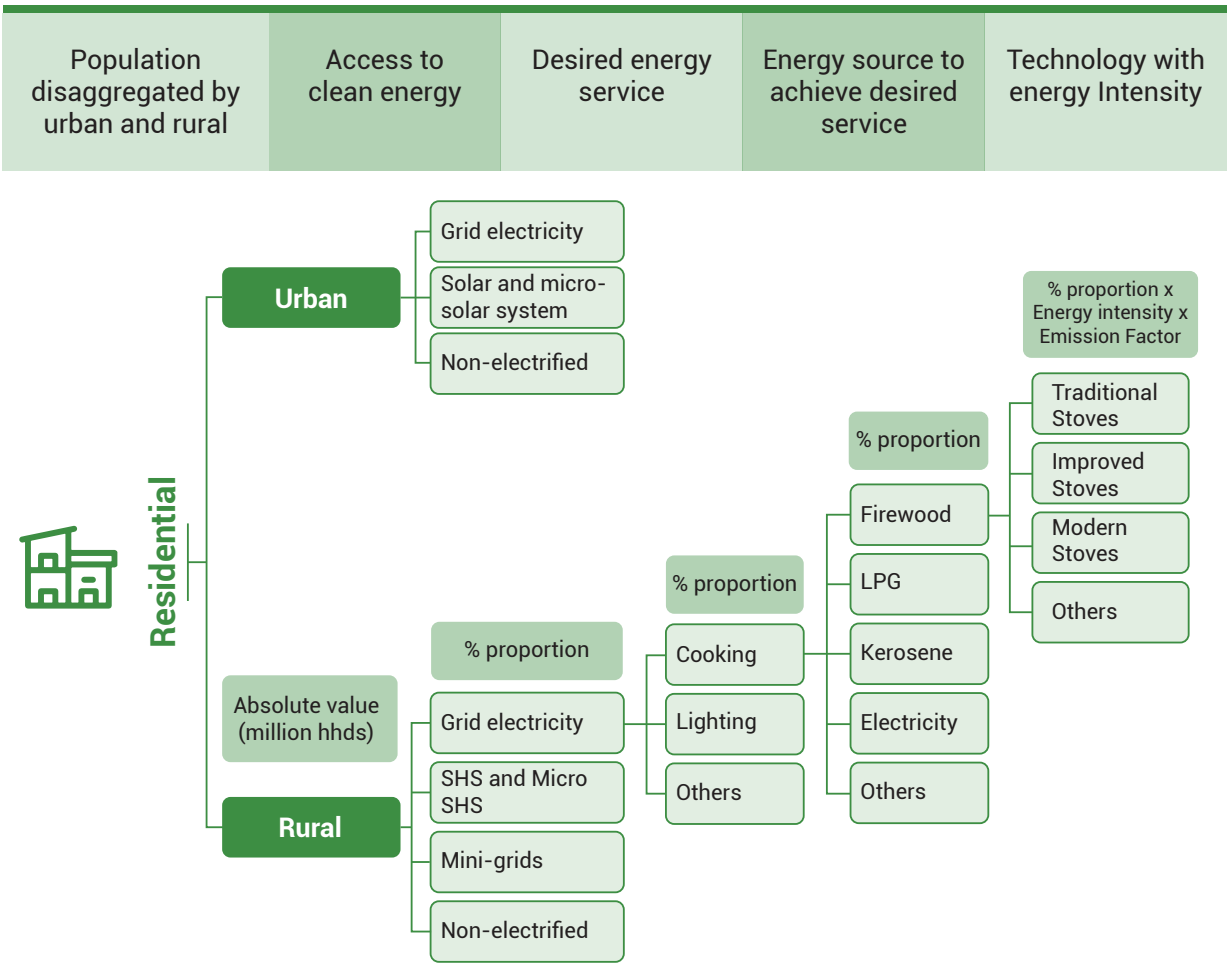


Figure 4-8. Section of tree structure in a bottom-up approach in residential energy sector scenario modelling

Source: Kenya long-term strategy

Data sources for modelling energy demand, current account and historical energy demand evolution, were obtained from national survey reports such as Economic Surveys, sectoral study reports, and peer-reviewed literature. The status as of 2022, sectoral inputs were derived from recently published policies, surveys, or unpublished databases. The Kenya National Bureau of Statistics (KNBS), and the Ministry of Energy conducted comprehensive surveys, including the Demographic and Health Survey of 2022 and the Household Cooking Sector Study of 2019, which are the latest data that segregated the proportion of households using different fuels and technology types. Data input followed a systematic approach based on the tree structure presented in Figure 4-8 above. Urbanisation has been rapid, with about 48% of households residing in urban areas by 2022, as illustrated in Figure 4-9. About 98% of total urban households were connected to the grid in 2022, with projections based on census reports from 2019 and a number of new connection data from Kenya Power reports (Kenya Power, 2023; KNBS, 2019). Additionally, about 1% of urban households were electrified using solar devices (solar lantern, micro solar home systems, and solar home systems), while only about 0.1% remained unconnected. Rural households have been on the rise but in a declining trend. In 2022, there were 6.3 million households, with about 30% of this population connected to grid electricity and 29.9% using solar technologies (solar home systems and micro-solar systems), as projected from national census data. The use of mini-grid electricity has also increased over the years, with over 100,000 rural households (representing about 1.5% of total rural households) connected to mini-grid electricity in 2022[3], according to data from the Energy and Petroleum Regulatory Authority (EPRA) database.

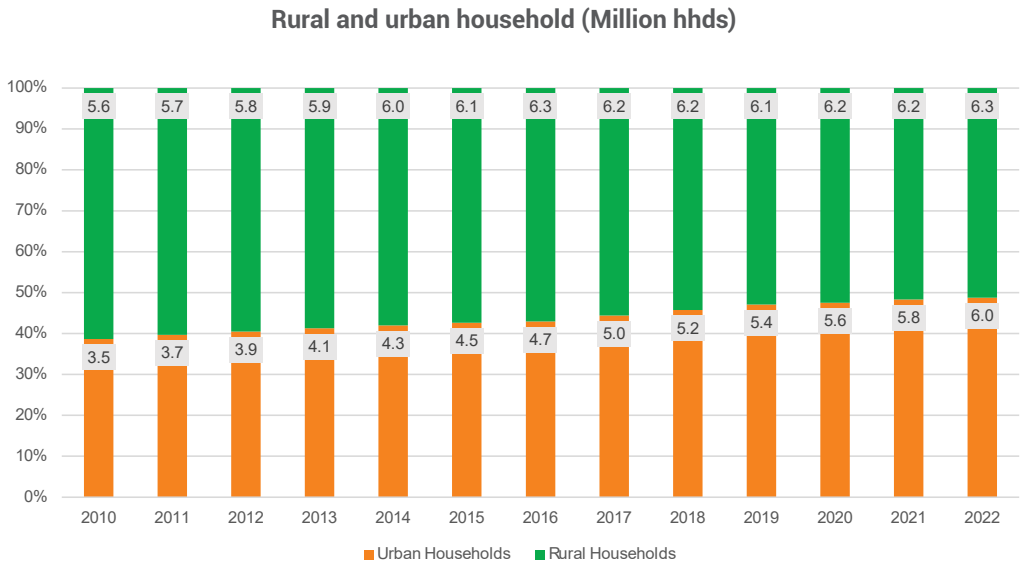


Figure 4-9. Demographic trend disaggregated in rural and urban areas

[3] Discussion with Energy Technical Working Group for NCCAP III review

Based on data availability and disaggregation from national reports such as the National Census Report of 2019, Household Energy Sector Report, 2019, and the Demographic and Health Survey Report of 2022, the main services derived from energy supply are for cooking (sometimes referred to as heating) and lighting, while all other applications are lumped into other services. Therefore, it was assumed that all household categories require energy for cooking, lighting, and other services. Various fuel sources are required for these services.

The evolution of cooking fuels between 2009 and 2022 is illustrated in Figure 4-10 and Table 4-1. Biomass remains the dominant energy source for the residential sector, though in a declining trend decreasing from 64.6% of households in 2009 to 51.6% in 2022. Similarly, charcoal and kerosene use have reduced, with the population of households using charcoal decreasing from 16.9% in 2009 to 11.4% in 2022, and the proportion of households using kerosene decreasing from 11.6% in 2009 to 3.8% in 2022. A major gain has been observed in increased adoption of LPG, which has risen more than four times from 5.0% to 29.4% between 2009 and 2022. The proportion of LPG users in urban areas doubled from 27.7% to about 54% between 2015 and 2019, and further to 62% in 2022 (KNBS, 2022). LPG usage in rural Kenya also rose, with the proportion of users rising from 2.5% in 2015 to 18% in 2019 (KNBS, 2019; MoE, 2019). However, the Demographic and Health Survey of 2022 reported an 8.8% adoption of LPG in rural areas in 2022, which is much lower than 18% LPG use in rural household reported by the Ministry of Energy study in 2019 (MoE, 2019). The increase in LPG usage is attributed to the then prevailing national policies on the adoption of clean cooking and other socio-economic push factors such as the rise in charcoal and wood prices. Usage of other clean cooking fuels, such as biogas and electricity, has not significantly increased over the period between 2009 and 2022.

Table 4-1. The evolution of residential cooking energy source in percent share

	Census 2009	KIHBS 2015	Census 2019	KDHS 2022
Electricity	0.8%	1%	0.90%	0.20%
Kerosene	11.6%	14.00%	7.80%	3.80%
LPG	5.0%	13.40%	23.90%	29.40%
Biogas	0.7%	0.20%	0.50%	0.20%
Firewood	64.6%	54.60%	55.10%	51.60%
Charcoal	16.9%	14.60%	11.60%	11.40%
Solar (Solar water heater, solar cookers)	0.1%	-	0.20%	-
Others: Vegetal waste/no food/coal	0.3%	1.90%	0.00%	3.40%

Source: National Census Report, 2009, Kenya Integrated Household Budget Survey, 2015/2016, *National* Census Report, 2019 and Kenya Demographic and Health Survey (KDHS), 2022.

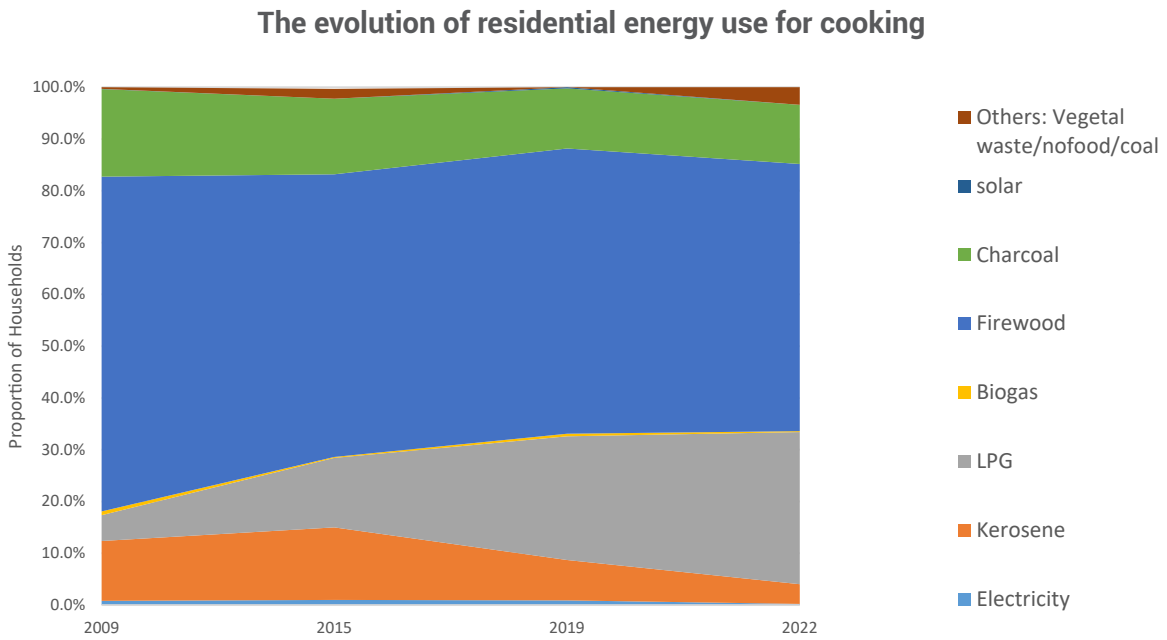


Figure 4-10. Evolution of residential cooking energy by proportion of households using energy sources

Source: National Census Report, 2009, Kenya Integrated Household Budget Survey, 2015/2016, *National* Census Report, 2019 and Kenya Demographic and Health Survey, 2022.a

The fuel is burnt in specific technologies—either efficient or inefficient technologies. Table 4-2 details fuel and various technology adoptions for cooking in shared proportions. The table can be read as follows: household categories (grid-connected and non-grid-connected, urban and rural) cooking with fuel 'x' (in column c1) as per the proportions in columns c2, c3, and c4 (rural, urban, and national respectively), deploying technology types 'y' used for burning fuel type 'x' given in columns c6, c7, and c8 (rural, urban, and national respectively) as derived from the Kenya Household Cooking Sector Study report (MoE, 2019). The Leap model inputs fuel types as saturation, enabling fuel stacking such that a household can use a charcoal stove, LPG, and electric cookers. However, the assessment restricts technology within the same fuel category to shared proportions such that a household can only use one technology (either three-stone open fire, or fixed biomass stove or improved portable artisanal firewood stove to cook at any given time). As such, the use proportions in column c6 and c7 were harmonised to 100% share proportion in c9 and c10. It thus follows that 26% of urban households use firewood for cooking and 82.9% of the household using firewood used traditional three-stone open fire as 14.8% use improved biomass stove, 1.5% using artisanal portable firewood stove and only 0.8% use modern branded firewood stoves such as Ecozoom, Envirofit, and Burn stoves among others. Table 4-2 illustrates computation of the fuel and technologies as applied in LEAP tool.

In the same manner, Integrated Household and Budget Survey (KIHBS 2015/2016) present fuel types used for cooking and technology type as illustrated in Table 4-3. The assessment adopts the same method of harmonisation categorising technologies with respective fuels.

Table 4-2. Status of residential fuel and fuel conversion technology use in 2019

c1	c2	c3	c4	c5	c6	c7	c8	c9	c10
Fuel type	% of hhds currently using in 2019			Fuel conversion device with energy intensity	% of hhds currently using in 2019			Computed share of energy devices for LEAP	
	Urban	Rural	Total		Urban	Rural	Total	Urban	Rural
Firewood				Three-stone open fire	21.80%	75.40%	58.10%	82.9%	81.4%
				Fixed biomass stove	3.90%	14.20%	10.90%	14.8%	15.3%
	26%	90%	70%	Improved artisanal portable firewood stove	0.40%	2.40%	1.80%	1.5%	2.6%
				Branded firewood stove	0.20%	0.60%	0.40%	0.8%	0.6%
				Gasifier stoves	0.00%	0.00%	0.00%	0.0%	0.0%
					26.30%	92.60%		**100.0%**	**100.0%**
Charcoal				Improved artisanal portable charcoal stoves	39.90%	30.80%	33.80%	82.4%	73.0%
	47%	40%	42%	Branded charcoal stove	3.60%	2.80%	3.10%	7.4%	6.6%
				Artisanal metallic charcoal stove	4.60%	8.60%	7.30%	9.5%	20.4%
				Nyama Choma Grill	0.30%	0.00%	0.10%	0.6%	0.0%
					48.40%	42.20%		**100.0%**	**100.0%**
LPG				6kg complete cylinder	39.10%	15.00%	22.80%	67.9%	86.7%
	54%	18%	30%	LPG stove (multiple burner)	13.60%	2.00%	5.80%	23.6%	11.6%
				Mixed LPG-Electricity stove	4.90%	0.30%	1.80%	8.5%	1.7%
					57.60%	17.30%		**100.0%**	**100.0%**

c1	c2	c3	c4	c5	c6	c7	c8	c9	c10
Fuel type	% of hhds currently using in 2019			Fuel conversion device with energy intensity	% of hhds currently using in 2019			Computed share of energy devices for LEAP	
	Urban	Rural	Total		Urban	Rural	Total	Urban	Rural
Kerosene	28%	3%	11%	Kerosene wick stove	27.70%	3.20%	11.10%	100.0%	100.0%
				Pressurised kerosene stove	0.00%	0.00%	0.00%		
					27.70%	3.20%		**100.0%**	**100.0%**
Electricity	7%	1%	3%	Mixed LPG-Electricity stove	4.90%	0.30%	1.80%	62.0%	60.0%
				Microwave	2.20%	0.20%	0.80%	27.8%	40.0%
				Electric coil stove	0.80%	0.00%	0.30%	10.1%	0.0%
				Electric induction stove	0.00%	0.00%	0.00%	0.0%	0.0%
					7.90%	0.50%		**100.0%**	**100.0%**
Other	0%	1%	0%	Biogas stove	0.10%	0.20%	0.10%	100.0%	33.3%
				Gel biofuel stove	0.00%	0.10%	0.10%	0.0%	16.7%
				Liquid biofuel stove	0.00%	0.00%	0.00%	0.0%	0.0%
				Solar cooker	0.00%	0.00%	0.00%	0.0%	0.0%
				Retained heat cookers	0.00%	0.30%	0.20%	0.0%	50.0%
					0.10%	0.60%		**100.0%**	**100.0%**

Source: MoE, 2019; Kenya household cooking sector study

Table 4-3. Data for residential cooking derived from KIHBS 2015/2016

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Aggregate fuel	% of hhds currently using in 2015			Specific cooking technologies	% of hhds currently using in 2015			Computed share of energy services	
	Urban	Rural	National		Urban	Rural	Total	Urban	Rural
Firewood				Three-stone open fire	13.70%	71.70%	46.40%	85.6%	84.9%
				Fixed biomass stove	2.30%	12.80%	8.20%	14.4%	15.1%
	16%	84%	55%	Improved artisanal portable firewood stove	0.00%	0.00%	0.00%	0.0%	0.0%
				Branded firewood stove	0.00%	0.00%	0.00%	0.0%	0.0%
				Gasifier stoves	0.00%	0.00%	0.00%	0.0%	0.0%
					16.00%	84.50%		100.0%	100.0%
Charcoal				Improved artisanal portable charcoal stoves	9.30%	3.70%	6.20%	40.8%	39.4%
	22%	9%	15% Artisanal metallic charcoal stove	Branded charcoal stove	0.00%	0.00%	0.00%	0.0%	0.0%
				13.50%	5.70%	9.10%	59.2%	60.6%	
				Nyama Choma Grill	0.00%	0.00%	0.00%	0.0%	0.0%
					22.80%	9.40%		100.0%	100.0%
LPG				6kg complete cylinder	60.00%	60.00%	60.00%	60.0%	60.0%
	28%	3%	13%	LPG stove (multiple burner)	40.00%	40.00%	40.00%	40.0%	40.0%
				Mixed LPG-Electricity stove	0.00%	0.00%	0.00%	0.0%	0.0%
					100.00%	100.0%		100.0%	100.0%

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Aggregate fuel	% of hhds currently using in 2015			Specific cooking technologies	% of hhds currently using in 2015			Computed share of energy services	
	Urban	Rural	National		Urban	Rural	Total	Urban	Rural
Kerosene	29%	2%	14% Pressurised kerosene stove	Kerosene wick stove	29.00%	2.00%	13.90%	100.0%	100.0%
				0.00%	0.00%	0.00%			
					29.00%	2.00%		100.0%	100.0%
Electricity	2%	0%	1% Electric coil stove	Mixed LPG-Electricity stove	0.80%	0.10%	0.40%	57.1%	50.0%
				Microwave	0.00%	0.00%	0.00%	0.0%	0.0%
				0.60%	0.10%	0.30%	42.9%	50.0%	
				Electric induction stove	0.00%	0.00%	0.00%	0.0%	0.0%
					1.40%	0.20%		100.0%	100.0%
Other	0.2%	0.2%	0.2%	Biogas stove	0.20%	0.20%	0.20%	100.0%	100.0%
				Gel biofuel stove	0.00%	0.00%	0.00%	0.0%	0.0%
				Liquid biofuel stove	0.00%	0.00%	0.00%	0.0%	0.0%
				Solar cooker	0.00%	0.00%	0.00%	0.0%	0.0%
				Retained heat cookers	0.00%	0.00%	0.00%	0.0%	0.0%
					0.20%	0.20%		100.0%	100.0%
Animal dung and Twigs	2.5%	1%	2%	Three stone open fire	13.70%	71.70%	46.40%	85.6%	84.9%
				Fixed biomass stove	2.30%	12.80%	8.20%	14.4%	15.1%
				Improved artisanal portable firewood stove	0.00%	0.00%	0.00%	0.0%	0.0%
				Branded firewood stove	0.00%	0.00%	0.00%	0.0%	0.0%
				Gasifier stoves	0.00%	0.00%	0.00%	0.0%	0.0%
					16.00%	84.50%		100.0%	100.0%

Source: KNBS, 2017; Kenya Integrated Household Budget Survey

Finally, cooking energy intensities used in the model is as shown in Table 4-4. Kerosene consumption intensity is based on an average of 10-year time series of imported illuminating kerosene divided by the total number of households using kerosene, with equal proportions between urban and rural households, as illustrated in Figure 4-11. On e-Cooking, reports have identified a range of electricity consumption between 29.82–59.65 kWh/month (EED Advisory, 2023) and 26.4–61.8 kWh/month/hhd (ESMAP, 2020) for households entirely cooking with electricity. Averaging these results produces about 44.1 kWh/month, which translates to 533 kWh/year. The modelling assumption regarding the status of e-Cooking was based on findings from the draft Kenya national e-Cooking study, which reported that 1.97% of both rural and urban households used electricity as their primary energy for cooking in 2022. Additionally, the report identifies that about 24% of total households own some electric devices that would support cooking activities, such as electric kettles and immersion heaters (Nuvoni Centre for Innovation Research, 2023). The varying range of electric heating devices at the household level includes water heating coils, electric kettles, microwaves, induction stoves, hotplates, rice cookers, electric ovens, electric hobs, air fryers, electric frying pans, slow cookers, infrared stoves, halogen ovens, and electric pressure cookers.

Table 4-4. Energy intensity for various cooking fuels

Cooking	Urban	Rural	Units	Data Source
LPG	68	47	kgs/hhd/year	Ministry of Energy, 2019
Wood	1,232	1,362	kgs/hhd/year	Ministry of Energy, 2019
Kerosene	72	72	Litres/hhd/year	Calculated
Charcoal	364	411	tonnes/hhd/year	Ministry of Energy, 2019
Agrowastes	270	421	tonnes/hhd/year	Ministry of Energy, 2019
Electricity	533	533	kWh/hhd/year	Calculated based on EED, 2023; Leary et.al., 2020
Mini-grid electricity		337	kWh/hhd/year	Computed from lower range of
Ethanol	144		Litres/hhd/year	Reported by Koko network

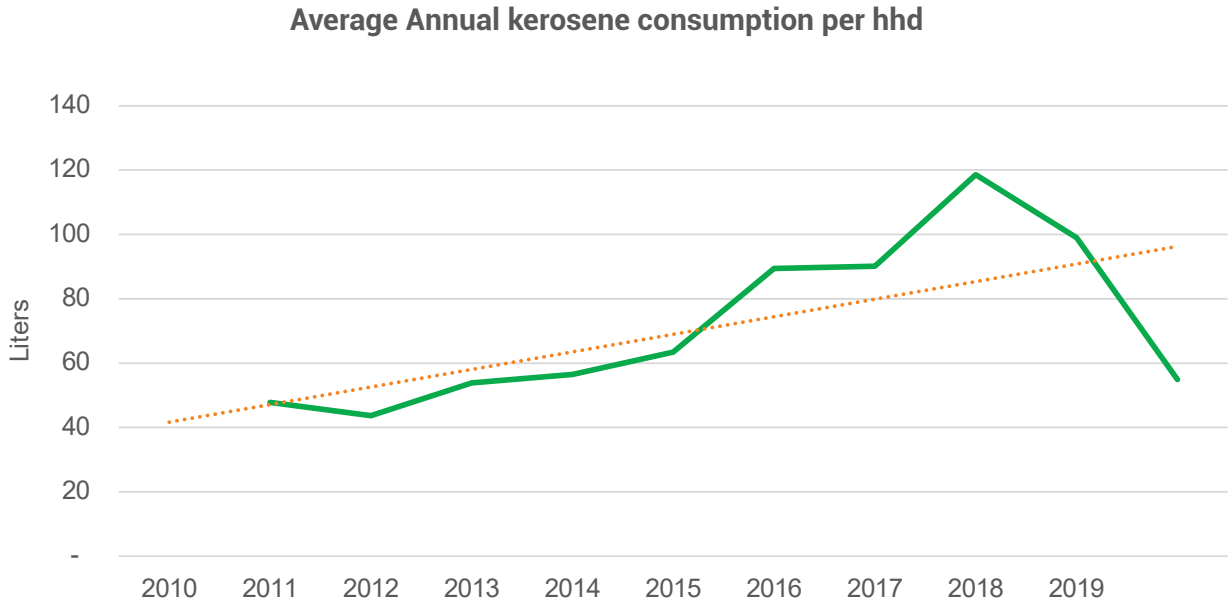


Figure 4-11. Kerosene consumption trend

Historically, lighting energy has heavily relied on kerosene, as illustrated in Table 4-5. The significant dependence on kerosene and traditional biomass not only contributes to indoor air pollution and adverse effects on human health (Berglund et al., 1991) but also generates GHG emissions. However, at the national level, Kenya has made significant gains in transitioning to modern and clean energy sources and technologies for lighting. Grid electricity connections increased to 57% in 2022 from 23% proportion share of the national population, as illustrated in Table 4-5 and Figure 4-12. Also, the proportion of households using solar (lantern and micro-solar home systems) has risen from a 2% share to a 28% share of the total population. Kenya aims for universal access to electricity by 2030, and given the current growth trajectory, this goal appears attainable. These changes illustrate the transition to cleaner lighting technologies, hence reducing GHG emissions.

Table 4-5. The evolution of proportion of households lighting by fuel source

	Census report 2009	KIHBS 2015	Census report 2019	KDHS 2022
Grid electricity	23%	41%	50%	57%
Solar (lanterns and micro solar home systems)	2%	14%	25%	28%
Kerosene	69%	35%	17%	6%
Gas	1%	0%	0%	1%
Firewood	5%	2%	3%	1%
Others (Drycell torch, candle, battery, generator)	1%	8%	6%	8%

Table 4-5. The evolution of proportion of households lighting by fuel source

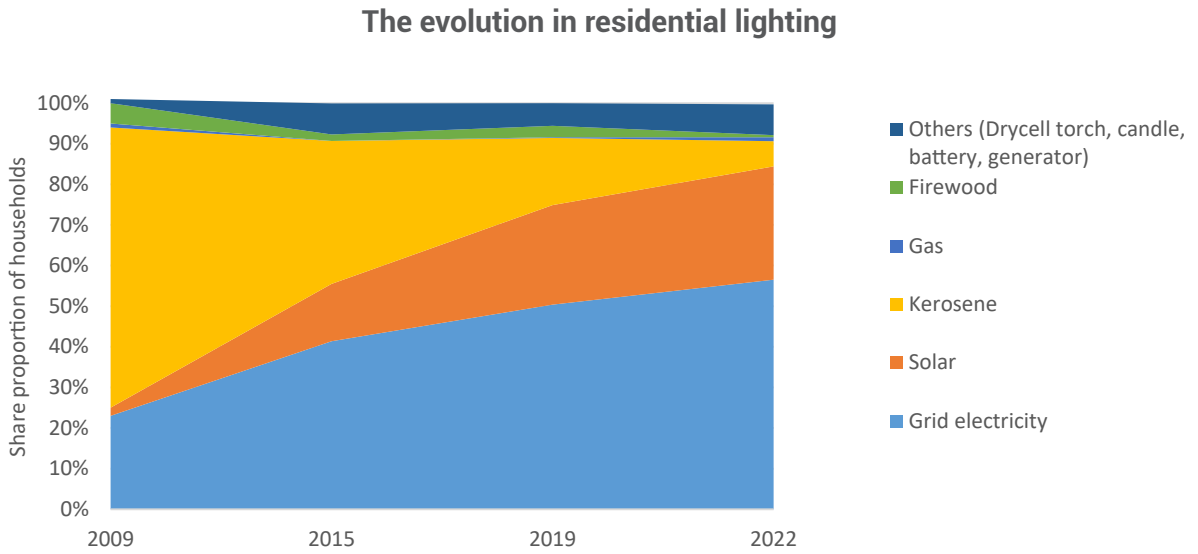


Figure 4-12. Evolution of residential lighting by fuel source

Source: The 2009 National Census; 2015/2016 Kenya Integrated Household and Budget Survey; 2019 National Census Report

Residential lighting computation assumed no fuel stacking as illustrated in Table 4-6. As such, all rural and urban households with any form of electricity grid, solar lanterns and micro solar systems and mini-grids were assumed to rely fully on the type of fuel for lighting. The non-electrified houses were assumed to adopt the respective lighting device but harmonised to 100% of the absolute number of non-electrified households. For example, in 2015, 17.8% of the urban population used kerosene for lighting, with 9.2% using tin lamps, 8.5% using lanterns and 0.1% using pressure lamps. This would translate to 78.1% of the 22.8% households that are not connected to electricity. Similarly, in 2019, 23.7% of the 43.8% rural households without electricity used kerosene, translating to 54.1% using kerosene. See Table 4-6.

Table 4-6. Residential lighting

	Household lighting (2015)		Household lighting by source (2015)	LEAP Data (computed non-electrified)	Household lighting by source (2019)		LEAP data (computed for Non-electrified homes)	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Mains Electricity	73.0%	17.1%	73.0%	17.1%	**88.70%**	**26.30%**	**88.70%**	**26.30%**
Solar SHS and Micro solar	4.2%	21.7%	4.2%	21.7%	**2.40%**	**29.90%**	**2.40%**	**29.90%**
Mini-grids	0.0%	0.0%	0.0%	0.0%	**0.00%**	**0.00%**	**0.00%**	**0.50%**
Non-electrified households	22.8%	61.2%	22.8%	61.2%	**8.9%**	**43.8%**	**8.9%**	**43.3%**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Kerosene	17.80%	48.60%	78.1%	79.4%	**5.20%**	**23.70%**	**58.43%**	**54.11%**
Pressure lamp	*0.10%*	*0.30%*	*0.4%*	*0.5%*	*0.20%*	*0.4%*	*3.85%*	*1.69%*
Lantern	*8.50%*	*20.60%*	*37.3%*	*33.7%*	*2.20%*	*9.4%*	*42.31%*	*39.66%*
Tin Lamp	*9.20%*	*27.70%*	*40.4%*	*45.3%*	*2.80%*	*13.9%*	*53.85%*	*58.65%*
Gas	0.00%	0.00%	0.0%	0.0%	**0.10%**	**0.2%**	**1.12%**	**0.46%**
Firewood	0.20%	2.70%	0.9%	4.4%	**0.30%**	**4.3%**	**3.37%**	**9.82%**
Solar Torch	1.50%	0.00%	6.6%	0.0%	**0.70%**	**8.1%**	**7.87%**	**18.49%**
Drycell torch	1.50%	7.30%	6.6%	11.9%	**0.70%**	**5.8%**	**7.87%**	**13.24%**
Candle	0.30%	1.70%	1.3%	2.8%	**1.80%**	**1.0%**	**20.22%**	**2.28%**
Battery	1.10%	1.60%	4.8%	2.6%	**0.10%**	**0.6%**	**1.12%**	**1.37%**
Generator	0.40%	0.50%	1.8%	0.8%	**0.00%**	**0.1%**	**0.00%**	**0.23%**
	22.8%	**61.2%**	**100.0%**	**102.0%**	**8.9%**	**43.8%**	**100.00%**	**100.00%**

Source: National Census Report, 2019 and Kenya Demographic and Health Survey, 2022

4.1.1.3 Commercial and Industrial Sector Data Inputs and Assumptions

Manufacturing is at the core of Kenya's economic development. It is one of the three pillars of the Kenya Long-Term Development Blueprint, referred to as Kenya Vision 2030. Introduced in 2008, this blueprint outlines the country's development goals to be achieved through medium-term plans. The expansion of manufacturing calls for additional efforts in expanding the national energy infrastructure to match the projected double-digit growth patterns. In the reference case, Kenya projects increased urbanisation, development of ICT infrastructure, numerous industrial parks, and the establishment of the first-ever steel smelting and manufacturing in the country. This growth trajectory would inevitably result in high energy demand for various industrial processes. Thus, key drivers for energy demand and projection for the commercial and industrial sector include national GDP and value added by sector, as illustrated in Table 4-7.

Modelling energy consumption in the commercial sector adopts a top-down approach, involving an intricate balance of imported fuel against sales and electricity consumption (demand against consumption). This top-down approach identifies final energy demand and distributes it among demand sectors without necessarily getting to technology-level analysis. Plausible scenarios in this context would be fuel switching and high-level modelling of industrial efficiency scenarios.

Final energy demand is balanced proportionate to the GDP value added by sector, based on data from annual reports on energy demand and supply in national economic surveys, typically presented as in Table 4-8 and Table 4-9. This assumes that energy demand by sector is directly proportional to their contribution to GDP—the higher the GDP contribution the higher the energy demanded. For instance, based on Kenya's sectoral categorisation in GDP reporting, Table 4-7 shows in summary the value added by different sectors categorised as agriculture, forestry, and fisheries; small commercial and services; manufacturing and construction; public administration, education, and health; and hotels, restaurants, and local eateries contributing to 21%, 38%, 26%, 13%, and 1.2% of the total GDP in 2021 respectively.

The demand-end use consumption provided in Table 4-10 is balanced based on data provided in Table 4-8 and Table 4-9. Thus, in Table 4-10, we assume that fuel oil imported in row 10 (R10), column 2 (C2) is shared between power generation and industrial and commercial use in row 9 (R9) and row 10 (R10), column 3 (C3). Thus, in computation we would first subtract the amount of fuel oil for power generation in R9:C3 from R10:C2, and then distribute the remaining fuel oil proportionately between manufacturing and construction and small commercials according to GDP contribution. In the second example, petroleum demand (blue banded rows) of motor gasoline, illuminating kerosene, and light diesel (R4, R7, R8: C2) are all primarily sold via retail pump outlets, primarily for transport (gasoline and diesel) and mainly for residential use (illuminating kerosene).

Table 4-7. Commercial and industrial sector value add to total GDP (Drivers of commercial and industrial demand)

GDP contribution by sector	2020	2021
Agriculture, forestry, and fisheries	21%	21%
Small commercials and services	38%	38%
Manufacturing and Construction	26%	26%
Public administration, Education, and Health	13%	13%
Hotels, restaurants, and local eateries	1.2%	1.2%
	100%	100%

Source: Author's own, Derived from KNBS, Kenya Economic Survey, 2022

Table 4-8. Fossil fuel demand and supply

Demand	2018	2019	2020	2021
Liquified petroleum gas	222.3	312.1	326.2	371.4
Motor gasoline (premium and regular)[1]	1,359	1,438.4	1,395.3	1,554.4
Aviation spirit	18.8	10.2	1.9	1.4
Jet/Turbo fuel	674.4	699.4	394.8	506.8
Illuminating kerosene	339.4	168.3	127	111.3
Light diesel oil	2,173.1	2,198.7	2,157.6	2,305.7
Heavy diesel oil	0.2	1.3	1.8	0.8
Fuel oil	402	382.8	273.9	340.3
TOTAL	**5,189.2**	**5,211.2**	**4,678.5**	**5,192.1**

[1]Adjustment for inventory changes and losses in production

Demand	2018	2019	2020	2021
Refinery usage				
Total domestic demand	5,189.2	5,211.2	4,678.5	5,192.1
Export of petroleum fuel	8.4	7	2.3	0.4
Total demand	**5,197.6**	**5,218.2**	**4,680.8**	**5,192.5**
Supply				
Import of crude oil				
Import of petroleum product	5,396.3	5,682.2	4,920.4	5,827.6
TOTAL	**5,396.3**	**5,682.2**	**4,920.4**	**5,827.6**
[2]Adjustment	198.6	468.1	239.5	635.1
Total supply	**5,594.9**	**6,150.3**	**5,159.9**	**6,462.7**

[1]Adjustment for inventory changes and losses in production

[2]Regular premium is no longer sold in Kenya since 2013

Table 4-9. Petroleum and electricity sales by sector

	Thousand tonnes			
	2018	2019	2020	2021
Petroleum sales (Types of users)				
Agriculture	60	26	24.8	26.6
Retail pump outlets and road transport	3,743	3,752	3,650.50	3,937.80
Rail transport	12	19	11.4	19.4
Tourism[1]	10	14	6.5	6
Marine (excl. naval forces)	5	6	1.1	2.1
Aviation (excl. government)	671	711	392.7	499.4
Power generation	34	29	75.8	147.5
Industrial, commercial, and others	635	636	494.4	530.5
Government	19	16	21.5	22.8
Balancing item	0	0	0	0
Total	**5,189**	**5,207**	**4,679**	**5,192**
Electricity Sales (Type of customers)				**GWh**
Domestic Customer (DC)	2,335	2366	2,508	2,630
Small Commercial (SC)	1,222	1,250	1,262	1,326
Commercial and Industrial (CI)	4,225	4,462	4,308	4,514
	7,881	**8,146**	**8,154**	**8,554**

[1] Comprises sales to tour operators.

Source: KNBS, Economic Survey Reports, 2019, 2022; Kenya Power, Annual Financial Report, 2022/2023

Table 4-10. Balancing final energy demand by sector

	C1	C2			C3		C4
R1	**Demand**	**Thousand tonnes**			**Thousand tonnes**		**Sales**
R2		**2020**	**2021**		**2021**	**2020**	
R3	Liquified petroleum gas	326.2	371.4		26.6	24.8	Agriculture
R4	Motor gasoline (premium and regular)[1]	1,395.3	1,554.4		3,937.8	3,650.5	Retail pump outlets and road transport
R5	Aviation spirit	1.9	1.4		19.4	11.4	Rail transport
R6	Jet/Turbo fuel	394.8	506.8		6	6.5	Tourism
R7	Illuminating kerosene	127	111.3		2.1	1.1	Marine (excl. naval forces)
R8	Light diesel oil	2,157.6	2,305.7		499.4	392.7	Aviation (excl. government)
R9	Heavy diesel oil	1.8	0.8		147.5	75.8	Power generation
R10	Fuel oil	273.9	340.3		530.5	494.4	Industrial, commercial, and others
R11					22.8	21.5	Government
R12					26.6	24.8	Agriculture
R13	**TOTAL**	**4,679**	**5,192**		**4,679**	**5,192**	

Source: Author's own derived from Table 4-8 and Table 4-9

Table 4-11. is an example of illustration of top-down energy consumption in the industrial and manufacturing sector in 2021.

Table 4-11. Energy demand balance in commercial and industrial sectors

% share GDP value add	Manufacturing and Construction	Tonnes/Year	GJ/Year	Percentage (%)
25%	**Food, Beverage, and Tobacco**			
	Wood	940,000.0	14,570,000	64.2%
	Fuel Oil	47,875.0	1,924,096	8.5%
	Diesel	49,188.0	2,129,860	9.4%
	Electricity (GWh)	1,128.5	4,062,600	17.9%
			22,686,556	***100%***
39%	**Cement and Construction Factories**			
	Fuel Oil	74,685	3,001,590	**7%**
	Coal	964,100	28,248,130	**69%**
	Diesel	76,734	3,322,581	**8%**
	Electricity (GWh)	1,760	6,337,656	**15%**
			40,909,958	***100%***
36%	**Other Manufacturing**		0	
	Fuel Oil	68,940	2,770,699	24%
	Diesel	70,831	3,066,998	26%
	Electricity (GWh)	1,625	5,850,144	50%
			11,687,841	***100%***

Source: Author's own

4.1.1.4 Energy Demand Mitigation Targets and Achievement in NCCAP 2018–2022

The country has indeed made strides in working towards the achievement of SDG 7, universal access to affordable and clean energy services while fulfilling its NDC commitments. In the period of NCCAP 2018–2022, the following milestones have been achieved by the various actors in the energy sector. Table 4-12 summarises the NCCAP 2018–2022 actions, targets, and achievements.

On the transition to clean cooking alternative fuels such as LPG, ethanol, and biogas, the target was to distribute 500,000 units of LPG, 250,000 biogas units, and 250,000 ethanol stoves. Consultations with energy stakeholders in clean cooking revealed a number of activities that have been implemented. Overall, about 2.7 million households now own and use cleaner cooking solutions, as can be deduced from Table 4-13. According to the biodigester inventory study (SEE, 2022), there are 20,756 functional biogas units. Direct consultations with major bioethanol actors through the cooking energy technical group reported 740,000 ethanol stoves sold as of December 2022. About 1.9 million new users have adopted LPG. Additionally, a recent draft report on e-Cooking suggested that on average, 1.97% of total households used e-Cooking in 2022 (Nuvoni Centre for Innovation Research, 2023). Moreover, LPG use in urban areas increased by 15 percentage points from 47% in 2018[4] to 62% in 2022 (KNBS, 2022).

On the uptake of efficient biomass stoves and the expected achievement of distributing 4 million improved biomass cookstoves by 2022, the Energy Technical Working Group reported on the implementation of the GCF co-financed project aimed at promoting of climate-friendly cooking in Kenya. This project targeted disseminating over 1.1milion improved cookstoves to households, along with a set of other value chain development-related activities. By the end of 2022, a total of 595,074 improved cookstoves were distributed to 411,876 households in rural and urban areas. Moreover, through the Kenya Off-Grid Solar Access Project (KOSAP) programme, 51,628 households benefitted. Therefore, a total of 463,504 cookstoves were distributed through these two projects. However, this figure may not be exhaustive and may not reflect the true picture of total improved cookstoves disseminated during the planning period (2018–2022) as it does not account for the efforts of the private sector and other Civil Society Organisations (CSOs) in improved cookstoves dissemination. Thus, the model mostly relied on estimating clean cookstove dissemination using historic growth trends in the adoption of improved cookstoves and recent surveys such as the MoE of 2019 cooking sector study and the KNBS Demographic and Health Survey of 2022. Based on these assumptions, approximately 700,000 households adopted improved cookstoves, while about 750,000 households stopped relying on traditional stoves, as depicted in Table 4-14.

Finally, efforts to enhance energy efficiency and energy conservation targeted transmission and distribution losses, residential energy efficiency through the adoption of Compact Fluorescent Lights (CFLs), and industrial energy efficiency. During the implementation period (2018–2022), the reduction of transmission and distribution losses from 18% to 14% was targeted, but no observable reduction was achieved. According to the Kenya Power annual report, transmission and distribution losses remained stable at 21.0%, 23.7%, 23.5%, 23.9%, and 22.4% in 2018, 2019, 2020, 2021, and 2022 respectively. In the residential sector, the government aimed to distribute 3.3 million CFLs, but the Energy Technical Working Group reported an achievement of distributing 4.3 million CFLs to 1.4 million households. However, this effort excludes CFLs obtained from the private sector and direct purchases from shelfs. Thus, the household and health

[4] Linear projection of the growth of LPG adoption from 27.7% in 2015, as reported by the Kenya Integrated Household and Budget Survey, 2015/2016, to 54% according to the census report.

survey dataset, along with projections to 2022 from available datasets, estimated that about 3.5 million households adopted efficient lighting. Lastly, as described in Table 4-12, approximately 1,315 energy audits have been implemented since 2012–2022, with an audit implementation rate of about 48%. This top-down approach branch in the implementation period (2018–2022) determined the actual energy consumed for the period based on balancing demand and supply, as presented in the Economic Survey report.

Table 4-12. Summary of NCCAP 2018–2022 priority actions, targets, and achievement in the residential sector

Priority Actions	Expected Results by 30th June 2023	Stakeholders Reported Achievements as of 31st December 2022
a) Transition to clean cooking with alternative fuels such as LPG, ethanol, and other clean fuels promoted in both rural and urban areas,	Develop and distribute 1 million clean energy stoves by 2022; LPG (500,000 units), biogas (250,000 units), and ethanol (250,000 units) stoves and related supply chains,	- A total of 20,756 functional domestic biogas units identified in the biogas inventory survey, -About 740,000 households adopting ethanol for cooking, -1.97% cook with electricity as the only stove or part of stack stoves,
b) Uptake of clean biomass (charcoal and wood) cookstoves, briquettes, and other clean cooking alternatives promoted in rural areas,	Develop and distribute 4 million improved biomass stoves by 2022. -Charcoal (2 million), -Biomass (2 million),	-464000 more households adopted improved cookstoves from GCF and KOSAP projects, excluding private purchases and adoption,
c) Increased energy efficiency and energy conservation,	1. Losses in electricity transmission and distribution reduced from 18% to 14%. 2. 3.3 million CFLs distributed to households through the Compact Fluorescent Light (CFL) initiative. 3. Energy efficiency and conservation projects delivered, which focus on: • Efficient lighting. • Energy efficiency in buildings. • Minimum energy performance standards; and • Distribution of clean lighting.	-Minimum performance standards developed and adopted for 6 appliances. The Kenyan Standards and Labelling programme covers refrigerators (1,315 models registered), air-conditioners (340 models registered), motors (12 models registered), and lighting (7 models registered), which are mandatory under the Standards and Labelling scheme. -Ministry of Energy commissioned the Kenya National Energy and Conservation Strategy, - 4.3 million CFLs distributed to trigger the market in 1.4 million households. - 1,315 energy audits carried out since the commissioning of energy management regulation in 2012. - Between 2020 and 2022, Kenya Association of Manufacturers (KAM) conducted 136 energy audits. - Implementation rates from Energy Audit Impact Study point to 48%.

Table 4-13. Change in number of households adopting modern fuels

Residential fuel transition	No. of households in thousand					
	2018	2019	2020	2021	2022	Difference between 2018–2022
Firewood	5,599	5,528	5,563	5,556	5,578	-21
Charcoal	1,654	1,624	1,601	1,586	1,513	-141
Twigs and Agri residues	100	91	74	55	37	-63
Electricity	90	98	117	140	156	66
LPG	2,947	3,694	4,066	4,522	4,814	1,867
Biogas	18	17	19	22	24	6
Kerosene	1,416	1,527	1,266	970	578	-838
Briquettes and Pellets	88	96	104	115	119	31
Other fossil	7	6	8	10	12	6
Ethanol fuel	2	5	221	480	742	740
Total	**11,921**	**12,688**	**13,040**	**13,456**	**13,573**	

Source: Author's own derived from LEAP modelling

Table 4-14. Adoption of improved and efficient cookstoves and decline in over dependence on traditional cookstove

Adoption of efficient cookstoves			
	Thousand households		
Urban Households	**2018**	**2022**	**Difference (2018–2022)**
Firewood stove technologies			
Traditional Wood Stove	474	439	-35
Improved Biomass Stove with Chimney	84	83	-1
Improved Portable	9	8	-1
Modern Branded Stove	4	4	1
Charcoal stove technologies			
Traditional Charcoal Stove	189	1	-188
Kenya Ceramic *Jiko*	628	831	203
Modern Charcoal Stoves	47	170	123
Nyama choma Grill	5	6	1
Rural Households			
Firewood stoves adoption			
Traditional Wood Stoves	4,129	3,773	-356
Improved Biomass Stove with Chimney	766	1,110	344
Improved Portable	111	131	20
Branded Modern Stoves	24	30	6
Charcoal stoves adoption			
Traditional Charcoal Stove	439	270	-169
Kenya Ceramic *Jiko*	306	197	-109
Modern Charcoal Stoves	40	38	-2
Total efficient cookstoves adopted			**698**
Total inefficient cookstoves withdrawn			**-748**

Source: Author's own derived from LEAP model

c) GHG emission abatement as of 2022

Based on these assumptions and achievements in the residential, commercial and industrial energy demand, total GHG emission in the energy sector in 2022 was 7.2 million tCO2eq.

The residential sector, emissions have shown a decreasing trend from 2018, as illustrated in Figure 4-13, dropping from 2.6 MtCO2eq in 2018 to 2.3 MtCO2eq in 2022. Burning firewood remains the dominant contributor to GHG emissions, while emissions from kerosene use have significantly decreased from 0.8 MtCO2eq in 2018 to 0.3 MtCO2eq in 2022. The increased use of LPG has led to an increase in LPG emissions from 0.7 MtCO2eq in 2018 to 1 MtCO2eq in 2022.

In commercial and industrial sector, the GHG emission increased from 4.4 MtCO2eq to 4.9 MtCO2eq as illustrated in Figure 4-14. Coal, heavy fuel oil, diesel, and burning firewood, are the highest emitters of GHG in the industrial sector contributing to 2.6 MtCO2eq, 0.6 MtCO2eq, 0.8 MtCO2eq and 0.6 MtCO2eq respectively in 2022. Coal emissions increased rose by 1.7times depicting more burning of coal in the manufacturing sector, while the emission from heavy fuel oil substantially reduced from 1 MtCO2eq in 2018 to 0.6 MtCO2eq in 2022 depicting a decline in use of heavy fuel oil. The use of diesel, firewood and charcoal were rather maintained in the planning period.

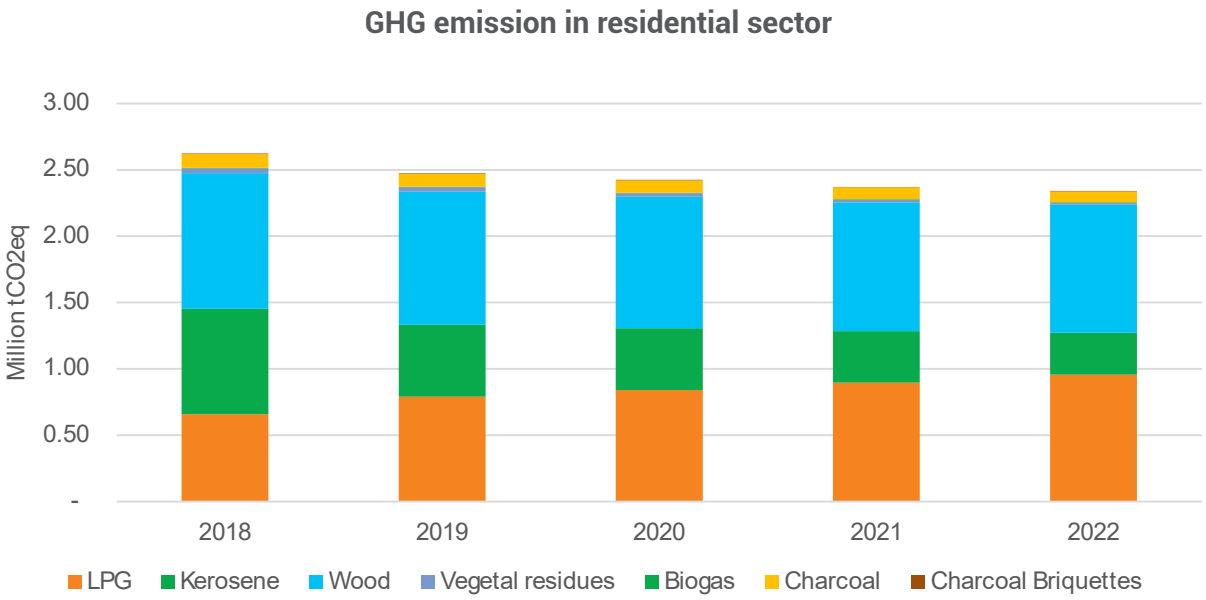


Figure 4-13. Residential sector GHG emissions in the planning period (2018–2022)

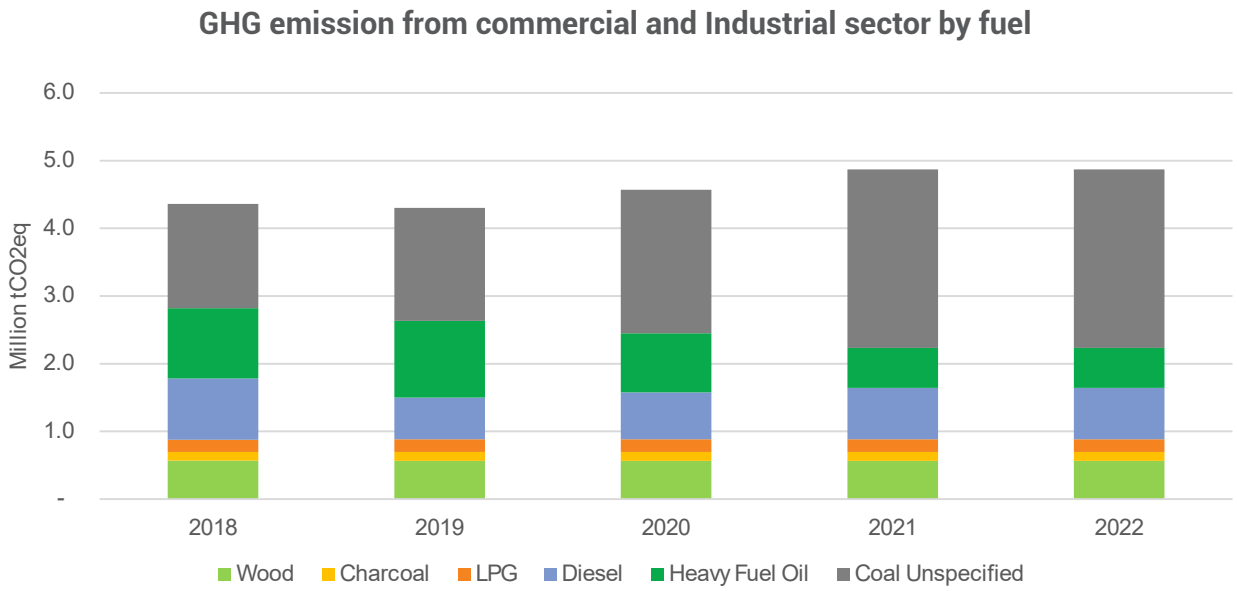


Figure 4-14. Commercial and Industrial energy demand emission in the planning period (2018–2022)

Total GHG emission abatement projection in the energy sector was 1.8 $MtCO_2eq$ in 2022, based on the Adjusted Baseline Scenario[5] emission against the actual emission as illustrated. This emission abatement is attributed to continuous energy efficiency measures in the industrial sector. As discussed in Table 4-12 above, 1,315 audits were conducted with a 48% implementation rate.

[5] In the first NCCAP (2013–2017), the baseline scenario was projected to 2030 based on the IPCC ad hoc Working Group III assumption regarding the methane Global Warming Potential, which was 21 times that of carbon dioxide. In 2015, this GWP was adjusted to 28 times that of carbon dioxide. Comparing the baseline based on AR3 to actual emissions based on AR5 is mathematically unsound. Hence, the baseline projection assumptions were adjusted to adopt the new GWP potential for methane.

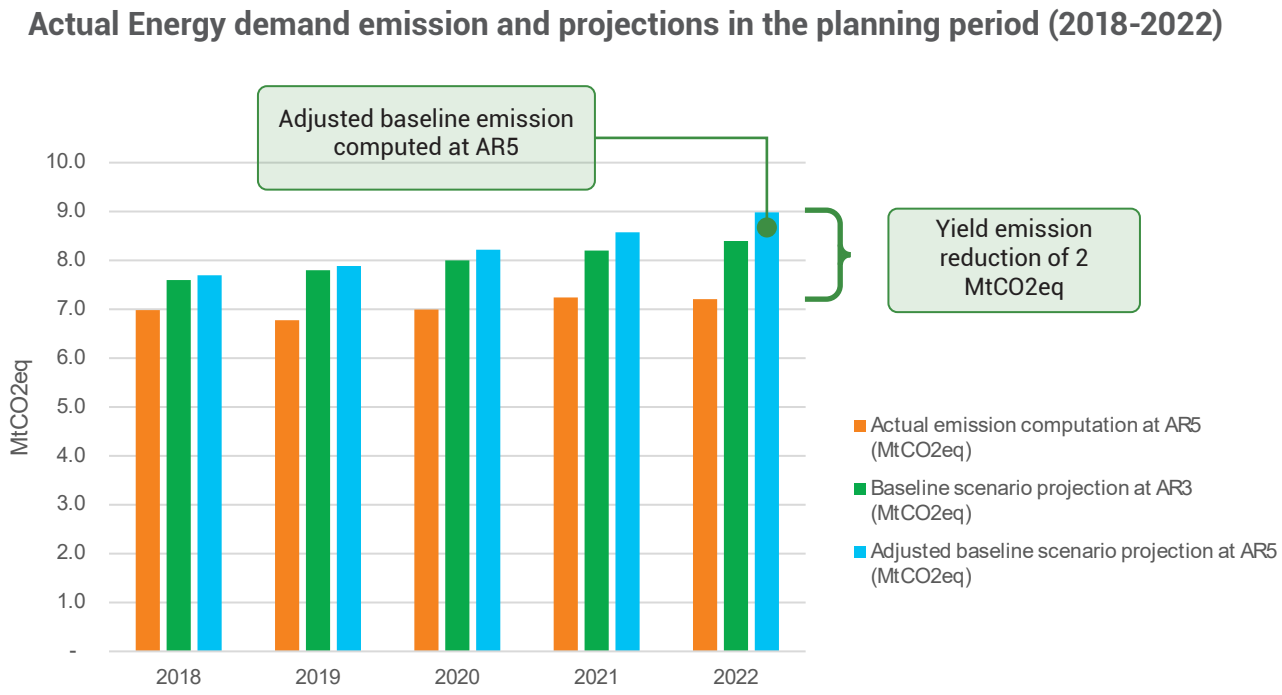


Figure 4-15. Overall energy demand sector emission in the planning period against projected baseline emission at AR5 and AR3

Table 4-15. presents a time series summary of actual emission in the energy demand sector computed at AR5[6], NDC baseline scenario projection computed at AR3[7], and the projected timeseries of allowed GHG emission towards the achievement of NDC. While the actual emission is lower than the projected baseline emission, the country has not met its target in achieving the NDC emission target, partly due to inadequate implementation of energy efficiency measures and the change in methane GWP factor that was originally used in the baseline projection.

[6] In AR5, the GWP of methane is stated to be 28 times that of CO2, effective from 2015

[7] In AR3, the GWP of methane is reported as 21 times that of CO2.

Table 4-15. Energy demand sector emission time series as of 2022 against the baseline scenario

	2010	2015	2020	2022
Baseline scenario emission computed at AR3 (MtCO$_2$ eq)	6.0	7.0	8.0	8.4
Allowed GHG emissions considering NDC target computed at AR3 (MtCO2eq)	6.0	5.6	5.4	5.3
Actual GHG emission computed at AR5 (MtCO2eq)	6.0	6.5	7.0	7.2
Gap or deviation from allowed GHG emissions NDC target	0.0	-0.9	-1.6	-1.9
Comment (partly due to change in GWP of methane)		Deficit	Deficit	Deficit

4.1.1.5 Variation in Energy Demand Emission Updated NDC and NCCAP III

The emission status in NCCAP has substantially varied from the emission status in the updated NDC and NCCAP 2018–2022. This difference can be attributed to variations in the modelling approach and data used. The LEAP tool uses a bottom-up approach in the residential sector and a top-down approach in the commercial and industrial sectors for final energy computation. It relies on IPCC default emission factors unless Tier 2 emission factors are provided. In the top-down approach used for the NDC update, the energy demand sector aggregates all imported kerosene and LPG fuel for residential demand, while other fuels such as diesel and gasoline for transport, heavy fuel oil for power, and coal for commercial and industrial purposes. However, it did not delve into a detailed energy balance for proper attribution. Additionally, the updated NDC analysis did not factor in methane and nitrous oxide emissions from stationary combustion of biomass, as specified in the IPCC methodology, as shown in Table 4-16.

Biogenic emissions of carbon dioxide resulting from biomass combustion do not constitute net additions of CO_2 to the atmosphere under conditions of sustainable biomass harvesting. In such conditions, the CO_2 released upon combustion of biomass-derived fuels can be recaptured during photosynthesis in the next biomass growth cycle. However, in non-sustainable biomass harvesting practices that lead to soil and land degradation, and in extreme cases, deforestation and desertification, net additions of CO_2 occur. In addition to biogenic emissions, other emissions from stationary combustion, as reported by the IPCC, are also considered, as illustrated in Figure 4-16.

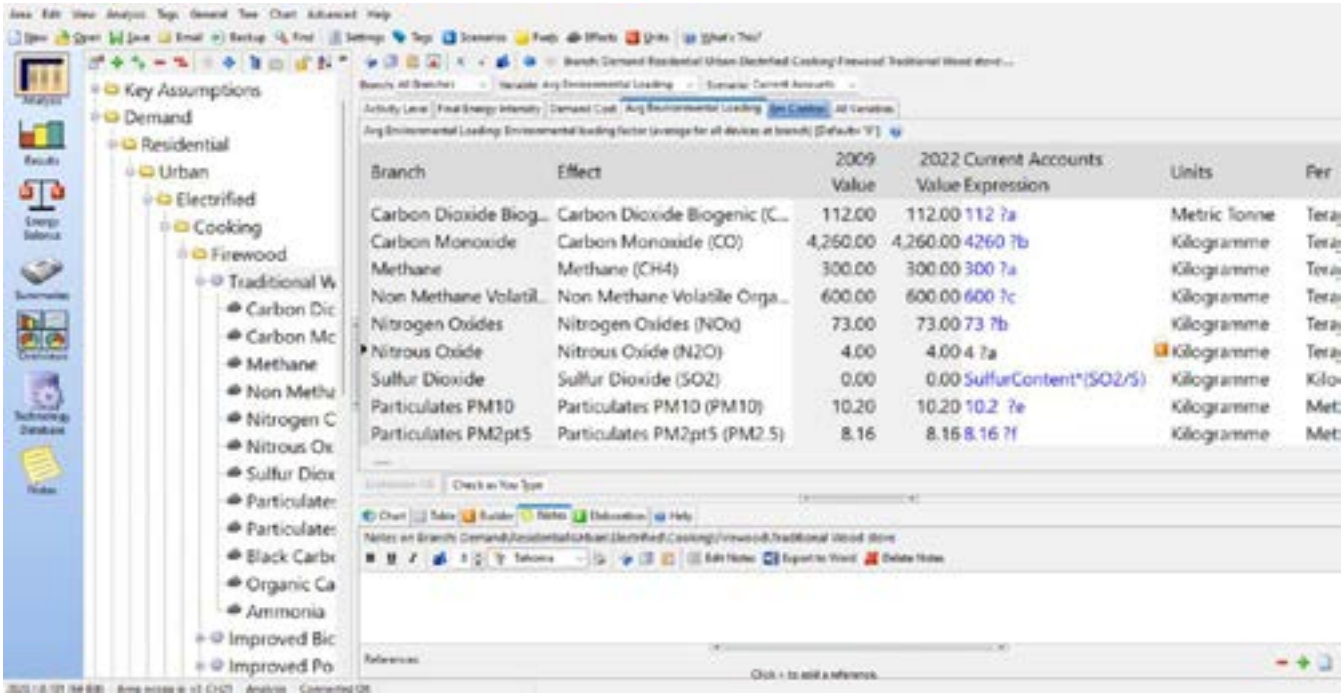


Figure 4-16. Illustration of biogenic methane and nitrous oxide consideration in LEAP tool

Table 4-16. Emission factors for burning wood and charcoal

Solid Biomass EF	CO_2 (Kg GHG/TJ)	Methane (Kg GHG/TJ)	N_2O (Kg GHG/TJ)
Wood or Wood waste	112,000	300	4
Other Solid biomass	100,000	300	4
Charcoal	112,000	200	1

Source: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

Thus in 2022, biomass (charcoal and firewood emission) contributed to about 1.8 $MtCO_2eq$ as illustrated in Figure 4-17.

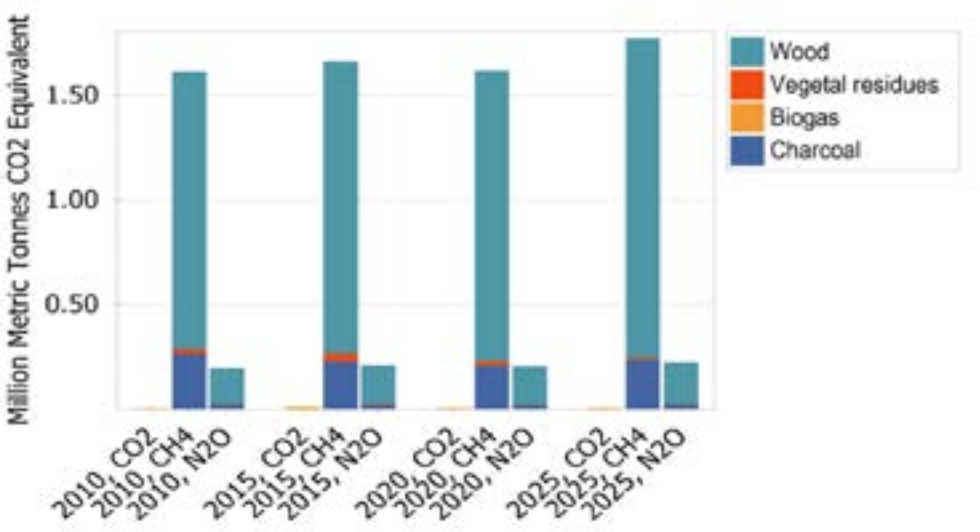


Figure 4-17. Demand emission from stationary biomass combustion

The grey box below further describes the areas of potential differences in GHG computation using LEAP tool and the excel based analysis that was deployed in the updated NDC emission estimation.

Box 1

In the residential sector, refer back to Figure 4-1, which accounts for finer details in disaggregated energy use in urban and rural areas, broken down by type of households, energy demand service, fuel used, and technology, with varied energy intensities converting the fuel. Most importantly, it considers biogenic methane emissions from firewood and charcoal (about 1.1 MtCO2eq), which were not captured in the updated NDC emission computation. In the commercial and industrial sector, LEAP considers all fuels based on rigorous energy balancing. Besides coal, it computes emissions from other fuels such as heavy fuel oil, diesel used in industries, and biomass, accounting for about 1.6 MtCO2eq. Finally, in other small commercial and service sectors, the analysis considered biogenic methane from biomass use in hotels and industries, LPG, and diesel use, accounting for about 0.87 MtCO2eq. These three components, as detailed in Table 4-17, were not clearly captured in the updated NDC report, hence underestimating GHG emissions in the energy demand sectors.

Table 4-17. Illustration of modelled GHG emissions based on historic data in LEAP tool and areas of significant difference with updated NDC

Energy Demand Emission by Sector	Million Metric Tonnes CO2 Equivalent			
	2010	2015	2020	2022
Manufacturing and Construction				
Diesel *(was not considered in Updated NDC)*	0.01	0.63	0.56	0.63
Heavy Fuel Oil *(was not considered in Updated NDC)*	1.18	1.01	0.87	0.59
Wood *(was not considered in Updated NDC)*	0.14	0.14	0.14	0.14
Coal Unspecified	1.54	1.52	2.12	2.63
Total	***2.87***	***3.29***	***3.70***	***3.99***
Rresidential Sector				
LPG	0.12	0.29	0.84	0.96
Kerosene	0.86	0.93	0.47	0.32
Wood *(was not considered in Updated NDC)*	0.99	1.04	1.00	1.00
Vegetal Residues *(was not considered in Updated NDC)*	0.02	0.04	0.03	0.01
Biogas	0.00	0.01	0.00	0.00
Charcoal *(was not considered in Updated NDC)*	0.17	0.12	0.09	0.09
Total	***2.16***	***2.43***	***2.44***	***2.38***
Other Commercial and Service				
Agriculture, Forestry, and Fishing	0.11	0.10	0.08	0.08
Small Commercial Agrifood	0.04	0.04	0.04	0.04
Service Sector	0.58	0.69	0.76	0.77
Total *(was not considered in Updated NDC)*	***0.72***	***0.82***	***0.87***	***0.88***
Grand Total Energy Demand Emission (MtCO2eq)	**5.8**	**6.5**	**7.0**	**7.2**

4.1.2 Electricity Supply

4.1.2.1 Electricity Generation Overview

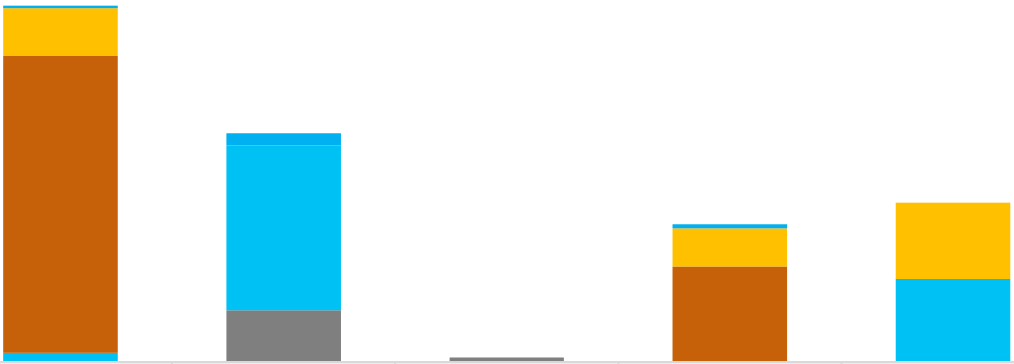
Electricity is a key pillar for national development and social welfare. The country has made significant progress in electricity access through grid and off-grid electricity. According to EPRA, 2022, over 70% of the population have access to electricity, the grid contributing to about 53% of the total grid connected households and off-grid solutions including solar home system, mini-grids and micro-solar systems contributing to about 23% of the total grid connectivity (EPRA, 2023).

Indeed, electricity demand was anticipated due to ongoing economic growth and expanding access to electricity among the population. With the implementation of the country's long-term development blueprint, Kenya Vision 2030, which projected a robust double-digit growth rate in national GDP from 2015 to 2030, various ambitious projects were envisioned, including the establishment and operation of special economic zones, expansion of port and container terminals, and the development of an ICT park and resort city, along with electrified rail transport, and iron and steel smelting, (GoK, 2007). Meeting the energy demands of these projects required a reliable electricity supply, necessitating contributions from renewable resources as well as coal and natural gas. Consequently, electricity emissions were forecasted to rise from 2.2 million tonnes of carbon dioxide equivalent (MtCO2e) in 2010 to 18.5 MtCO2 e in 2030 (GoK, 2013). The decline in hydroelectricity in 2010, attributed to climate change impacts, led to the commissioning of numerous independent power producers (IPPs) and embedded power producers (EPPs) to meet the shortfall in supply. As a result, baseline emission projections reached 41 $MtCO_2e$ by 2030, accounting for 28.7% of the total national emissions (GoK, 2013). Despite these challenges, Kenya is committed to sustainable and low-carbon development, evidenced by its ambitious commitments and deliberate efforts to expand renewable electricity development as outlined in the NCCAPs and NDCs, to which the country is a signatory.

Kenya's energy planning is guided by the Least Cost Power Development Plans (LCPDPs), which aim to optimise the development of power resources while minimising costs. These plans are updated bi-annually. The NCCAP 2018–2022 was informed by the LCPDP 2017–2037. In this planning period, electricity demand was projected to rise 13,156 GWh in a low growth scenario, and 14,334 GWh and 16,456 GWh in reference and high growth scenarios respectively. To achieve the vision scenario outlined in the plan, an additional 2,405 MW from renewable sources was proposed, including 913 MW from geothermal, 442 MW from solar PV, 93 MW from hydro, 800MW from wind, 157 MW from biomass/biogas, and 30 MW from distributed solar and mini-grids. Additionally, the plan sought to decommission a total of 300 MW of thermal capacities, including 120 MW from Kipevu, 109MW from Ibera Africa, and 74 MW from Tsavo (Government of Kenya, 2018).

Additional capacity in MW between 2018–2022

Towards this ambition, the country has made significant progress and achieved 869MW of additional installed capacity between 2018–2022 from renewable electricity sources, against the planned 2,405 MW. The breakdown of new additional capacity from 2018 includes, 269 MW of geothermal, 410 MW of wind, 170 MW of solar PV, and 19 MW from numerous small hydropower plants, as illustrated in Figure 4-18. There was an additional 59 MW of fossil-based power plant commissioned in the planning period. On the other hand, a total of 84 MW of fossil-based power plant—28 MW Embakasi GT and 56 MW from Ibera Africa—was retired in the planning period against the planned 300 MW.



	2018	2019	2020	2021	2022
Hydro_power	3	13	-	4	-
Solar	50	-	-	40	80
Wind	310	-	-	100	-
Geothermal	10	173	-	-	87
Biomass	-	-	-	-	-
Fossil_fuel	-	54	5	-	-

Figure 4-18. Additional capacities (MW) achieved between 2016 and 2022

Source: Author's own consolidated from Kenya Power

The renewable electricity-dominated expansion has led the country to a low-carbon pathway. The evolution is significant compared to the 2010 grid mix. In 2010, about 52% of the total installed capacity was from hydro generating plants, followed by fossil fuel sources, which accounted for 33%, and geothermal at 13.2% of the total installed capacity. Wind, solar, and biomass accounted for only about 2.2%. The country has advanced in the installation of more renewable energy sources, realising 31% of the total installed capacity being geothermal, 27% hydro, 14.1% wind, and 5.5% solar in 2022. Figure 4-19 illustrates how the total installed capacity has changed by the main energy sources. While the total installed capacity of fossil fuel generation remains high, its contribution to the final grid generation in 2022 has reduced to only 13% from 33% in 2010, accounting for 23.3% of the total installed capacity. Figure 4-19 illustrates the evolution of the grid electricity mix between 2010 to 2022. Geothermal generation has steadily increased since 2010, while wind generation increased significantly with the commissioning of Lake Turkana Wind Power in 2018 and the 100 MW Kipeto Wind in 2021. Geothermal electricity has become the baseload electricity source in Kenya, accounting for 40.5% of the total grid mix in 2022. Hydropower, wind, and solar account for 27.4%, 16.8%, and 2.5% respectively. The Kenya grid electricity mix was about 87% renewable in 2022. From historic production, the renewable electricity share in the grid mix was 79% in 2018, then rose to 89%, 93%, 93%, in 2019, 2020, and 2021, respectively, then dropped to 87% in 2022 (Kenya Power, 2023).

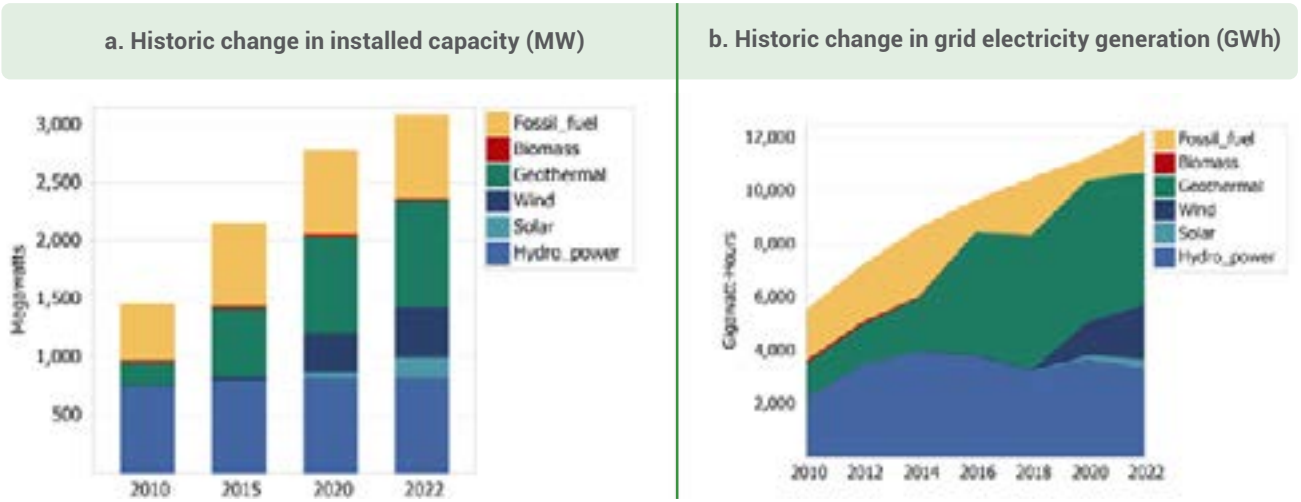


Figure 4-19. Total national installed capacity and electricity grid mix for Kenya.

Source: Author's own based on LEAP modelling

4.1.2.2 Electricity Generation Data Inputs and Assumptions

LEAP is a demand-driven tool that links supply to demand. It follows a systematic process to establish electricity demand supplied in accordance with the daily load curve while accounting for transmission and distribution losses, both commercial and technical. The modelling of the electricity generation sector relies on annual reports from Kenya Power for historic data on installed capacity and annual generation. The main data requirements for modelling include, annual historic energy generation in GWh, installed capacity in MW, average monthly availability by source, and dispatch merit order. The model aligns with the LCPDP, considering both committed power plants and expansion power plants. Committed power plants are implemented together with their installed capacity, assuming that power purchase agreements are signed and financial closure is reached. Expansion power plants, on the other hand, are modelled within the LCPDP baseline scenario and are dispatched only in scenarios based on high demand cases. The daily load curve, as illustrated in Figure 4-20, depicts the average consumption behaviour throughout the day, with peak demand typically occurring between 19:00hrs and 23:00hrs and baseload recorded between 2:00hrs and 6:00hrs. This data is important for modelling demand and dispatching power base on baseload, shoulder loads, and peak loads of power plants.

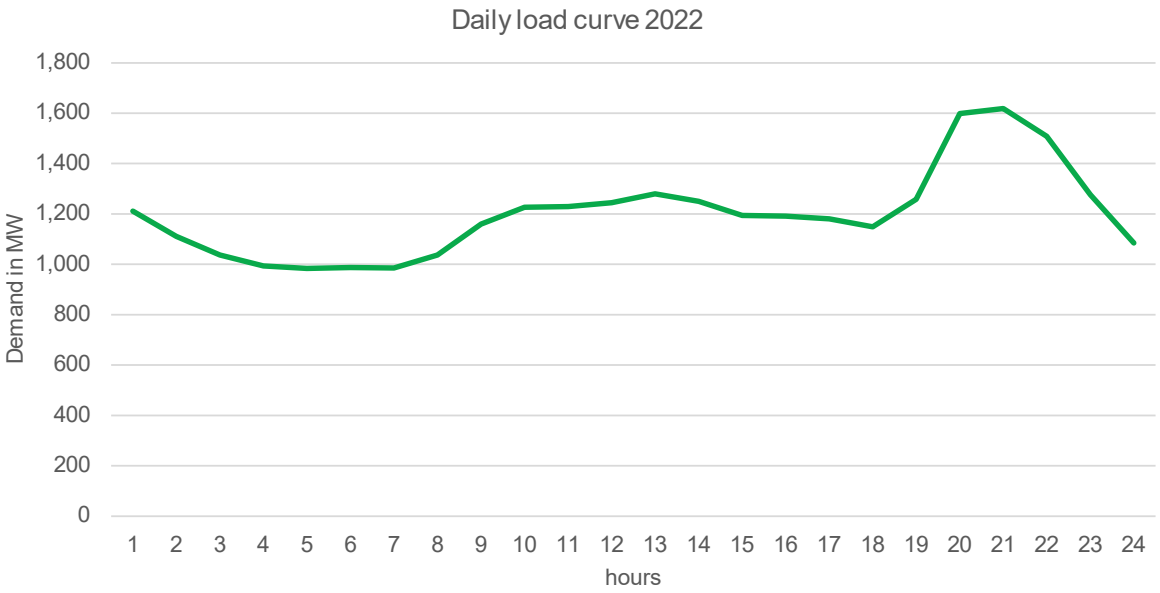


Figure 4-20. Typical daily load curve

Electricity is transmitted and distributed to consumers through transmission and distribution lines. Often, losses are experienced due to the technical performance of infrastructure and the distance of transmission and distribution. Long-distance networks are prone to higher losses. Commercial losses result from unaccounted-for electricity consumption. Kenya's electricity technical and commercial losses have been rising steadily, as demonstrated in Figure 4-21. NCCAP 2018–2022 prioritised action to reduce technical losses from 18% in 2018 to 14% in 2022. However, by 2022, the technical and commercial losses continued to rise, reaching 21%, 24%, 23%, 24%, and 22% in 2018, 2019, 2020, 2021, and 2022 respectively.

Technical losses indeed have significant GHG emission implications. The higher the losses, the greater the need to generate more electricity to meet demand. Reducing electricity losses decreases the need to generate electricity by certain percentages, thus abating GHG emissions that would have otherwise been emitted due to the additional combustion of thermal energy sources.

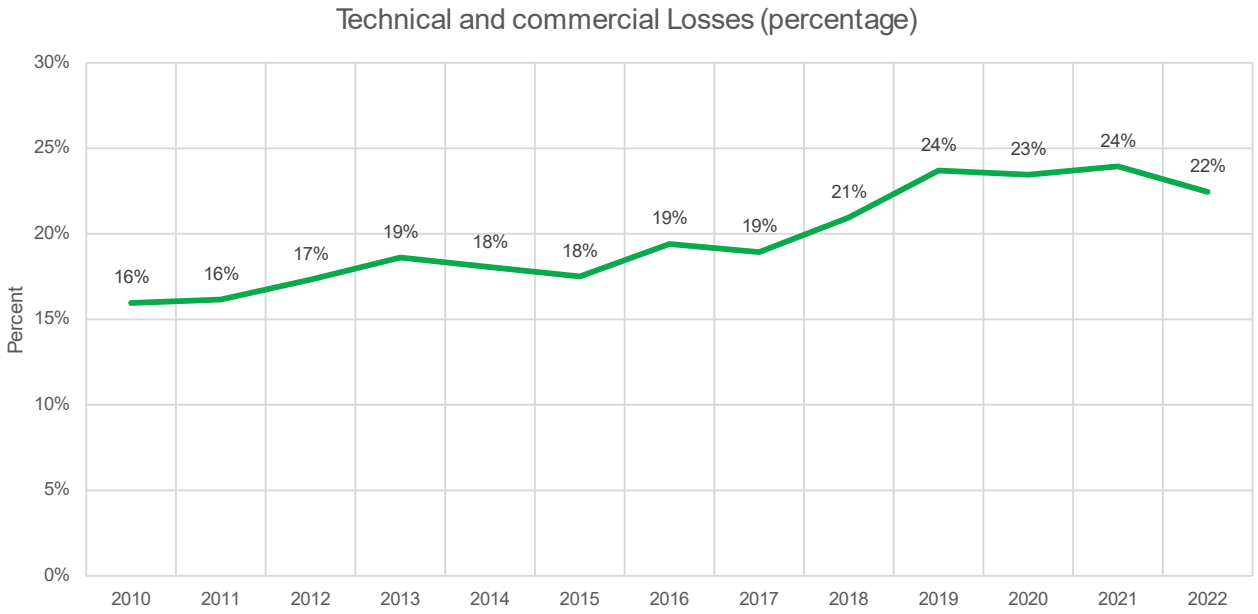


Figure 4-21. Evolution of technical and commercial system losses

In LEAP, current installed capacity and historic generation are input as exogenous capacity (MW) and historic production in GWh respectively. Table 4-18 presents historical production from the financial years 2015/16 to 2021/22 and installed and effective capacity by source from the financial years 2015/2016 to 2021/2022.

Table 4-18. Historic electricity generation and installed capacity as of 2022

	Installed capacity (MW)	Effective capacity (MW)	Historic electricity generation in GWh						
			2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Hydro	838.2	809.2	3,787	3,341	3,224	3,741	3,636	4,143	3,350
Geothermal	950.0	871.0	4,609	4,451	5,053	5,033	5,352	5,035	4,951
Fossil Fuel	647.0	622.0	1,246	2,164	2,202	1,298	882	875	1,578
Wind	435.5	425.5	57	63	47	1,192	1,284	1,700	2,052
Biomass	2.0	2.0	0	1	4.3	0.3	0.3	0.3	0.4
Solar	120.3	120.3	1	1	0	60	91	88	305
Imports			67	184	171	170	161	197	338
Systems Total	**2,756.8**	**2,650.4**	**9,767**	**10,205**	**10,701**	**11,494**	**11,463**	**12,101**	**12,653**
Off-grid Thermal	35.6	23.0	39.9	40.8	46.9	57.6	60.1	64.8	71
Off-grid Solar	2.3	1.9	0	0	0	0	0	0.26	0.25
Off-grid Wind	0.6	0.0	0.79	0.54	0.12	0.06	0.33	0.0	0.0
Off-grid Total	**37.9**	**24.9**	**41**	**41**	**47**	**58**	**60**	**65**	**71**
Total Capacity MW	**3,081**	**2,926**							
Systems Peak Demand (MW)			1,586	1,656	1,802	1,882	1,926	1,994	2,057

Other information that aided the simulation of electricity generation and dispatch included targeted electricity imports from regional networks. In the planning period, the country's electricity imports doubled from 171 GWh in 2018 to 338 GWh. Electricity imports are expected to increase in the NCCAP III following the conclusion of Kenya Power signing Power Purchase Agreements (PPAs) with Ethiopia in 2023, starting with 200 MW and then 400 MW after three years (Kenya Power, 2023). The electricity from Ethiopia is sourced from the Grand Resonance Dam and is considered renewable. Hence, this will have a significant boost in Kenya's electricity mix towards renewables.

Captive power[8] and mini-grids[9] have grown in the past few years, connecting residential and industrial power requirements. These electricity sources have been captured as off-grid standalone systems. The model assumes that captive systems don't face losses, as most captives are within demand points. However, mini-grids experience technical distribution and commercial losses because of power theft. Table 4-19 shows the capacity of mini-grids and captive generation.

Table 4-19. Captive and mini-grid electricity systems

	Installed Capacity as of 2022 (MW)		Installed capacity as of 2022 (MW)
Captive Solar PV	53.7	Mini-grid solar	10.8
Captive Hydro	29.0	Mini-grid solar/diesel	14.1
Captive Cogeneration	97.4	Mini-grid diesel	29.6
Captive Diesel	21.3	Mini-grid wind	0.6
Captive Coal*	30.0		
Captive WHR	83.5		
Captive Geothermal	3.7		

*No evidence of completion

Source: EPRA database

[8] Captive power is the electricity generated and consumed by the producer within the manufacturing or commercial industry. It is often prioritised over and then supplemented by grid electricity.

[9] Mini-grids are distributed generations that connect small rural or urban communities located away from the grid or not connected to the national grid network

4.1.2.3 Electricity Generation GHG Emission Mitigation Targets and Achievements in NCCAP II (2018–2022)

As mentioned earlier, in the NCCAP 2018–2022, the total projected additional renewable electricity for the grid was 2,405 MW, but only 869 MW was achieved. Nonetheless, the expected rise in demand in the reference scenario was 14,334 GWh; however, the actual demanded generation, including losses, was 12,237 GWh, as illustrated in Figure 4-22. From Figure 4-22, it is evident that the renewable electricity mix in the grid is on a rising trend, with a significant contribution from wind energy. In 2022, there was a decrease in hydropower generation, resulting in increased fossil fuel generation, as illustrated in Figure 4-23.

With the above achievements GHG emissions from grid electricity generation have been low—1.34 MtCO2eq in 2018, 0.77 MtCO2eq in 2019, 0.51 MtCO2eq in 2020, 0.54 MtCO2eq in 2021, and 0.98 MtCO2eq in 2022. The NCCAP 2018–2022 estimated emission reduction of 13.2 MtCO2eq in 2022. Compared to the baseline projection, it can be reported that emission abatement was 11.5 MtCO2eq in 2020 and about 15.8 MtCO2eq in 2022. However, if we consider the targeted emission in 2022 towards the achievement of NDC, then it can be reported that the current actions have exceeded the target by 7.9 MtCO2eq in 2020 and 13.4 MtCO2eq in 2022, as illustrated in Table 4-20.

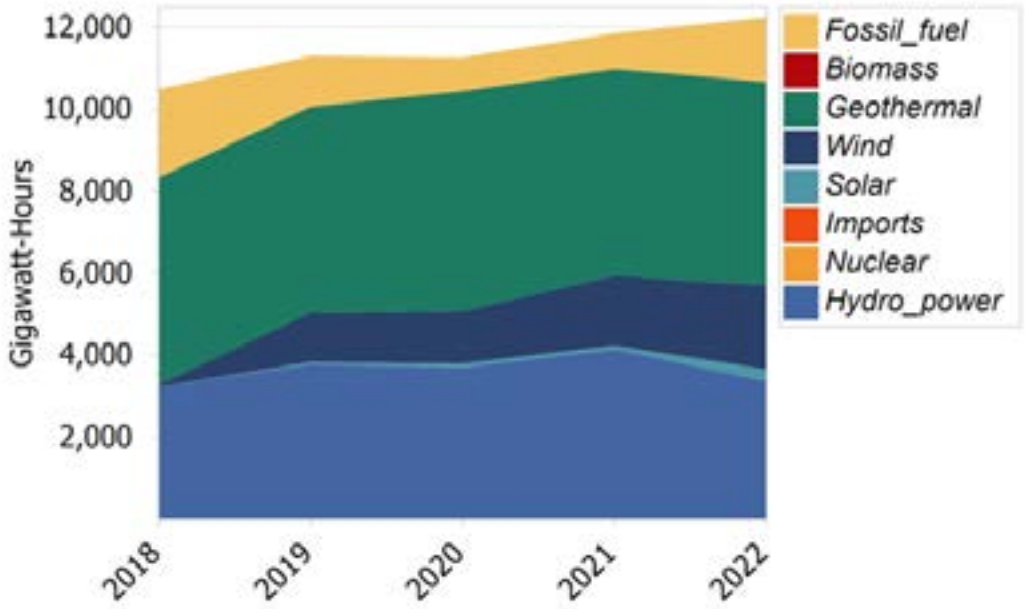


Figure 4-22. Electricity generation by source in the planning period

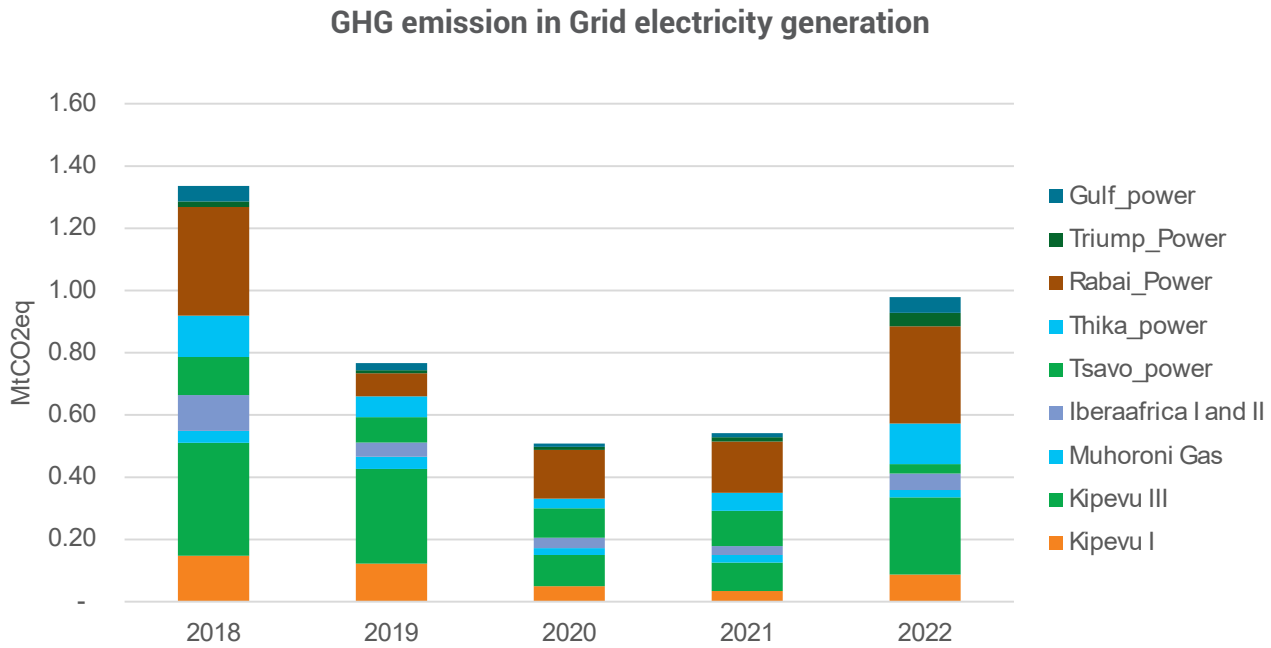


Figure 4-23. GHG emissions by power plant

Baseline and allowed emissions were adopted from the reference scenario of the Kenya NDC.

Table 4-20. GHG emission abatement in the electricity sector

	2010	2015	2020	2022
Baseline scenario emission ($MtCO_2eq$)	1	1	12	16.8
Allowed GHG emissions considering NDC target as of 2022 ($MtCO_2eq$)			8.4	14.4
Actual emissions ($MtCO_2eq$)	1.0	1.0	0.5	1.0
Deviation from target ($MtCO_2eq$) allowed GHG emission NDC target			7.9	13.4
Comment		Exceeded	Exceeded	Exceeded

4.1.2.4 Challenges Faced and Lessons Learnt in Implementation of NCCAP II

Key challenges in implementation of actions

Some of the notable key challenges that were faced and identified by stakeholders in the consultative forums during the implementation period included the following:

- Limited electricity access/affordability and availability; low awareness on benefits of clean energy technologies.
- Disconnects between clean cooking and electricity access policy; and bottlenecks in the supply chain limited the contribution of e-Cooking to date.
- Unfavorable fiscal policies.
- Affordability of modern technologies such as e-pressure cookers.
- Ineffective or broken value chain/supply chain or lack of adequate distribution networks for some of the solutions (technology and the fuel).
- Lack of appropriate technical capacity among entrepreneurs in the clean cooking sector
- Absence of local content, relying more on imported solutions.
- Product durability and quality of solar and other distributed modern energy technologies such as micro-solar home systems. It was noted that some of the distributed systems or retailed solar lanterns are low quality.
- Lack of uniformity making formulaic credit decisions difficult: The financial lives of the poor are unstable, with low income and irregularities that vary widely across the population. A financial product for one would be unsuitable for another.
- Inadequate data and low awareness on measurement and verification hinders implementation of energy audit recommendations.
- Absence of adequate building code and energy efficiency enforcement strategy for residential areas that encourage energy efficiency in the residential sector.
- Many RE resources are away from the grid, requiring large investment in transmission infrastructure.
- Transmission constraints have delayed or curtailed the full exploitation of some renewable energy resources.
- Delayed IPP project support instruments such as Letter of support and Partial Risk Guarantees (PRG)

Lessons learnt

- Rapid rise in electrification rates (EPRA, 2023) has enabled e-Cooking to reach over 75% of the population. Almost 25% of households now use electricity for various cooking and heating purposes as part of their fuel mix (Nuvoni Centre for Innovation Research, 2023).
- Access to information, benefitting both supply and demand sides (end users) as well as policymakers, has enhanced the promotion of products and innovation across various supply options, all while safeguarding the interests of entrepreneurs.
- Levies and taxes significantly influence the direction and pace of modern energy technology dissemination . High taxes on renewable energy technologies hinder their adoption rate.
- Adequate energy data, including both demand and supply information, exists but is limited. Therefore, there is a need to standardise the collection, analysis, and sharing processes.
- Pay As You Go (PAYG) loan repayment periods typically range from 6 months to 2 years, ensuring affordability through lower regular payment amounts.
- In a PAYG scheme, the device itself serves as collateral, reducing the risk compared to traditional unsecured loans. Additionally, because there's no need for face-to-face interactions to collect payments, operational costs are lower, ultimately reducing the overall financial burden on the customer.
- There is a need for Geothermal Development Company (GDC) to maintain a strong financial balance sheet to ensure timely provision of necessary risk guarantee instruments, which have been causing delays in the development of power plants.

4.2 Transport Sector

4.2.1 Overview of the Sector and GHG Emission Profile by Source

The transport sector in Kenya is a crucial component of the country's economy, facilitating the movement of goods, services, and people via various modes of transport such as road, rail, air, and maritime. It has been identified as one of the sectors with the most significant growth in emissions, with projected emissions increasing from 7 MtCO2eq in 2010 to 21 MtCO2eq in 2030 (GoK, 2013). Additionally, according to the updated NDC technical analysis report, the sector is the largest consumer of petroleum products in the country, accounting for more than two-thirds of total petroleum consumption. As part of efforts to mitigate emissions, the sector is targeted to achieve a reduction of 3.5 MtCO2eq by 2030 (Ministry of Environment and Forestry, 2020).

Road transport serves as the dominant mode of transportation in Kenya, facilitating about 80% of passenger and freight movements. The road network encompasses national highways, urban roads, and rural roads, with major highways linking cities and towns nationwide. However, challenges persist in road infrastructure and maintenance, particularly in remote areas. Road transport is a critical component of Kenya's transportation system. Matatus (minibuses) and buses are the primary modes of public transport within and between cities, following established routes in urban areas and supporting interconnectivity rural areas. The significant rise in motorcycles, reaching approximately 2.35 million in 2022, and private cars, numbering 1.3 million, As can be observed in Figure 4-24. Motorcycle taxis, commonly referred to as *boda bodas*, are popular for short-distance travel in both urban and rural areas, offering flexible and cost-effective transportation options, especially in congested urban centres and areas with limited public transit availability.

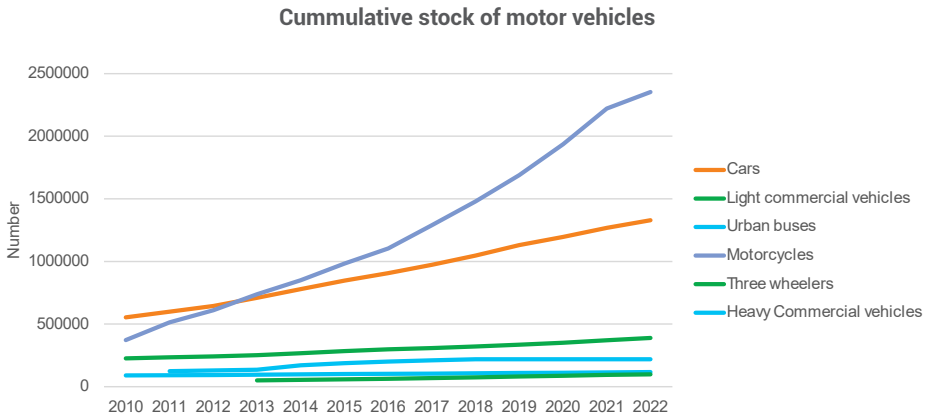


Figure 4-24. Cumulative growth of road transport vehicles by type

Source: Author's own Compiled from National Transport and Safety Authority (NTSA) data, Economic Survey reports, 2020–2022

Kenya's railway network is undergoing substantial development and expansion under the management of the Kenya Railways Corporation. A key project is the Standard Gauge Railway (SGR), linking Mombasa to Nairobi and Nairobi to Naivasha, supplemented by the Metre Gauge Railway (MGR). The SGR has improved freight and passenger transport, resulting in reduced travel durations and expenses.

Kenya boasts several international and domestic airports, with JKIA in Nairobi serving as the primary gateway for international flights and Moi International Airport in Mombasa as another key international hub. Additionally, numerous domestic airports facilitate regional and local flights, connecting various parts of the country. Aviation transport mainly relies on aviation gasoline and jet kerosene, with the latter commonly used for flight takeoffs. The increase in jet kerosene usage, as observed in Figure 4-25, indicates a steady rise in domestic flight takeoffs. However, a decline in fuel consumption is observed from 2020 to 2022, as can be observed in Figure 4-25.

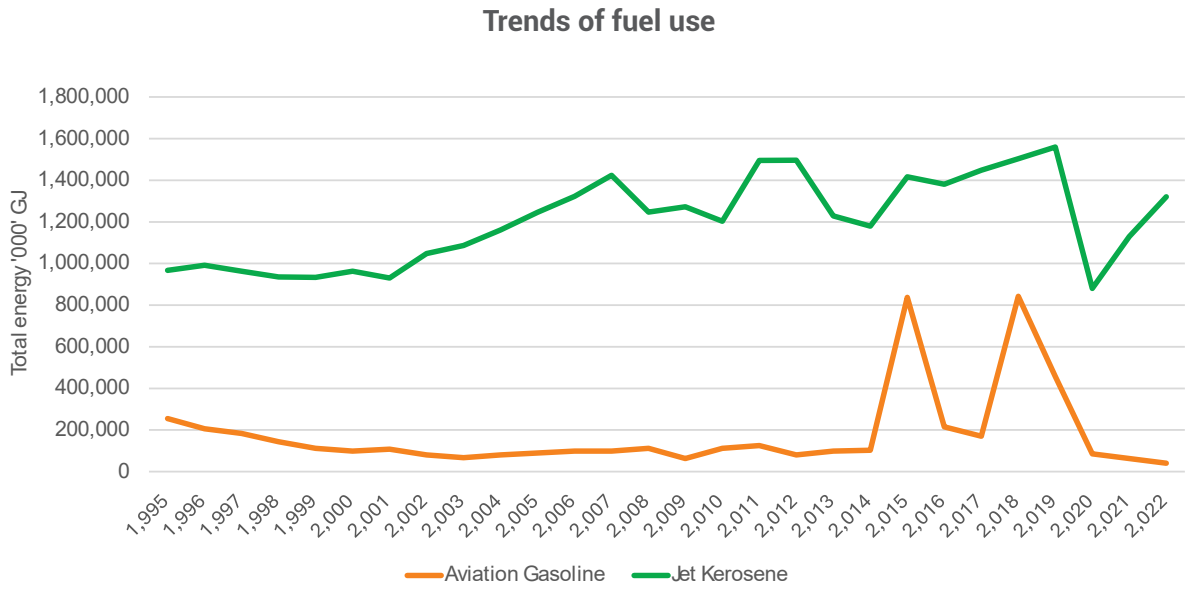


Figure 4-25. Fuel consumption in the aviation sector

Source: Author's own compilation from the second bi-annual report data, Economic Survey reports, and data provided by the transport technical team

Kenya's coastline along the Indian Ocean underscores the importance of maritime transport for international trade. The Port of Mombasa serves as the country's primary seaport, managing a substantial volume of imports and exports. Other ports include Lamu and Kisumu.

Kenya's transport sector grapples with numerous challenges, such as insufficient infrastructure, traffic congestion, and road safety concerns. To tackle these issues, the government has been investing in infrastructure development and improvement projects. Initiatives include extending the SGR to other regions, upgrading road networks, and improving aviation infrastructure.

Despite challenges, the transport sector in Kenya is evolving and undergoing significant developments to support economic growth, trade, and connectivity both domestically and regionally.

4.2.2 Transport Sector Data Inputs and Assumptions

Data from the transport sector was mainly obtained from the Economic Survey 2022. This included registration data of new vehicles, cargo handling data at the port, as well as rail transportation for both passengers and freight. Table 4-21 shows the categories of road transport vehicles and their cumulative population. Modelling the transport sector requires information on annual mileage, fuel economy by fleet, and calibration fraction on road presence of vehicle type, as illustrated in Table 4-22.

Table 4-21. Cumulative stock of vehicles by category

	2015	2016	2017	2018	2019	2020	2021	2022
Cars	847,743	906,356	973,054	1,047,737	1,130,220	1,195,936	1,268,456	1,329,810
Light commercial vehicles	283,692	298,032	308,758	321,597	335,622	350,647	370,835	389,681
Urban buses	100,986	103,270	104,801	106,678	109,949	111,933	113,648	116,728
Motorcycles	983,986	1,103,710	1,290,144	1,479,138	1,689,241	1,935,946	2,221,149	2,352,662
Three wheelers	59,140	62,955	68,122	74,381	81,703	87,599	93,949	97,950
Heavy Commercial vehicles	188,602	201,063	210,476	219,073	219,074	219,075	219,076	219,077

Table 4-22. Annual mileage and Fuel economy

Vehicle Category	Average Annual Mileage (km/year)	Fuel Economy (L/100km)	Calibration Fraction
Cars	21,663	15	30%
Light commercial vehicles	26,866	16	40%
Urban buses	43,160	33	40%
Motorcycles	28,967	4	45%
Three wheelers	28,270	8	60%
Heavy commercial vehicles	51,679	27	30%

The rail transport accounts for both passenger and freight transportation for both meter gauge and standard gauge railway. Data input in LEAP is detailed in Table 4-23.

Table 4-23. Rail transport data

	2015	2016	2017	2018	2019	2020	2021	2022
Meter Gauge Railway								
Passengers								
Passenger (million passenger-km)	99	113	88	132	169	49	112	95
Freight								
Tonnes-km (million tonnes-km)	1,283	1,141	857	314	278	393	343	424
Standard Gauge Railway								
Passengers								
Passenger (million passenger-km)			229	786	753	374	921	1,108
Freight								
Tonnes-km (million tonnes-km)				1,361	1,959	2,095	2,539	2,829

Other transport sectors, including aviation and maritime, considered data such as the number of domestic flights for takeoff and landing, and the annual importation of aviation gasoline. Additionally, data on the number of maritime vessels categorised by type, engine power rating, and operating time per vessel per year were included. Computation of vessel types, their numbers, power ratings, and operational times gave the final energy demand per vessel category, as illustrated in Table 4-24.

Table 4-24. Summary maritime modelling data

Percentage share of total vessels	Vessel categories	Number of vessels	Weighted engine power in Hp/vessel	Engine power in kW	Estimated operating time (Hrs/ year/ vessel)	Total Hrs/ year	Energy consumption (kWh/vessel)	Final energy demand (kWh)
0.8%	KPA	17	944	693.9	1,230	20,913	853,652	14,512,084
0.3%	KFS	7	441	323.9	5,475	38,325	1,773,489	12,414,426
0.4%	Cargo and Barge	9	600	441.0	806	7,254	355,446	3,199,014
8.4%	Fishing	185	232	170.7	730	135,050	124,596	23,050,188
0.1%	Dredging	3	717	526.8	432	1,296	227,556	682,668
0.4%	Oil bunkering and Oil exploration	9	150	110.3	432	3,888	47,628	428,652
1.8%	Passenger and Ferry services	39	238	175.3	806	31,434	141,267	5,509,413
87.8%	Others	1,932	175	128.7	806	1,557,192	103,718	200,382,683
	Total	**2,201**				**1,795,352**	**3,627,352**	**260,179,127**

4.2.3 Transport Sector GHG Emission Mitigation Targets and Achievements in 2018–2022

The NCCAP II outlined strategic objective No. 7b of the NCCAP 2018–2022, which aimed to establish an efficient, sustainable, world-class transport system and logistics services capable of withstanding the projected impacts of climate change.

Transport Mitigation priorities are broadly classified in four main categories: low-carbon and efficient transportation systems, such as e-mobility; reduction of fuel consumption and deployment of renewable energy technologies in the transport sector; adoption of mass transportation and bus rapid transport in major Kenyan cities; and promotion of non-motorised transport, such as walking and cycling.

Kenya's e-mobility sector is undergoing rapid transformation with numerous actors supporting its growth. These include power generation, transmission, and distribution companies like Siemens, Knight Energy, among others, contributing infrastructure, research, and academia. Assemblers such as BasiGo, financiers like KCB and Total Kenya, as well as mass adopters including Uber, Bolt, Nupea Ride, among others, are also actively involved (German Embassy, 2022). During the pilot phase, it was reported that buses charge at night, and Kenya boasts the largest fleet in East Africa. Over 300 days of fleet operation, it is estimated that 66 tonnes of CO_2 were mitigated, with 27,000 litres of diesel avoided over a distance of 145,000 km covered, based on stakeholder consultations. Table 4-25 summarizes smart targets and implementation status.

Table 4-25. Achievement status of NCCAP II

Description of smart target	Implementation status
Priority action 1. Development of an affordable, safe, and efficient public transport system	
1) 70 km of BRT for Nairobi Metropolitan Area designed, constructed, and implemented in 5 routes.	- Design for BRT Lines 3 and 5 completed. - BRT Line 2 under construction. - BRT Line 1 concept designs completed.
2) Use of electric hybrid vehicles (buses) piloted and appropriate incentives provided for their use.	-15 E-buses by BasiGo, in partnership with CitiHoppa and East Shuttle, started operations in March 2022. -Registration guidelines for electric vehicles (EVs) by NTSA established. -NTSA set to acquire new EVs for piloting -Piloting projects of 3 & 2-wheeled vehicles completed in at least two counties; Nairobi and Kisumu -Standards for electric vehicles completed
3) SGR extended from Nairobi to Naivasha.	-Extension of SGR from Nairobi to Naivasha completed in 2019. - Connection of SGR and MGR railway lines at Longonot Station completed to facilitate transshipment.

Description of smart target	Implementation status
4) Feeder public transport to BRT, commuter rail, and SGR developed and provided for the public.	14 buses provided by Kenya Railways Corporation (KRC) for last-mile connectivity from the stations to other areas.
5) 150 km of non-motorised transport (NMT) facilities constructed, including pedestrian and bicycle access within, and to town centres and transit stations.	- 449 km of NMT constructed countrywide by Kenya Urban Roads Authority (KURA), Kenya National Highways Authority (KeNHA), and Kenya Rural Roads Authority (KeRRA). - Footbridges constructed across the country.
Priority action 2. Reduce fuel consumption and fuel overhead costs	
1) SGR from Nairobi to Mombasa electrified.	Electrification of SGR provided in the basic infrastructure but deferred.
2) 30% of freight from Mombasa to Nairobi shifted from road to rail;	20% shift of freight to rail achieved.
3) Roadmap for improvement of heavy-duty truck efficiency developed, including increased use of low-rolling resistance tyres, super structure fittings etc. and, development of vehicle standards; and	-Emissions quantification conducted by Northern Corridor Transit and Transport Coordination Authority (NCTTCA). -Driver sensitisation on Eco-driving and aerodynamics conducted by KeNHA. - New regulations on Euro-4 compliance for all new trucks came into force in January.
4) Develop and start the implementation of a roadmap for the improvement of heavy-duty truck efficiency.	Roadmap development ongoing since 2023.
5) Light-duty vehicles fuel economy improved through labelling, promotion of fuel-efficient driving, and improved traffic management.	Ongoing improvements.
Priority action 3. Encourage low-carbon technologies in the aviation and maritime sectors	
1) Shore power infrastructure for four berths installed to provide power to ships while at berth instead of using their engines.	-Shore power connected for small marine crafts. -Cruise terminal budget approved. -Feasibility studies ongoing for alternative marine power sources like hydrogen. -Review of solar and wind power development at the port.
2) 2 new aircraft (B787) with fuel-efficient engines purchased;	2 new aircraft purchased.

Description of smart target	Implementation status
3) Service Charter on Sustainable Aviation Fuels (certification and use of biodiesel production for captive use at the airports) implemented by 2020.	-Feasibility studies on the implementation of service charter on Sustainable Aviation Fuels completed. -Stakeholders workshop held on sustainable aviation fuel.
4) 0.5 MW solar power plant installed at Moi International Airport and commissioned in 2018.	Construction of 0.5 MW solar plant at Moi Int. Airport completed and commissioned in 2019, connected to the grid.

Cargo handling by rail has been on the rise, although it has not yet reached the 30% target. By 2020, cargo handling by rail had reached 20%, as illustrated in Table 4-26, with 80% of the cargo still being handled by road. About 29% of the total cargo handled at Kenyan ports is transit cargo.

Table 4-26. Progress in cargo handling by rail and other sources

	Thousand Metric tonne							
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Total Cargo at the port	**26,732**	**27,384**	**30,272**	**30,923**	**34,440**	**34,116**	**34,551**	**33,880**
Transit cargo (29%)	7,667	7,748	8,637	9,604	9,947	10,181	9,541	10,234
Cargo handled in country (71%)	19,065	19,636	21,635	21,319	24,493	23,935	25,010	23,646
Cargo handling by rail	**1,542**	**1,380**	**1,147**	**3,544**	**4,826**	**5,063**	**6,051**	6,877
Percentage of cargo handled by rail	6%	5%	4%	11%	14%	15%	18%	20%
Cargo by road	25,190	26,004	29,125	27,379	29,614	29,053	28,500	27,003

Impacts of the mitigation actions

Although numerous mitigation actions have been undertaken in the transport sector, there has been only marginal progress in terms of real implementation of low-carbon pathways. The generation of captive solar power has been factored into electricity generation from captive power sources. Other activities contributing to mitigation include the shift of 20% cargo from roads to the SGR, the introduction of electric buses, and the increasing adoption of hybrid and electric cars. Additionally, innovative LPG-fueled cars have contributed to emission reduction. Moreover, there is a rapid growth trend in hybrid cars and an emergence of fully electric cars.

Model assumed that about 398,900 fleets of cars are on road on a daily basis. Of this total, 5% (19,900 cars) were assumed to be hybrid cars, 1% (4,000 cars) were assumed to be LPG cars (mostly promoted in Nairobi), and electric cars accounted for 0.1% (about 400 cars), based on inputs from transport sector consultative meetings, as illustrated in Table 4-27. The two-wheelers have also been piloted, and we have used a similar assumption as for electric cars, estimating conservatively that there are only about 800 electric motorcycles (0.1% of the total fleet on the road). Although electric buses are currently limited, they are increasing in number. Discussions with transport stakeholders indicated mainly BasiGo buses, with an estimated 20 fleets by the time of study.

Table 4-27. Distribution of fleet of cars on the road by fuel type

Passenger road transport - Cars	2018	2019	2020	2021	2022
Gasoline	254.6	272.1	285.2	299.5	310.8
Diesel	50.3	54.3	57.4	60.9	63.8
Hybrid	9.4	11.9	14.4	17.1	19.9
Electric	-	-	-	0.2	0.4
LPG cars	-	0.8	1.8	2.9	4.0
Total	**314.3**	**339.1**	**358.8**	**380.5**	**398.9**

Modelling transport sector emissions while considering the assumptions made and the transformation in the transport sector, transport sector GHG emissions is presented in Table 4-28. The GHG emissions increased from 10 MtCO2eq in 2018 to 12 MtCO2eq in 2022. Motor Gasoline and Diesel are the highest emitting fuels.

Table 4-28. Transport sector GHG emission between 2018–2022

	2018	2019	2020	2021	2022
LPG	-	0.00	0.01	0.01	0.01
Motor Gasoline	3.94	4.10	4.20	4.65	4.96
Aviation Gasoline	0.06	0.03	0.01	0.00	0.00
Kerosene Type Jet fuel	0.11	0.11	0.06	0.08	0.10
Diesel	5.98	6.30	6.37	6.48	6.52
Compressed Natural Gas (CNG)	0.07	0.09	0.11	0.13	0.16
Total	**10.16**	**10.64**	**10.76**	**11.36**	**11.75**

A time series comparison between the actual GHG emission until 2022 against the baseline projection illustrates that in the baseline projection, it was expected that by 2022, 13.6 MtCO2eq would be emitted, yet the actual emission was 11.8 MtCO2eq, resulting in an abatement of 1.8 MtCO2eq. The MTAR 2018–2022 cumulatively targeted a 1.7 MtCO2eq emission abatement in 2022. While it is not directly relatable, there is a significant attribution of the NCCAP II actions to the realisation of emission reduction. As illustrated in Table 4-29, to be on track in achieving NDC by 2022, the allowed emission from the transport sector was 11.5 MtCO2eq. This thus shows that there is a 0.3 MtCO2eq deviation from the target.

Table 4-29. GHG emission mitigation status in the transport sector in million tonnes of CO_2eq

	2010	2015	2020	2022	2022
Baseline scenario emission (MtCO2eq)	7.0	9.0	12.0	13.6	0.01
Allowed GHG emissions considering NDC target (MtCO2eq)	7.0	8.2	10.2	11.5	4.96
Actual GHG emission (MtCO2eq)	7.0	8.8	10.8	11.8	0.00
Gap or deviation from allowed GHG emissions NDC target	0.0	-0.5	-0.5	-0.3	0.10
Comment			Deficit	Deficit	6.52
Compressed Natural Gas (CNG)	0.07	0.09	0.11	0.13	0.16
Total	**10.16**	**10.64**	**10.76**	**11.36**	**11.75**

4.2.4 Challenges Faced and Lessons Learnt in Implementation of NCCAP II

Below is the list of challenges faced during the implementation of NCCAP II as articulated by the sector leads.

1. **Financial Sustainability and Resource Management**: Ensuring adequate funding and resource allocation for sustainable transportation projects to support technological advancements and infrastructure development.
2. **Building Strong Political Consensus**: Cultivating a collaborative and supportive political environment to garner widespread backing for sustainable transport initiatives, fostering unified efforts towards achieving common goals.
3. **Efficient Land Use Planning**: Implementing effective land use strategies to accommodate the expansion and enhancement of transportation infrastructure, while considering environmental concerns and engaging stakeholders.
4. **Managing Urbanisation and Population Growth**: Addressing the impact of rapid population growth and urbanisation on public transport systems, proactively planning for increased demand, and ensuring seamless rural-urban mobility.
5. **Promoting Adoption of Electric Mobility**: Facilitating the integration of electric mobility solutions by establishing favorable policies, regulations, and incentives to encourage investment and uptake.
6. **Standardisation and Charging Infrastructure**: Encouraging collaboration among equipment suppliers to adopt common charging standards, while concurrently establishing a robust charging infrastructure network for electric vehicles.
7. **Streamlining Land Acquisition Processes**: Addressing challenges associated with land acquisition by devising transparent and efficient procedures that consider community interests and project sustainability.
8. **Enhancing Last Mile Connectivity**: Focusing on improving last-mile connectivity for passengers and freight, ensuring comprehensive accessibility and coverage within the transportation network.
9. **Strategic Policy Frameworks**: Developing responsive and forward-looking policies that consider technological advancements, environmental standards, and vehicle end-of-life strategies to promote sustainable transportation practices.
10. **Investing in Sustainable Aviation Technologies**: Exploring funding options and incentives to support the development and adoption of Sustainable Aviation Fuel (SAF) technologies, reducing the aviation sector's carbon footprint in the long term.

11. **Fiscal Measure:** The tariff rate on imported electric vehicles has been reduced by 50%, shifting from 20% to 10%.
12. **Draft 2023 Budget Policy Statement:** The government is yet to roll out EV charging infrastructure.
13. **Policy challenges include:** EURO 4/IV KeBS standards (KS 1515: 2019) has not been implemented, East African Community (EAC) member countries are yet to Implement EAS 1047:2022 standards, and EAC EAS 1047:2022 standards on Air Quality–Vehicular exhaust emission limits have not been enforced. Implementation of such standards would promote the growth of e-mobility and low-emission vehicles.

Lessons learnt



1. **Infrastructure and Facilities**: Incorporate wider road reserves to accommodate facilities and construct durable non-motorised transport (NMT) facilities.
2. **Financing Strategies**: Explore alternative financing models such as Public-Private Partnerships (PPPs) and green financing for sustainable transportation projects.
3. **Regulations and Policies**: Finalise policies and regulations promptly to provide clear guidelines for project implementation.
4. **Equipment and Interoperability**: Ensure interoperability of different equipment in the market to promote seamless integration.
5. **Last Mile Connectivity**: Conduct demand mapping studies to match bus demand with passenger needs for efficient last-mile connectivity.
6. **Safety and Efficiency**: Adopt at-grade crossing facilities where possible to improve traffic flow and road safety.
7. **Resource Prioritization**: Strategically prioritise resources from budgetary plans to maximise project impact.
8. **Public Engagement**: Involve public participation and stakeholder engagement in decision-making processes.
9. **Sustainable Transport Development**: Develop relevant policies and regulations to guide sustainable transportation practices.
10. The rollout of BasiGo's electric buses validates the feasibility of electric bus operations in Kenya.
11. Implementing electric hybrid vehicles (buses) with appropriate incentives to promote their use
12. **Policy challenges include** EURO 4/IV KeBS standards (KS 1515: 2019) not being effected, EAC member countries yet to implement EAS 1047:2022 standards, and EAC EAS 1047:2022 standards on Air Quality–Vehicular exhaust emission limits not enforced. Implementation of such standards would promote the growth of e-mobility and low-emission vehicles.

4.3 Agriculture Sector

4.3.1 Overview of Agriculture Sector

The agricultural sector in Kenya is highly vulnerable to the impacts of climate change due to its reliance on rainfed agriculture and the predominance of small-scale farming. Climate change poses challenges such as increased frequency and intensity of droughts, unpredictable rainfall patterns, rising temperatures, and increased pest and disease outbreaks. To address these challenges and promote climate change adaptation and mitigation in the agricultural sector, several initiatives have been undertaken in Kenya:

1. Climate-Smart Agriculture: Climate-smart agriculture (CSA) practices aim to increase agricultural productivity, build resilience, and reduce greenhouse gas emissions. Examples of CSA practices include agroforestry, conservation agriculture, crop diversification, improved water management, and integrated pest management. These practices help farmers adapt to changing climatic conditions, conserve soil moisture, sequester carbon, and reduce emissions from agricultural activities.
2. Irrigation Systems: To mitigate the impacts of erratic rainfall patterns and droughts, Kenya has been investing in irrigation systems. Small-scale farmers are encouraged to adopt both traditional and modern irrigation techniques such as drip irrigation and sprinkler systems. Irrigation helps maintain crop productivity during dry spells, reduces reliance on rainfall, and improves water use efficiency.
3. Research and Development: Kenya has been actively investing in research and development to develop climate-resilient crop varieties and farming techniques. This includes breeding drought-tolerant crops, heat-resistant varieties, and disease-resistant varieties. Additionally, research institutions work to develop and disseminate climate information and early warning systems to farmers, helping them make informed decisions.
4. Agroforestry and Afforestation: Planting trees and integrating them into agricultural landscapes through agroforestry practices help mitigate climate change. Trees sequester carbon dioxide, provide shade, reduce soil erosion, improve soil fertility, and create microclimates that benefit crops and livestock. Kenya has promoted afforestation programmes such as the Greening Kenya Campaign and the National Tree Planting Day to increase tree cover.
5. Sustainable Land Management: Implementing sustainable land management practices, such as terracing, contour ploughing, and soil conservation techniques, helps prevent soil erosion and degradation. These practices enhance soil fertility, water retention, and resilience to climate change impacts, leading to improved agricultural productivity.
6. Climate Financing and Policy Support: The Kenyan government has established policies and frameworks to support climate change adaptation and mitigation in agriculture. This includes the NCCAP, the Climate Change Act, and the Agriculture Sector Development Strategy. International climate financing mechanisms like the Green Climate Fund (GCF) and the Adaptation Fund provide financial support for climate change initiatives in the agricultural sector.

7. Farmer Training and Capacity Building: Enhancing the knowledge and skills of farmers through training programmes and capacity building is essential for successful climate change adaptation and mitigation. This includes training on climate-smart practices, water management, soil conservation, pest and disease control, and improved agricultural techniques. Farmer field schools and extension services play a crucial role in disseminating information and providing technical support to farmers.

By promoting climate change adaptation and mitigation strategies in the agricultural sector, Kenya aims to enhance food security, build resilience among farmers, reduce greenhouse gas emissions, and contribute to sustainable development. In 2020, the sector developed its low-carbon, climate-resilient development pathway. The broad objective of the Agriculture LTS is to identify medium- to longer-term priority adaptation and mitigation actions. It involves laying out a development pathway that strikes a balance between adaptation, building climate resilience and reducing emissions from the sector (GoK, 2020). The Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) tool was adopted to project livestock population and impacts under changing climatic conditions, with an initial inventory based on the available data from 2020 to 2050 at the national level by scenario and animal species. The livestock population considered in this context includes cattle (beef and dairy), goats, sheep, pigs, and poultry.

BETA prioritises agricultural transformation and inclusive growth as its number one initiative. This initiative aims to implement various strategies, including providing fertiliser subsidies, supporting small-scale irrigation and value addition projects, implementing climate-smart agricultural practices to enhance productivity, and improved livestock production.

The emission status in the agricultural sector has been fluctuating. According to the Kenya Second National Commission, emissions from agriculture were projected to increase from 30 MtCO2eq in 2010 to 39 MtCO2eq in 2030 (Government of Kenya, 2015), largely due to livestock enteric fermentation and agricultural soil. The updated NDC reported agricultural sector emissions in 2018 was 40 MtCO2eq. The total emission reduction potential in the NCCAP 2022 was 2.61 MtCO2eq, with agroforestry accounting for 1.66 MtCOeq, increased farm area under sustainable land management contributing to 0.55 MtCO2eq, and the implementation of Kenya's Dairy Nationally Appropriate Mitigation Action (NAMA) accounting for 0.40 MtCO2eq (Government of Kenya, 2018).

4.3.2 Agriculture Sector Data Inputs and Assumptions

Agricultural emissions are mainly attributed to enteric fermentation, manure management, and mineralisation of soil organic carbon. Therefore, data requirements include the updated population of livestock (e.g., cattle, sheep, camels, goats etc.), cultivated land in hectares by crop type such as maize, rice, beans, etc., and total annual fertiliser demand for agriculture. Kenya has established Tier 2 emission factors for dairy cattle. Hence, the model analyses dairy sector GHG emissions separately to factor in the Tier 2 emission factor from dairy farming in Kenya.

Moreover, Kenya is currently upscaling the new non-flooded rice variety in multiple irrigation schemes. Although still at low stages, the government aims to increase land under rainfed rice farming and non-flooded rice growing to mitigate on GHG emissions and reduce water use for rice cultivation. In this case, we input data on the average acreage under flooded and non-flooded rice cultivation.

Data considered for the modelling was updated to 2021 based on previous reports. Livestock population data are as presented in Table 4-30. IPCC Tier 1 emission factors were used for all animals except for dairy cattle, which used Tier 2 emission factors (41 kg CH_4 $head^{-1}$ yr^{-1}) as presented by the sector technical team. Table 4-31 shows the various emission factors that were used for different animals' enteric fermentation and manure management.

Table 4-30. Livestock population data for enteric fermentation

										'Million heads			
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dairy Cattle	3.3	3.7	3.7	4.2	4.5	4.3	4.2	4.5	4.6	4.7	4.9	5.1	5.0
Other Cattle	8.2	10.3	10.4	12.1	13.6	13.5	14.5	16.0	13.8	13.0	13.4	15.6	16.1
Swine	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.5	0.5	0.6	0.6
Sheep	9.3	10.8	10.9	15.4	16.6	17.4	16.8	19.0	18.8	19.5	20.1	22.4	24.2
Goats	13.9	18.2	18.0	21.0	24.6	25.4	25.1	26.7	25.7	26.7	27.5	30.5	32.1
Donkeys	0.8	1.0	0.9	1.3	1.7	1.9	1.7	2.0	2.2	2.2	2.3	2.6	2.9
Camels	1.2	1.5	1.8	2.8	2.9	2.9	3.1	3.2	3.3	3.3	3.4	4.0	4.3

Source: Consolidated from Second bi-annual report data and agricultural sector technical committee

Table 4-31. Emission factors for livestock enteric fermentation by type

	Emission factors (Kg/Animal per year)					
	Camels	Goats	Sheep	Pigs	Other Cattle	Dairy Cattle
Methane from Enteric Fermentation	10.5	5	5	1	27	41*
Methane from Manure Management	2.56	0.2	0.2	5	2	4.1*

*Tier 2 methane factor for enteric fermentation and manure management from dairy cattle

Source: Compiled from IPCC default factors

Kenya identifies the main types of manure management systems as follows: daily spread, where manure is removed daily from the sheds and spread in fodder or food crop; dry lot, where dung is deposited on hard surfaces where animals are kept and removed periodically; solid storage, where manure is stored in heaps in the farmyard; deep bedding; compost; and liquid slurry. In LEAP, we assume a single value obtained from aggregated emission divided by the heads of cattle, yielding 0.14kg N_2O head^{-1} yr^{-1}.

Mineralisation of soil organic carbon is the second-highest contributor of agricultural sector GHG emissions. Table 4-32 shows the area under crop agriculture for the seven major crops grown in Kenya.

Table 4-32. Activity level data for crop farming of the major crops grown in Kenya

	Area under crop production in thousands of hectares											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rice	24	21	22	28	27	26	25	23	31	32	31	32
Wheat	160	132	149	150	147	145	153	153	153	153	141	141
Maize	2,008	2,132	2,159	2,123	2,116	2,267	2,338	2,092	2,142	2,142	2,265	2,288
Sugarcane	226	243	299	300	284	224	221	191	202	197	165	150
Tea	172	188	191	199	203	208	219	233	234	269	261	261
Irish potato	122	136	99	105	116	177	171	171	171	171	220	231
Coffee	160	160	110	110	110	114	114	115	116	116	97	92

Source: Author's own, compiled from second biannual communication to UNFCCC and extrapolation to 2021

Data for rice cultivation was adopted from GHG inventory and is detailed in Table 4-33 .

Table 4-33. Time series of the area under rice production in Kenya categorised by farming practice (in hectares)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rainfed Upland	5,290	4,780	4,875	3,000	2,958	3,706	4,453	4,112	4,849	4,739	4,804	6,638
Rainfed Lowland	2,190	2,488	2,518	4,000	3,924	4,636	5,348	4,938	5,818	5,686	5,765	7,966
Irrigated	21,619	18,330	19,790	23,717	23,303	21,287	19,536	18,040	21,657	21,166	21,459	29,651
Total	**29,099**	**25,598**	**27,183**	**30,714**	**30,186**	**29,438**	**29,337**	**27,090**	**32,324**	**31,591**	**32,028**	**44,255**

Source: Projection from GHG inventory

4.3.3 Agriculture Sector Mitigation Targets and Achievements in NCCAP II

The agricultural sector poses significant challenges for decarbonisation, with enteric fermentation and soil organic compound mineralisation being the two major contributors to GHG emissions in Kenya's agricultural landscape. Other sources of GHG emissions within this sector include those stemming from rice cultivation, the burning of crop residues and forests, and the management of manure on land. Despite Kenya's interest in mitigating GHG emissions in agriculture, the sector has been adversely impacted by climate change, necessitating a greater focus on adaptation efforts. Moreover, considering the discourse surrounding loss and damage, the agriculture sector faces insurmountable losses due to droughts and incurs significant financial damages due to floods, landslides, and other climate change-related events.

In the strategic objective for mitigating GHG emissions in Agriculture during the NCCAP 2018–2022 period, the aim was to reduce emissions without compromising productivity. Key focus areas included agroforestry, sustainable land management, efficient livestock management systems to enhance productivity, effective manure management, addressing overcapacity of artisanal fishing vessels, boosting aquaculture production, and increasing rice production. Table 4-34 summarizes mitigation actions and implementation status as outlined in NCCAP II.

Table 4-34. Summary of priority actions and implementation status

Description of smart target	Implementation status summary
Priority area 1: Sustainable land management	
Increase farm area under sustainable land management. a. Support the reclamation of 60,000 hectares of degraded land. b. Area under integrated soil nutrient management increased by 250,000 acres. c. Farm under conservation agriculture increased to 250,000 acres, incorporating minimal tillage. d. Increase the total area under agroforestry at farm level by 200,000 acres (81,000 hectares) by 2022.	- About 52,075 ha of degraded land were reclaimed. - Area under soil nutrient management increased by 10,286 acres. - Area under conservation agriculture increased by 20,050 acres. - Private sector contributed to distributing 13.6 million tree seedlings to 371,351 farmers and established 98 tree nurseries across 24 counties. - Farm Africa promoted agroforestry in smallholder farming systems through the distribution of 200,000 tree seedlings to 10,000 farmers from 2020 to 2021 in Tharaka Nithi and Embu counties.
Priority area 2: Efficient livestock management system and enhanced productivity	
Implement the Nationally Appropriate Mitigation Action (NAMA) for the diary sub-sector involving 267,000 households in the programme leading to GHG emissions reduction by: a. Increasing dairy productivity while maintaining herds of animals (152,700 households). b. Energy efficiency in processing facilities. c. Household biogas adoption by 20,000 households.	- According to the biogas inventory study in 2022, there were 20,000 households using biogas technology.
Priority area 3: Manure management	
Increased adoption of biogas technology-use by 80,000 households, leading to an abatement of 1.2 million tCO2e 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 tCO2e by 2022.	- About 1,297 households adopted improved manure management as of 2020.

Description of smart target	Implementation status summary
Priority area 4: Sustainable fisheries	
Increased deep/offshore fishing fleet from 9 to 68 by 2022.	
Increased number of farmers using low-carbon (Recirculation) aquaculture systems from 20 to 180 by 2022.	- 10 farmers using low-carbon (recirculating) aquaculture.
Put 50% of the 30,000 hectares under rice production into efficient production technologies by 2022. Increased area under rainfed rice production from 400 hectares to 600 hectares by 2022.	

Impacts of Priority Mitigation Actions.

The agricultural sector remains one of the hardest to decarbonise sectors. It is observed that in 2022, despite efforts in sustainable land management practices such as soil nutrient management and conservation agriculture, emissions reductions remain minimal, with these practices covering only around 1% of agricultural areas. However, progress was noted in improving productivity while curbing the steady growth of dairy livestock, although slightly. Other categories of livestock populations continue to grow, as illustrated in Figure 4-26. The slower rise in dairy population could potentially be attributed to breeding methods. As a result, enteric fermentation and soil organic compound mineralisation remain to be the major emitters in the agricultural sector.

The target of 80,000 households adopting biogas technology fell short, with only 1,297 units realised. It is worth noting that this achievement likely overlaps with the 20,000 biogas units reported in the biogas survey, which are accounted for in emission avoidance within the energy sector. As for tree seedlings distribution, its impact will be significant once the survivability and changes in forest cover area are identified. However, the accounting of this contribution will be attributed to the agriculture sector but reported in forestry sector emission reduction estimations.

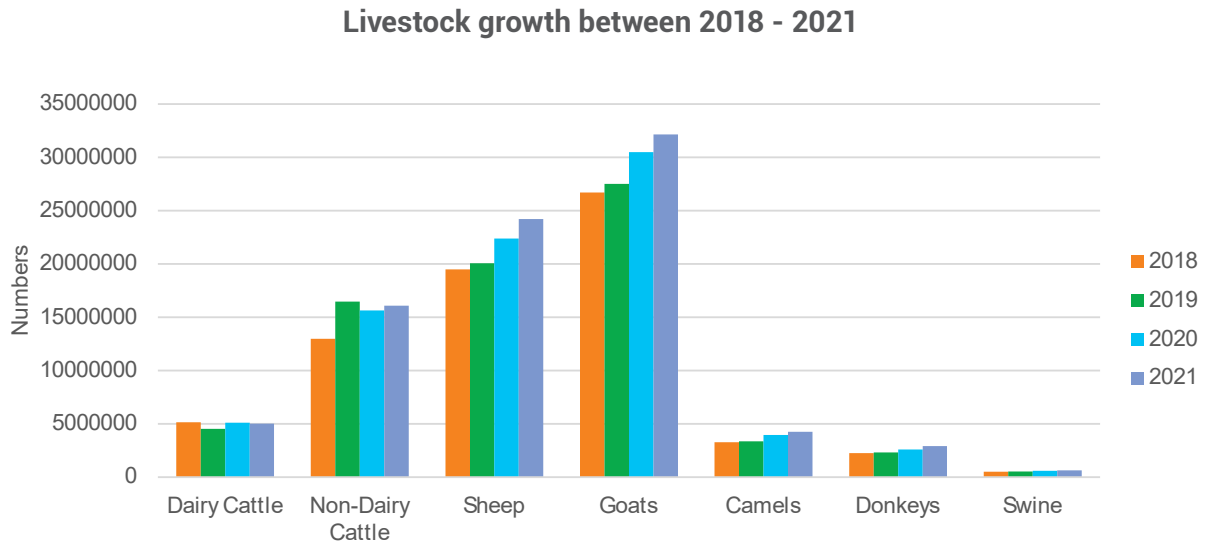


Figure 4-26. Population growth of livestock in NCCAP II period

Source: Author's own based on agriculture stakeholders' data update for dairy cattle

Therefore, in 2022, the total GHG emissions from the agriculture sector were about 49.6 million tonnes of CO_2equivalent, based on LEAP modelling with a revised GWP of methane, as illustrated in Figure 4-27. Mineralisation of soil organic carbon accounts for 32.5%, while enteric fermentation and manure management together account for 66%. Fertiliser application contributes 1%, and rice farming only contributes 0.4%to the total emissions.

Figure 4-27 illustrates the agricultural sector GHG emissions in the reference scenario projection, updated NDC computation, and LEAP modelling using two global warming potentials of methane (AR3 21 times and AR5 28 times). The IPCC AR5 revised the GWP for methane upward to 28times that of CO2. This change in GWP has contributed to a significant rise in agricultural sector emissions from enteric fermentation, manure management, and rice cultivation. Additionally, in the first scenario projection (baseline scenario), there were limitations in verifiable data, leading to challenges. This is evident in the updated NDC, which shows emissions about 8 MtCOeq higher than the baseline scenario emission.

Thus, factoring the changes in data and emission factors, agricultural sector emissions in the adjusted baseline[10] and the emission status are illustrated in Table 4-35 . The table shows that in 2022, there was an absolute abatement of 4 MtCO2eq from the agricultural sector, of which 2.6 MtCO2eq resulted from reduced enteric fermentation and manure management in livestock. Specifically, this can be associated with the flattening of

[10] The adjusted baseline incorporates the updated GWP of methane from 21 GWP to 28 GWP and NOx from 310 GWP to 265 GWP as per the AR5 report. It also captures the correct livestock population as reported in the National Inventory Report, 2017, and projects growth based on the historic growth trend to 2021. Additionally, it incorporates the Tier 2 emission factor of dairy enteric fermentation, with an emission factor of 41 kg methane per head.

the high growth trend in dairy cattle through intensified breeding and adjustment of emission factors to Tier 2 for dairy cattle. On the other hand, crop land management resulted in an emission abatement of 1.36 MtCO2eq.

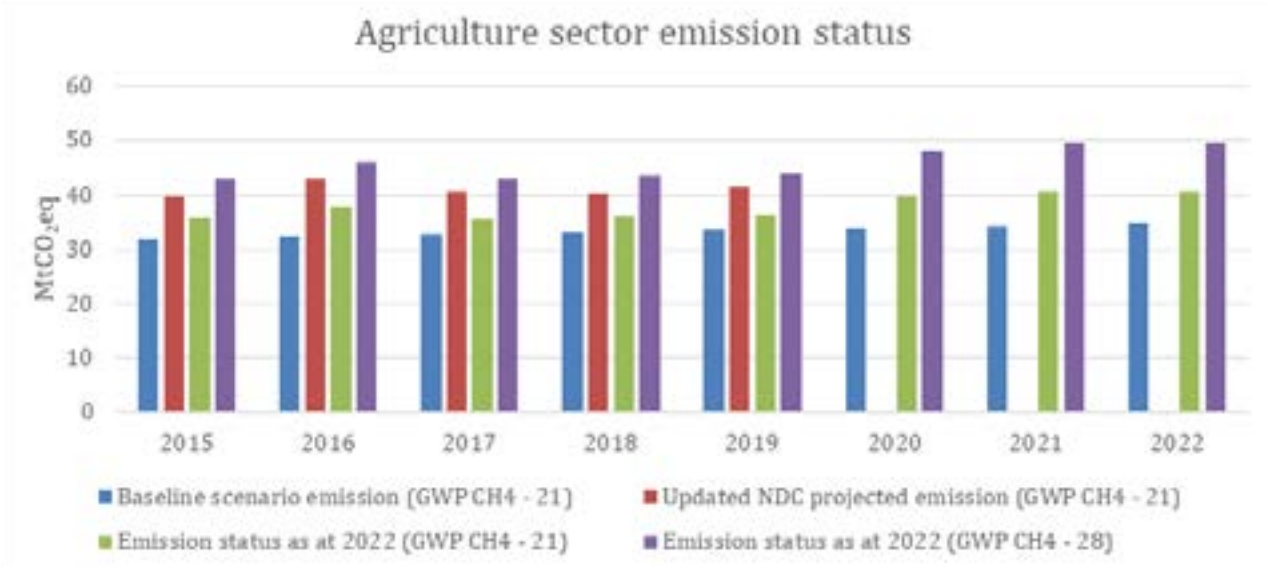


Figure 4-27. Agriculture sector emission relating to reference scenario projection, updated NDC computation, and LEAP modelling using two GWP of methane (AR3–21 times GWP and AR5–28 times GWP)

Source: Author's own from LEAP modelling, updated NDC, 2020, and NDC 2015

Table 4-35. Agricultural sector emission in baseline projection and actual in the planning period

	2018	2019	2020	2021	2022
Adjusted Baseline emission projection (MtCO2eq)	48.0	49.2	50.6	52.0	53.4
Actual Emission status (MtCO2eq)	43.4	46.5	48.0	49.4	49.4
Estimated abatement (MtCO2eq)	**4.6**	**2.7**	**2.6**	**2.5**	**4.0**

Source: Author's own, LEAP modelling

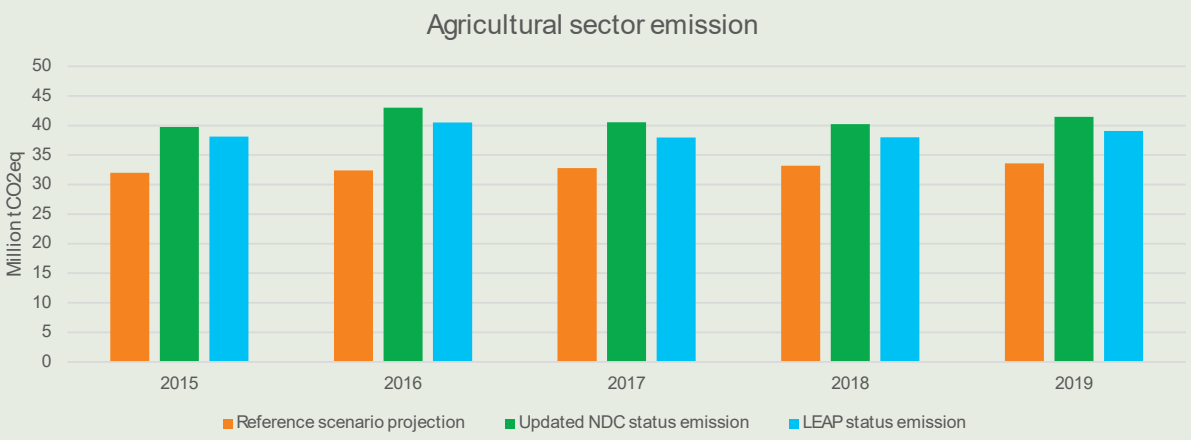
However, upon comparing the current level of emissions against the projected baseline emissions in the NDC and the allowed emissions necessary to achieve the set target for the country, it becomes evident that we are in deficit. Table 4-34 summarises the GHG emission status and avoidance in the agricultural sector as of 2022. Arguably, it shows that the country's baseline emission projection in 2022 was estimated to be 34.8 MtCO2eq. To be on track towards achieving the NDC target by 2022, the actual emission should have been 33.1 MtCO2eq. However, the change in GWP of methane, the Tier 2 emission factor in dairy farming, and the updated livestock figures in the national inventory report (NIR) illustrate higher actual emissions, putting the country in a deficit of 16 MtCO2eq to attain the targeted emission.

Table 4-36. GHG emissions in the agricultural sector

	2010	2015	2020	2022
Baseline scenario emission (MtCO2eq) (GWP21)	30.0	32.0	34.0	34.8
Allowed GHG emissions considering NDC target (MtCO2eq) (GWP21)	30.0	31.7	32.7	33.1
Actual GHG emission (MtCO2eq) (GWP28)	32.7	43.0	48.2	49.6
Gap or deviation from allowed GHG emission for NDC target	- 2.7	- 11.3	- 15.5	- 16.4
Comment (partly due to change in GWP of methane)		Deficit	Deficit	Deficit

Box 2 Data differences in the agriculture sector

The differences in emission projections in agricultural sector are due to multiple factors. In the NCCAP 2013-2017, the projected livestock population in the baseline, and corresponding enteric emissions (15.5 MtCO2e), were lower than the actuals reported in the NIR 3 (22.3 MtCO2e). During the NCCAP 2013-2017 process, the livestock population was capped based on expert opinion and the perceived livestock carrying capacity of the ASALs rather than validated population data. By 2020, the Ministry of Agriculture and Livestock State Department of Livestock had Tier 2 dairy cattle data available. The second national communication used a Tier 1 emission factor of 46 kg CH4 hd-1 yr-1against the Tier 2 emission factor of 41 kg CH4 hd-1 yr-1 for enteric fermentation. Finally, the changed global warming potential of methane in IPCC ad hoc working group 5 revised the GWP potential of methane from 21 times to 28 times CO_2 emission, which significantly contributed to the high estimated emission in NCCAP 2023–2027. The reference scenario projection, NDC targeted emission, and updated NDC projection were based on the AR3 global warming potential of methane. The figure below shows LEAP model result at AR3 GWP for methane (21GWP) used in the baseline and the updated NDC. The LEAP tool modelled result is comparable to the updated NDC emission result.


Agricultural sector emission
Million tCO2eq
50
45
40
35
30
25
20
15
10
5
0
2015
2016
2017
2018
2019
Reference scenario projection
Updated NDC status emission
LEAP status emission

4.3.4 Challenges Faced and Lesson Learnt in the Implementation of NCCAP II

The agricultural sector, being highly GHG-emitting and hard-to-decarbonise due to its focus on food security, Some of the major challenges identified by stakeholders in the sector include:

1. **Lack of Reporting Mechanism**: The absence of a structured reporting mechanism for Climate Change Actions in the Agriculture Sector hinders the effective monitoring and evaluation of initiatives.
2. **Limited Integration of Climate Actions**: The agriculture sector has faced challenges in fully integrating climate actions. Despite recent efforts by the government through programmes like FLLoCA, which established climate change units at the county level.
3. **Unpredictable Rainfall**: Unreliable rainfall patterns pose a significant challenge to agricultural planning and productivity, affecting crop yields and livelihoods.
4. **Inadequate Irrigation Infrastructure**: The scarcity of well-developed irrigation systems limits the sector's ability to cope with fluctuating rainfall and provide a consistent water supply to crops.
5. **Continued Reliance on Fuelwood**: The persistent dependence on fuelwood for energy needs contributes to deforestation and environmental degradation.
6. **Political Will for Sustainable Wood Management**: Ensuring sustainable management and usage of wood products requires stronger political goodwill and commitment to implement effective policies and regulations.
7. Failed rains led to prolonged dry periods, negatively affecting the tree-planting exercises.
8. Getting a reliable supply and adequate number of tree seedlings for the required species of fruit trees
9. Inadequate technical capacity in conservation agriculture (CA) and limited access to CA equipment and services

Lessons learnt

A crucial lesson learnt in the sector is the importance of developing and adopting an effective and verifiable climate-smart implementation monitoring framework. To address this, the government has taken significant steps by establishing the Climate Smart Agriculture-Multi-Stakeholder Platform (CSA-MSP), creating the Kenya Climate Smart Agriculture Monitoring and Evaluation Framework, and developing the Kenya Climate Smart Agriculture Monitoring and Evaluation tool. These initiatives aim to enhance accountability, transparency, and data-driven decision-making in climate-smart agricultural practices. By employing these monitoring mechanisms, policymakers and stakeholders can track the progress and impact of climate-smart initiatives, fostering a more sustainable and resilient agricultural sector in Kenya. Additionally, the government must remove regulatory barriers to smallholder agroforestry and increase the tenure security of agroforestry farmers.

4.4 Industrial Processes and Product Use

4.4.1 Overview Industrial Processing and Product Use

The manufacturing and construction industries played a significant role in Kenya's economy, contributing 26% of the national GDP in 2022 (KNBS, 2022). The manufacturing sector is regarded as a key driver of Kenya's growth toward becoming a newly industrialising middle-income economy by 2030 as outlined in Kenya Vision 2030. Various development trajectories have been identified in short-term and medium-term plans (MTPs). Kenya's economic potential is evident in its agricultural and extractive sectors, which include products such as coffee, tea, sugarcane, cotton, fluorspar, titanium, gypsum, lead, and silicon. However, the production and refining processes of these products result in GHG emissions that are often challenging to decarbonise. In developed economies, this sector is typically decarbonised through the adoption of emerging technologies such as carbon capture and storage. In 2015, Kenya's industrial processes were estimated to contribute to 3 MtCO2eq of total GHG emissions, with projections indicating an increase to 6 MtCO2eq by 2030 (Government of Kenya, 2015).

Industrial manufacturing processes in Kenya, particularly those with significant GHG emissions, include cement production, iron and steel production, and chemical manufacturing. Cement production, in particular, involves the combustion of fossil fuels and the chemical breakdown of limestone, resulting in substantial CO_2 emissions. It accounts for about 60% of the total industrial sector emissions. Similarly, the iron and steel industry contributes to emissions through its high energy consumption and the use of carbon-intensive processes. Efforts are being made to adopt cleaner technologies and implement energy-efficient practices in these sectors to reduce emissions. Despite these efforts, cement production stayed relatively constant between 2015 and 2019 but saw a sharp increase to 9.2 million tonnes in 2022, representing a 52 percentage point increase from 2016. Ordinary Portland Cement (OPC) accounts for 14% of the total national cement production, while Portland Pozzolana Cement (PPC) and Portland Limestone Cement (PLC) account for 83% and 3%, respectively. Figure 4-28 illustrate trends in cement production in Kenya.

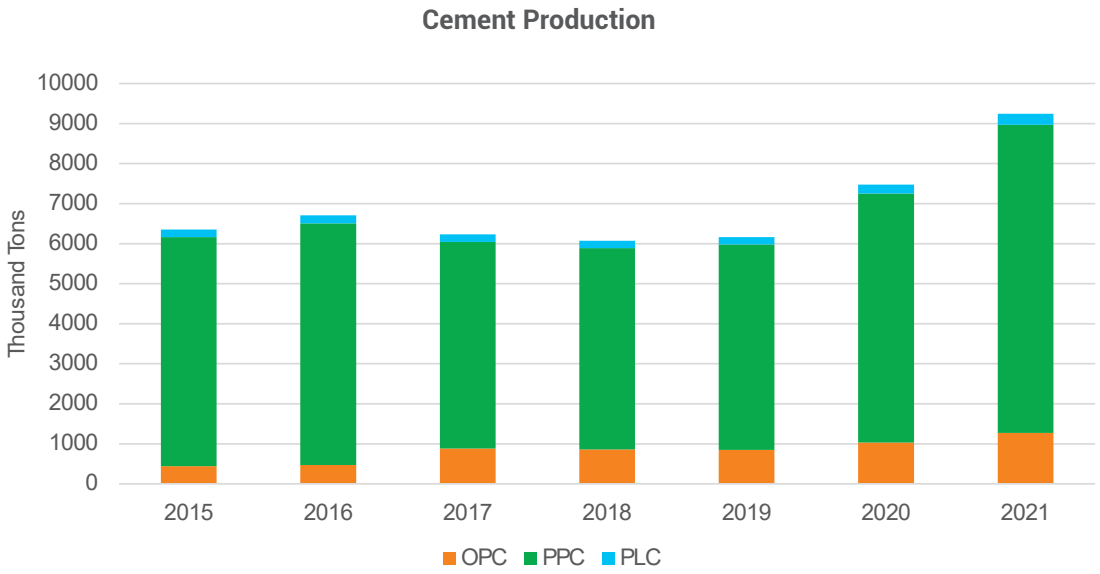


Figure 4-28. Cement production in Kenya

Charcoal production remains a significant challenge in Kenya due to the continued reliance on charcoal use, contributing to GHG emissions during the production process. Although there have been limited studies conducted on charcoal production, it is evident that the process is closely linked to both the use of charcoal and the technologies employed in its production.

Since charcoal production is driven by demand, higher demand leads to increased production, and lower efficiency necessitates more trees required to produce a tonne of charcoal. Table 4-37 shows different kiln types used in charcoal production and their respective efficiencies. Despite the existence of modern kilns, recent reports or surveys indicating the adoption of new technologies are lacking. According to the Ministry of Environment Water and Natural Resources report on the charcoal value chain reported that 90% of charcoal production still relies on traditional kilns (MoEWN, 2013). Many of the technologies listed in Table 4-37 are still in the prototype phase and are rarely used, including the KEFRI Drum, Kinyanjui type, portable metal kiln, and ring kiln. Moreover, there is a data gap regarding the adoption and utilisation rates of these improved kiln technologies. Charcoal production results in the emission of CO2 and CH4 during the conversion of wood to charcoal.

Table 4-37. Charcoal Kiln types and their efficiencies

Technology	Brief description	Investment cost	Efficiency [%] (est.)
Traditional	Wood is stacked and covered with greenery, then soil covers the wood pile.	Very low	10–20
Improved traditional	Similar to traditional method, but includes a wire mesh over the fire and chimneys.	Low	10–25
Casamance	Similar to traditional method, but with more elaborate sorting of wood.	Low	15–30
KEFRI Drum	An oil drum with a welded stove box, a chimney and a grill for wood. Domestic production.	Medium—requires welding and metal	28–30
Kinyanjui type	Drum with combined lighting and chimney in the lid. Uses small twigs—no felling of trees.	Medium— requires welding and metal	25–30
Meko retort	Drum kiln where volatile gases are recycled to heat wood. Elaborate design and operation. Less methane emissions.	High—precision welding	30–50 (less wood needed)
Portable metal kiln	Imported, transportable metal tin with frame.	Expensive—imported as finished product	Around 30
Ring kiln	Larger round metal kiln with controllable air flow chimneys.	Very expensive (75,000)	>30
Half orange brick kiln	4–5 bags of charcoal required for small model, not easily repairable.	Low to medium	Around 50
Dome brick, square brick	Larger dome or square design for 80–120 bags, only square type is repairable.	Expensive—but cheap per sack	High

Source: Charcoal NAMA, 2016

Product use

Product use is mainly associated with refrigeration and air conditioning. HFCs are among the top global warming gases and ozone-depleting substances regulated under the Montreal Protocol, and they are widely used in cooling devices. Kenya's approach to sustainable cooling involves two main strategies: increasing energy efficiency in cooling appliances and transitioning to less environmentally harmful cooling media.

Cooling is essential across various sectors, including buildings, agriculture, transportation, and healthcare. However, traditional cooling methods often rely on high-energy consumption and the use of refrigerants that contribute to global warming. Sustainable cooling aims to provide efficient and climate-friendly cooling solutions to meet growing demand while reducing environmental harm. The adoption of energy-efficient cooling technologies, such as efficient air conditioning systems, low-power refrigeration units, and thermal insulation, helps to reduce electricity consumption and decrease greenhouse gas emissions associated with cooling. Moreover, integrating renewable energy sources into cooling systems, such as using solar power for air conditioning, solar-powered refrigeration, along with other renewable energy-driven cooling solutions, further reduces direct and in-direct emissions from unsustainable electricity sources.

Kenya is a signatory to the Kigali Amendment, which was adopted in 2016. The Kigali Amendment aims to reduce the production and consumption of HFCs, a highly potent greenhouse gas used in various applications such as refrigeration, air conditioning, and insulation production. This amendment is an extension to the Montreal Protocol on Substances that Deplete the Ozone Layer.

The Kigali Amendment was adopted on October 15, 2016, during a Meeting of the Parties to the Montreal Protocol in Kigali, Rwanda. HFCs were developed and widely used as replacements for CFCs and HCFCs, which were phased out under the original Montreal Protocol due to their harmful ozone-depleting effects.

Key points and objectives of the Kigali Amendment include:

1. Phasing down the production and consumption of HFCs globally.
2. Setting specific reduction targets for both developed and developing countries.
3. Providing financial assistance and support to developing countries to facilitate the transition to alternative technologies and products with lower global warming potential.
4. Encouraging the development and adoption of climate-friendly alternatives to HFCs.
5. Promoting technology transfer and capacity-building activities to assist developing countries in implementing the amendment.

By implementing the Kigali Amendment, countries aim to mitigate global warming and contribute to achieving the goals outlined in the Paris Agreement.

Cooling Demand in Kenya

Cooling needs in Kenya cut across all economic sectors, including residential, commercial and industrial, institutional sectors, and transportation in the form of vehicle air conditioning and cold storage in transit trucks for vaccines and agricultural products. Sustainable Energy for All

(SEforALL), identifies cooling needs in three broad categories: food, nutrition, and agriculture. It argues that the cold chain infrastructure in Kenya is largely underdeveloped, with the total market opportunity estimated at US$2.1 billion by 2030. Additionally, cold storage for vaccines in health services is equally underdeveloped, partly attributed to low electricity access in rural areas. Furthermore, residential ownership of air conditioning in residential areas is steadily rising, partly due to the growing affluent middle class and mostly to enhance comfort in response to the changing climate and increasing incidences of heat stress. SEforALL's chilling prospects study estimates that 9.6 million people are at risk of heat stress in four vulnerable regions (Coast, Eastern, North-Eastern, and Rift Valley).

The residential sector in Kenya requires cooling for space cooling and refrigeration. According to the census report, 8.8% of households own refrigerators, with higher ownership in urban areas (19.1%) compared to rural areas (2.4%) (KNBS, 2020). Sub-Saharan Africa faces substantial post-harvest losses, with 50% of fruits and vegetables, 20% of cereals, pulses, and legumes, and 40% of roots and tubers lost before reaching consumers (Njagi and Wainaina, 2018).

Agriculture plays a vital role in Kenya's economy, contributing 21% to the national GDP in 2022, with crop farming, animal production, and fish farming accounting for 27.8%, 4.1%, and 0.5% of the national GDP, respectively (KNBS, 2023). The agri-food sector's significant cooling demands are seen in horticulture, dairy, animal production, fish production, and processing, with notable quantities of exports in horticultural products, fish, and milk (KNBS, 2023).

Challenges in the sector include inadequate cold chain facilities and collection centres, prompting the government to encourage private investments in cold storage and low-cost solutions like charcoal coolers and wet walls (ASCU, 2012). Kenya's dairy production, primarily led by small-scale farmers, requires cold storage facilities, but the number of licensed cooling service providers falls short of the sector's needs. Some farmers adopt off-grid solar cooling and local solutions due to limited access to electricity (Kenya Dairy Board, n.d.).

Fish farming demands refrigeration throughout the value chain, especially in bulk storage and transportation trucks, given the highly perishable nature of the product. Dominant fish farming regions include Nyanza, Central, Western, and Rift Valley (Munguti et al., 2014). Additionally, large office buildings, hospitality sectors, data centres, and food processing companies are significant end-users of cooling technologies in Kenya. The African air conditioning market is projected to grow significantly between 2017–2023 (market research estimate).

Cooling Technologies and Suppliers/Distributors

The Energy Regulations (Appliances' Energy Performance and Labelling) aim to register, test, and rate all imported appliances in the country in accordance with levels of energy conservation. This includes details like brand, model, capacity, annual electricity demand, and star rating. In Kenya's star rating system, ratings range from 1 to 5, with 1 being the least efficient and 5 the most efficient. As of 2020, approximately 500 licenses were issued for 55 refrigerator brands in Kenya. The top 10 Kenyan refrigerator brands are Samsung, Von, Bruhm, Ramtons, Haier, Mika, Bosch, LG, Hisense, and ARMCO as illustrated in Figure 4-29. According to the EPRA star rating, 59% of refrigeration in the market holds a 1-star rating, 40% have a 2-star rating, and only 1% achieve a 3-star rating.

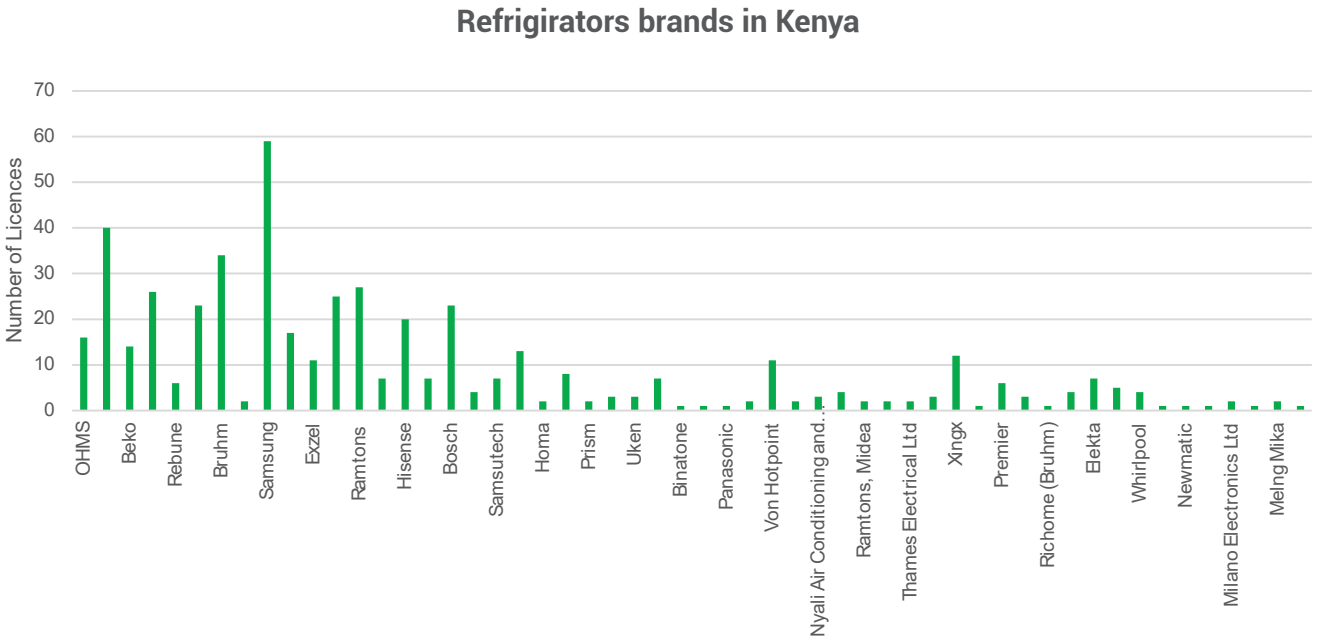


Figure 4-29. Common brands of refrigerators in Kenya

Source: derived from EPRA register.

The air conditioning market, using registered product models as indicators, shows that Westpoint is the leading supplier, followed by Daikin, then Trane and Midea. Samsung, Mika, and LG are also common brands in the Kenyan market. As mentioned earlier, air conditioning cuts across various use sectors including residential (small capacities), hospitals, other commercial buildings, and agri-food processing (mostly medium to large capacity). Figure 4-30 shows major suppliers and stockists of various air conditioner brands in Kenya.

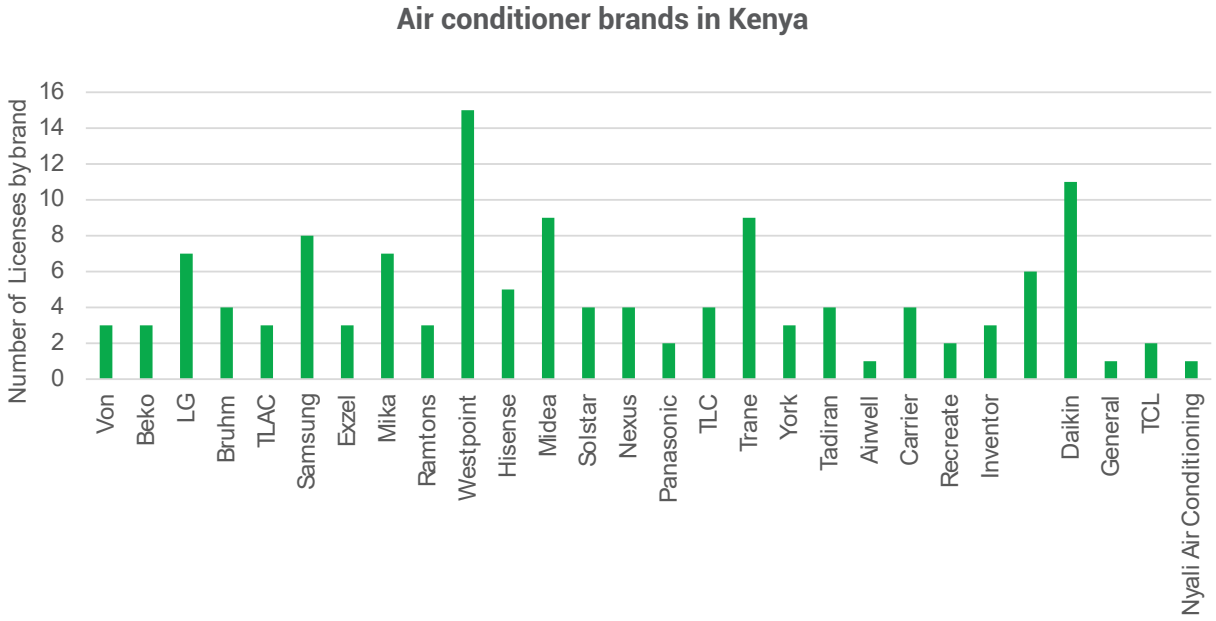


Figure 4-30. Capacity distribution of registered brands of air conditioning

Source: derived from EPRA register.

The most common refrigerant for stationary refrigeration, air conditioning, and mobile air conditioning is R-134A, as illustrated in Table 4-38, transitioning from R-22. Other dominant refrigerants include R-404A, R-407C, and R-410A. Emerging types are R-452A and R-507A.

Table 4-38. Refrigerant and air conditioning gases used in Kenyan cooling appliances in tons.

Year	HCFC-22	HCFC - 141B	HFC-32	HFC-134A	HFC-152A	HFC-404A	HFC-407C	HFC-410A	R-452A	HFC-507A
2005	549.5	30.0								
2006	701.4	31.0								
2007	820.1	30.5								
2008	991.2	30.0								
2009	995.0			5.5		2.2	0.8	0.1		
2010	901.3			4.1		1.7	9.2			
2011	884.0			28.0		15.5	0.2	2.0		
2012	770.0			20.5	1.0	8.2	3.7	3.7		0.6
2013	529.8			20.5	0.5	5.6	3.8	6.6		0.1
2014	450.9			28.8	2.4	12.9	4.1	12.3		0.0
2015	374.6			16.6	2.1	23.6	13.2	13.2		3.3
2016	274.0			16.6	2.1	20.9	9.3	15.1		3.0
2017	103.0			16.6	2.1	23.6	10.0	18.8		3.9
2018	300.0		0.1	63.4	0.8	48.0	23.4	54.9		11.3
2019	115.7		1.0	114.5	1.9	68.1	17.0	49.8		5.0
2020	117.0		1.8	88.5	4.6	68.8	24.7	49.2	0.04	14.9
2021	91.9		1.8	83.3	3.2	63.4	22.5	52.7	0.04	12.6
2022	37.4		1.8	90.7	3.5	69.3	24.5	58.0	0.04	14.2

GIZ, 2022; Greenhouse Gas Inventory for the Refrigeration & Air Conditioning report

4.4.2 IPPU Sector Data Inputs and Assumptions

Industrial process and product use mainly involve emissions occurring from industrial processes, the use of greenhouse gases in products, and the non-energy use of fossil fuel carbon.

The amount of emissions produced is directly linked to the amount of goods manufactured. Each type of product has specific emission factors. Emissions in this sector are determined by multiplying the total production of industrial products by the process emission factor associated with each product. Therefore, the main data needed for emissions calculations in the IPPU sector are the annual production levels and the stock of industrial products.

Table 4-39 illustrates the annual production of industrial minerals. In Kenya, cement production is the highest source of industrial process emissions, categorised as OPC, PPC, and PLC. The proportionate shares of production of the three types of cement are 3%, 14%, and 83% for OPC, PPC, and PLC, respectively. Similarly, the emission factors for the three categories of cement are 494 kg CO_2/tonne cement, 426 kg CO_2/tonne cement, and 395 kg CO_2/tonne cement for OPC, PPC, and PLC cement, respectively.

Table 4-39. Industrial process data for GHG emission accounting

Mineral Production (Tonnes)	2014	2015	2016	2017	2018	2019	2020	2021
Cement	**5,882,500**	**6,352,900**	**6,707,200**	**6,230,300**	**6,070,000**	**6,163,000**	**7,473,600**	**9,247,700**
OPC	*1,000,025*	*444,703*	*469,504*	*881,100*	*858,471*	*849,608*	*1,030,283*	*1,274,854*
PPC	*4,706,000*	*5,717,610*	*6,036,480*	*5,162,000*	*5,029,429*	*5,128,466*	*6,219,066*	*7,695,361*
PLC	*176,475*	*190,587*	*201,216*	*186,900*	*182,100*	*184,889*	*224,207*	*277,429*
Soda Ash	**409,845**	**319,761**	**301,719**	**303,580**	**294,856**	**282,049**	**254,579**	**283,621**
Glass		50,834	54,291	52,620	52,620	52,620		

Source: Greenhouse Gas Inventory, Economic Survey report, 2023

On the other hand, global warming consideration for HFCs is accounted for in the IPPU based on the greenhouse gas inventory data. Kenya mainly relies on the following refrigerants for mobile air conditioning: R-134A, R-32, R-125, and R-143A and R-134A for mobile air conditioning. Table 4-40 provides the data available for HFCs modelling.

Table 4-40. HFC imported in the country for cooling in stationary and mobile refrigerants in tonnes

Refrigerant	2010	2011	2012	2013	2014	2015	2016
R-134A	190.99	200.06	193.71	196.55	202.35	206.7	208.44
R-32	15.4923	20.3422	25.9355	32.3891	39.9103	48.8214	58.1228
R-125	36.9253	42.043	47.7033	53.9753	61.6297	70.2498	83.1044
R-143A	25.2824	25.584	25.6464	25.4124	25.5476	25.1784	29.3852
Mobile Air Conditioning							
R-134A	97.69	105.9	107.92	108.23	111.61	114.31	114.87

Source: Greenhouse Gas Inventory

4.4.3 IPPU Sector Mitigation Targets and Achievements

The mitigation actions proposed in the NCCAP 2018–2022 period included aimed at addressing industrial processes such as implementation of the charcoal NAMA and optimised cement production to reduce GHG emissions from clinker production. Additionally, actions were proposed to address energy usage in the industrial sector and the waste generated from it, including improving industrial efficiency through energy audits and energy standards, as well as waste recycling and re-use, facilitated by the use of sustainable energy resources for industrial heating. Furthermore, an action focusing on industrial symbiosis aimed to set up waste exchange clearance centres in all special economic zones by 2022.

While these actions primarily relate to industrial processes, the majority emphasise energy and waste management. As a result, the description and reporting of GHG emissions for waste recycling are reported within the waste sector, while energy efficiency-related emissions are reported within the energy sector. The priority actions and their implementation status are summarised in Table 4-41.

Table 4-41. Priority actions and implementation status under IPPU

Description of smart target	Implementation status
Priority action 1: Industrial process emissions abatement	
Implement NAMA for charcoal production in Kenya. The sector also emphasised optimising manufacturing and production efficiency by promoting the adoption of a sustainable charcoal system. This involved encouraging the uptake of efficient kiln technologies to enhance yields to an impressive range of 30% - 42%. Furthermore, a charcoal certification and labeling scheme was proposed to ensure the implementation of sustainable practices in the production process.	No new data on adoption of improved charcoal kilns; however, reduction in charcoal consumption directly impacts production.
Optimise cement production to reduce GHG emissions from clinker.	
Undertake a baseline survey of all Special Economic Zones (SEZs) and Industrial Parks (IPs) by 2022; Increase the number of entities adopting environmentally sound technologies by 50% by 2022.	Study by KIRDI, JKUAT, and other partners identifying potential for circular economy.
Promote sustainable energy sources for industrial heating processes (Under energy sector).	- *(Emissions estimation in the energy sector).* - Safaricom rolled out 1,405 solar PVs and lithium batteries all in Base transceiver stations. 261 generators switched off. - There are over 94 private sector (manufacturing and commercial) adopting captive electricity generation. By 2022, the total capacity of 53.7 MW solar, 29 MW hydro, and 97.4 MW Cogen, 3.7 MW geothermal.
Priority area 3: Industrial symbiosis	
Set up waste exchange clearance centres in all SEZs and County Aggregated Industrial Parks (CAIPs) by 2022; • Undertake a baseline survey of all SEZs and IPs by 2022. • Set up a Waste and By-product Exchange database for match making.	(*Emission abatement considered in the waste sector*).
Set up common waste management facilities for all SEZ and CAIPs (effluent Treatment Plants) by 2022.	
Set up a waste and by-product exchange database for match-making;	
Number of trainings have been facilitated by KAM, and about 100 of such trainings have been done.	

Environmental Impacts of the Priority Mitigation Actions Relevant to IPPU

The implementation of the charcoal NAMA, as outlined in the MTAR 2018–2022, is expected to result in a total reduction of 5 MtCO2eq upon achieving sustainable biomass supply, efficient charcoal production, and charcoal certification. However, to prevent double counting, the plan estimates an abatement of 1 MtCO2eq from improved charcoal production technology efficiency. While mitigation from cement manufacturing was not prioritised due to the unlikely scenario of coal use avoidance in the production process, it was noted that replacing clinker with pozzolana slag could lead to some abatement. Other mitigation opportunities, such as industrial energy efficiency and industrial symbiosis, were considered in NCCAP II under industrial processes and product use. They were estimated to potentially yield 1.1 MtCO2eq and 0.79 MtCO2eq in 2030, respectively. However, these opportunities are not considered as mitigation opportunities under the IPPU. Hence, according to the MTAR 2018–2022, only about 1.08 MtCO2 would be abated from charcoal production.

However, during the planning period from 2018–2022, cement production showed a significant increase, rising by about 52 percentage points between 2018 and 2022, as illustrated in Figure 4-31a. This surge in cement consumption consequently led to an increase in process emissions, as illustrated in Figure 4-31b, from 2.55 MtCO2eq in 2018 to about 4 MtCO2eq in 2022.

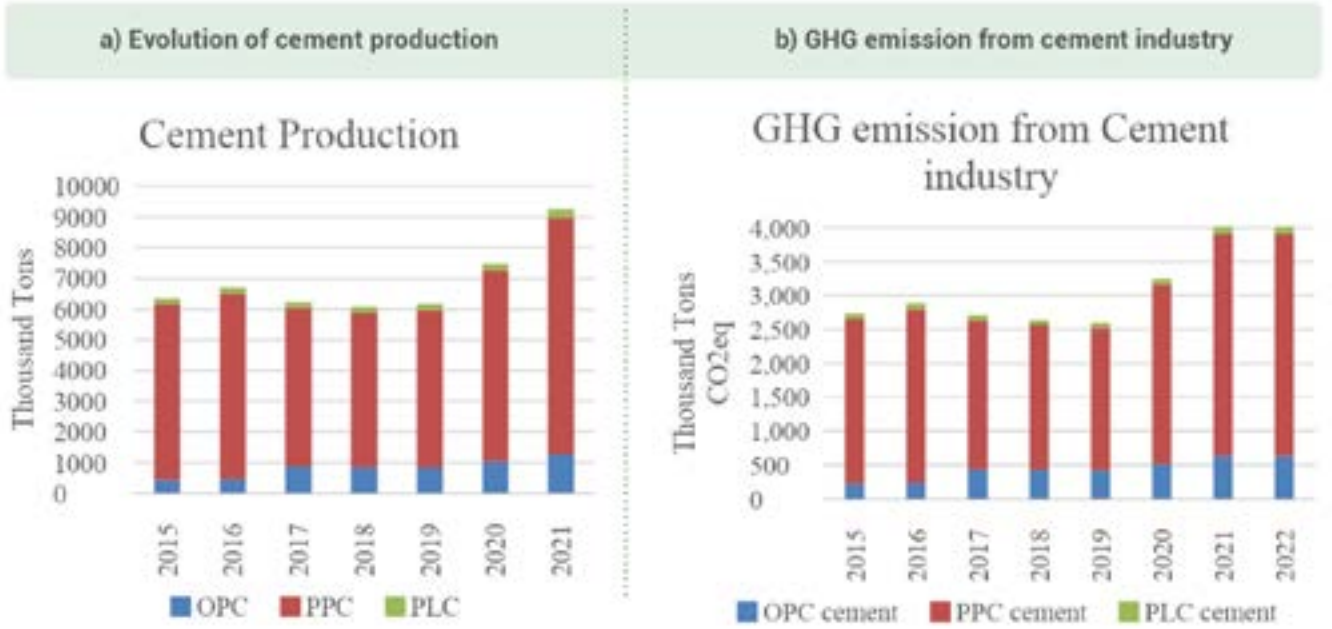


Figure 4-31. GHG emissions from the cement industry

Conversely, a reduction trend in charcoal production emissions can be observed as illustrated in Figure 4-32**.** While there is no specific data available on adoption of improved kilns, the reduction is attributed to indirect benefits resulting from decreased demand for charcoal as households transition from charcoal dependency to modern technologies. By 2022, charcoal use had decreased by 122,000 tonnes/year. This reduction in charcoal use has led to a decrease in biogenic emissions of 0.24 $MtCO_2eq$ from charcoal production compared to the baseline scenario, as illustrated in Figure 4-32.

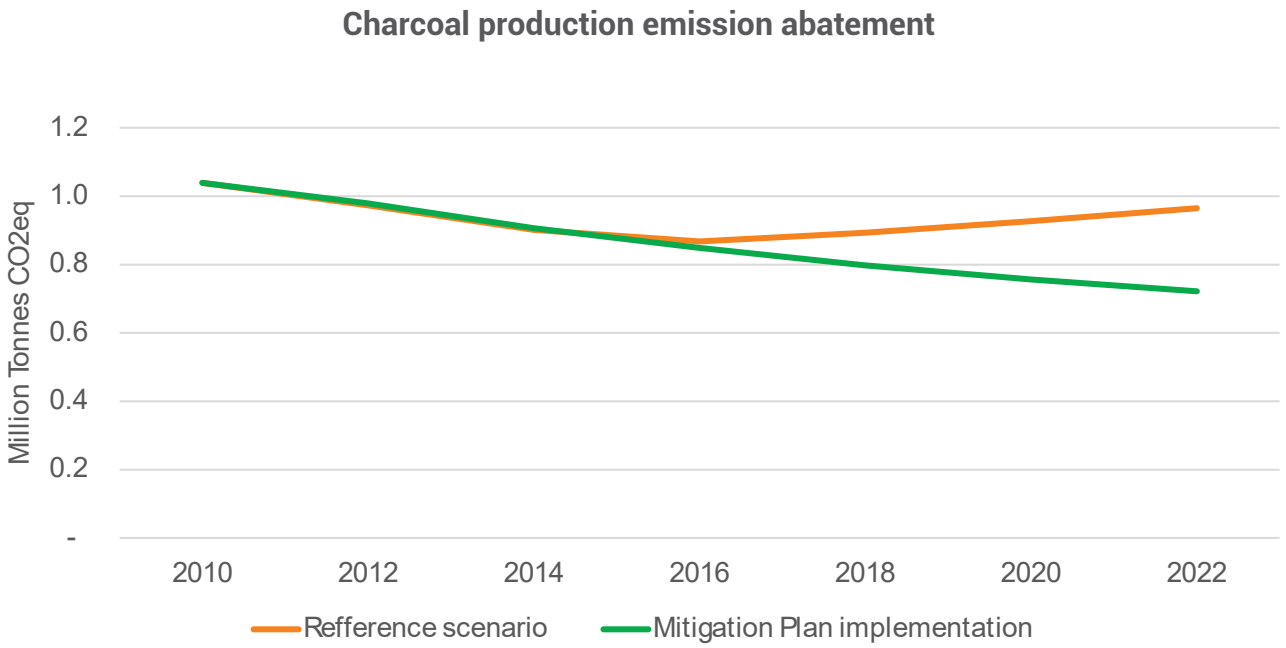


Figure 4-32. Emission avoidance resulting from charcoal production

Source: Author's Own based on LEAP model

Overall emissions from IPPU in the planning period amounted to 5.15 MtCO2eq, as summarised in Figure 4-33. Charcoal production accounted for 0.98 MtCO2eq, while cement production accounted for 4.02 MtCO2eq. In comparison to the projected baseline emissions, IPPU emissions were projected to increase to 4.4 MtCO2eq in 2022 (Government of Kenya, 2018), while the allowed emissions towards the achievement of NDC were 4.0 MtCO2eq based on linear projection, demonstrating that the country is facing a deficit of 0.8 MtCO2eq to achieve the target towards NDC achievement, as illustrated in Table 4-42.

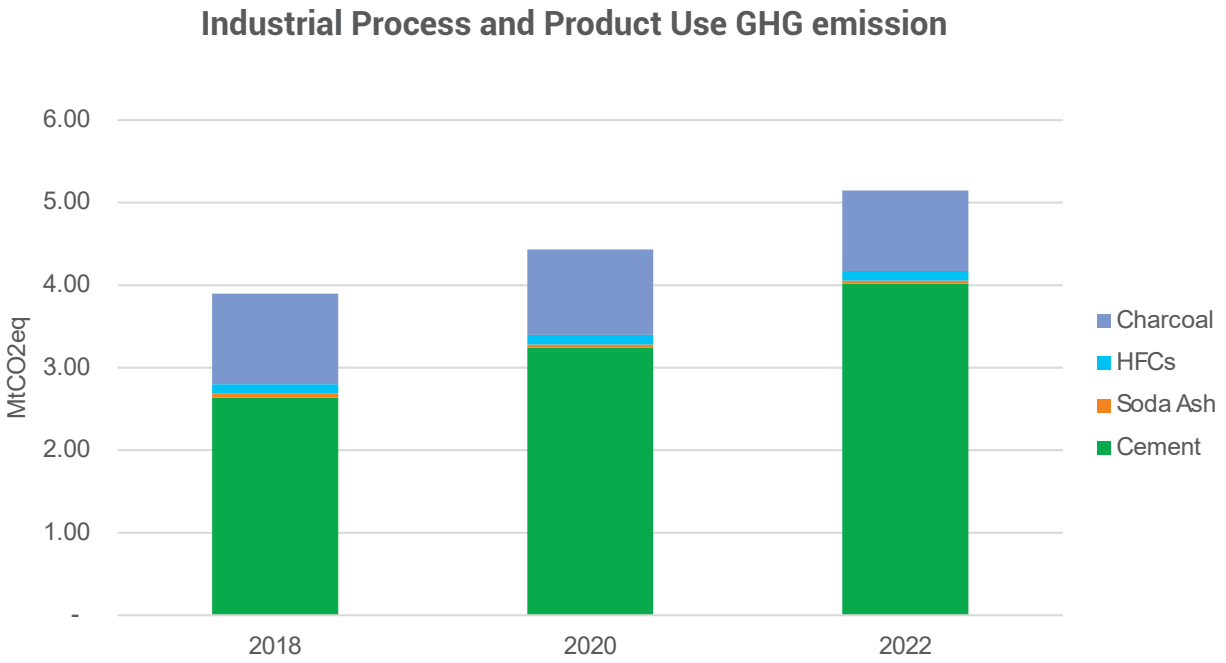


Figure 4-33. Industrial Process and Product Use GHG emission between 2018–2022

Source: Author's own based on LEAP modelling

Table 4-42. GHG emission status for IPPU

	2010	2015	2020	2022
Baseline scenario emission (MtCO2eq) (GWP21)	2.0	3.0	4.0	4.4
Allowed GHG emissions considering NDC target (MtCO2eq) (GWP21)	2.0	2.9	3.7	4.0
Actual GHG emission (MtCO2eq) (GWP28)	3.2	4.1	4.5	5.2
Gap or deviation from allowed GHG emission to NDC target			-0.5	-0.8
Comment (due to GWP+HFC +Charcoal data)			Deficit	Deficit

4.4.4 Challenges Faced and Lessons Learnt in the Implementation of NCCAP II

During stakeholders consultations, several challenges emerged that hindered the effective implementation of NCCAP II. Some of these challenges include; -

1. Lack of clarity on industrial process emissions: Stakeholders expressed uncertainty regarding what industrial process emission means. Many of the priority actions outlined in NCCAP II were primarily focused on energy or waste-related initiatives. For instance, the implementation of circular economy strategies aimed at reducing waste disposal while simultaneously improving energy efficiency and adopting alternative energy sources.
2. Inadequate coordination among all stakeholders.
3. Challenges in private sector adoption of climate-oriented investments: The private sector faced several key challenges, including low technical capacity of the intersection of climate and business, low ability to identify emissions points in value chains, restricted access to climate finance, uncertainty regarding the legal and regulatory environment, and a lack of involvement in multilateral processes and negotiations related to climate change.
4. Unavailability of sufficient data, especially regarding the use of HFCs for refrigeration. While EPRA tracks and licenses technology suppliers, there is inadequate information on the stock of refrigeration equipment, their capacity, and the type of refrigerants.

Lessons learnt

Industrial processes represent one of the challenging sectors to decarbonise. One of the key takeaways is the need for adequate capacity building among stakeholders, along with the policy and economic incentives to facilitate a smoother transition towards low-carbon practices within the industrial sector.

4.5 Waste

4.5.1 Overview of the Waste Sector

Waste generation and management in Kenya face several challenges due to population growth, urbanisation, inadequate infrastructure, and limited resources. Moreover, data on waste generation, collection, and management are not readily available for decision support. Here's an overview of waste generation and management in Kenya:

Kenya generates a significant amount of waste, including municipal solid waste (MSW), industrial waste, agricultural waste, and healthcare waste. Rapid urbanisation and population growth contribute to increased waste generation. MSW, comprising household, commercial, and institutional waste, is the most common type. As of 2022, the urban population had increased to a 43% share of the national population, increasing by10 percentage points since 2010 (KNBS, 2020). It is estimated that municipal solid waste generation is 0.5kg per capita per day, and in most urban areas, the rate of growth of waste generation is much faster than the rate of urbanisation. Moreover, the rate of urbanisation is evolving, partly due to rural-urban influx and devolution.

Waste collection services in Kenya vary across different regions. In urban areas, municipal authorities or private companies typically provide waste collection services. However, coverage is often limited, particularly in informal settlements and rural areas. In these areas, waste is often informally collected by scavengers or waste pickers. Most of the waste management efforts are targeted towards urban dwellers, arguably because, according to technical group discussions and the second bi-annual communication, 69% of the waste generated in Kenyan households is primarily organic waste. This organic waste is either reused as animal feed or organic manure in rural areas. Additionally, a significant portion of the inorganic waste, such as plastic bottles and glass, is repurposed for other uses (City Council of Nairobi, 2010; JICA, 2014).

The majority of waste in Kenya is disposed of in open dumpsites or uncontrolled landfills. These disposal methods pose environmental and health risks, as they can contaminate soil, groundwater, and air. Additionally, open burning of waste is prevalent, releasing harmful pollutants into the atmosphere.

Recycling rates in Kenya are relatively low, but efforts are being made to promote recycling and resource recovery. Informal waste pickers play a significant role in collecting and recycling recyclable materials, such as plastics, glass, and metals. Both the county government and the private sector are working to establish formal recycling facilities and promote waste segregation at its source.

Waste-to-energy initiatives are gaining attention in Kenya as a means of reducing waste volumes and generating renewable energy. Several waste-to-energy projects are being implemented to convert organic waste into biogas or produce electricity through anaerobic digestion or incineration with energy recovery.

The Kenyan government has enacted policies and regulations to address waste management challenges. The sustainable Waste Management Act of 2022 appoints the National Environmental Management Authority (NEMA) as responsible for regulating and overseeing waste management activities. Key regulatory frameworks include the Waste Management Regulations, Plastic Bags Regulations, and E-Waste Regulations. The Constitutional provision of the right to a clean and healthy environment underscores the importance of effective waste management.

County governments are tasked with refuse removal, refuse dumps, and solid waste disposal, making the implementation of legal frameworks and robust policy measures crucial. As of June 2023, 31 Counties have enacted Acts, Policies, and Regulations specifically addressing solid waste management, demonstrating a commitment to promoting sustainable waste management and circular economy practices for green growth. Notably, Counties are working to formalise waste collection, support waste recycling initiatives, and establish material recovery sites.

Public awareness and education campaigns are crucial for promoting proper waste management practices. The government, NGOs, and other stakeholders engage in initiatives to raise awareness about waste segregation, recycling, and the importance of responsible waste disposal. Educational programmes are conducted in schools and communities to promote waste reduction and recycling.

Waste management in Kenya faces challenges such as inadequate infrastructure, limited funding, and lack of proper waste management facilities. However, the Kenyan government has developed the National Solid Waste Management Strategy to address these challenges and improve waste management practices. The strategy prioritises waste reduction, resource recovery, and the development of sustainable waste management infrastructure.

Efforts are also being made to attract private investments and partnerships to boost waste management infrastructure and promote circular economy approaches. Furthermore, initiatives such as the ban on single-use plastic bags and the introduction of recycling programmes for e-waste demonstrate Kenya's commitment to improving waste management and reducing environmental impacts. Lastly, the government aims to implement extended producer responsibility, facilitating take-back schemes, recycling, and waste reduction.

4.5.2 Waste Sector Data Inputs and Assumptions.

Input data in the LEAP tool were based on domestic waste generation, collection, and disposal. GHG emission calculation follows the IPCC guideline, and GHG estimation is calculated as follows:

$$Emission(tCO_2eq) = \left(W_{gen}\left(\frac{ton}{year}\right) * pddis * MCF * DOCfrac * DOCdis * CH_{4\,frac} * 1.3\right) - \left(CH_{4rec}\left(\frac{ton}{year}\right) * (100 - CH_{4frac})\right)$$

Wgen	=	Total waste generated in tonnes/year
pddis	=	Fraction of the total generated waste which is collected
MCF	=	Methane correction factor
DOCfrac	=	Proportion of degradable organic compounds in waste collected
DOCdis	=	Proportion of the degradable compounds dissimilated
CH4 frac	=	Fraction of methane in the landfill gas
CH4rec	=	Proportion of methane recovered
1.3	=	Conversion of Carbon to CH_4
CH4frac	=	Oxidised fraction of the methane

The primary driver of waste is generally the distribution of the population between urban and rural areas. Municipal solid waste, commonly associated with urban populations, is the largest contributor to GHG emissions in the waste sector. Figure 4-34 shows that by 2028, there will be more people residing in urban areas than in rural areas.

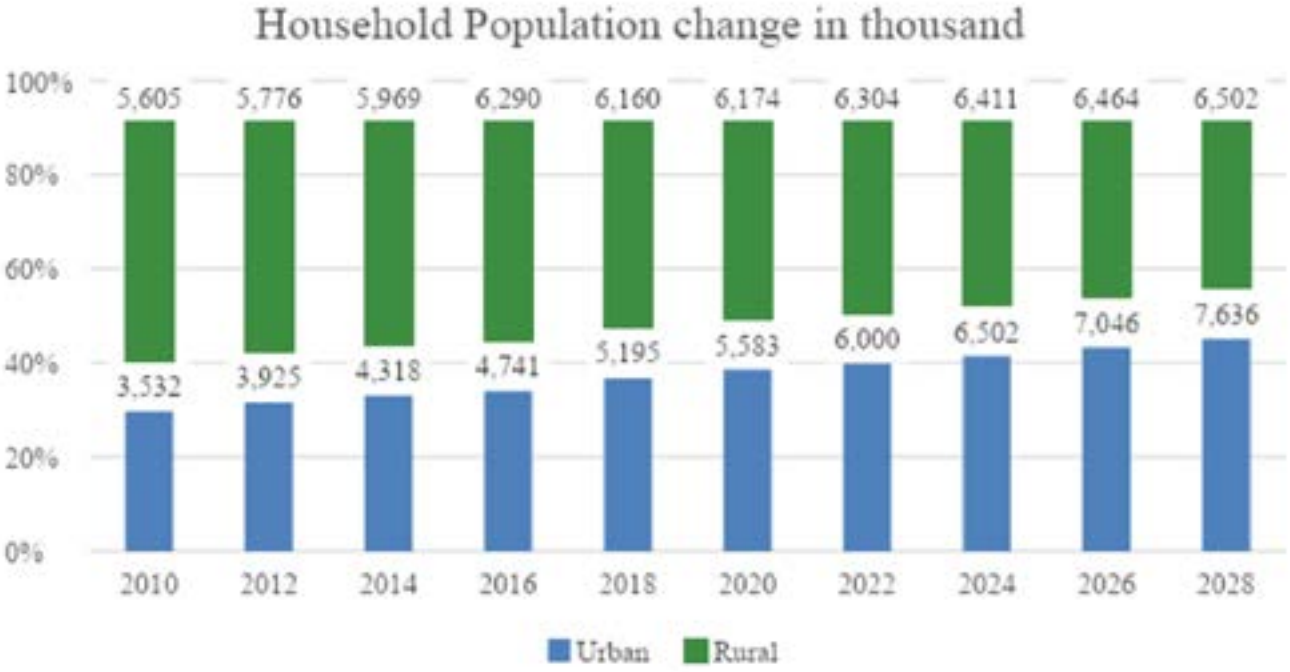


Figure 4-34. Changing population between urban and rural areas

Source: Author's own based on LEAP modelling

Table 4-43 illustrates waste generated from urban populations that are collected and disposed of at disposal sites. The data is based on the 2019 census data on urban population by county, the proportion of urban population of selected county against total population, and the percentage of solid waste collected as per the estimation of various municipalities. Total solid waste generated is computated by multiplying the estimated waste generation per capita by the total urban population. Only a proportion of the waste generated is collected, with an average of 48% for the whole country.

Table 4-43. Solid waste generation and collection status in Kenya's urban areas

County	Urban Pop. in Million (2019)	% Total Urban	% SW Collected	Total SW Generated Tonne	Total SW to Disposal Sites Gg	% of SW Disposal by Urban Area	Per Capita Waste (tonne/ca/pa)
Nairobi	4.40	29.6%	0.70	1.28	0.9	45.1%	0.29
Mombasa	1.21	8.2%	0.65	0.35	0.2	11.5%	0.29
Kiambu	1.71	11.5%	0.60	0.49	0.3	15.0%	0.29
Nakuru	1.05	7.1%	0.45	0.30	0.1	6.9%	0.29
Uasin Gishu	0.50	3.4%	0.55	0.15	0.1	4.0%	0.29
Kisumu	0.44	3.0%	0.20	0.13	0.0	1.3%	0.29
Other Urban	5.53	37.3%	0.20	1.60	0.3	16.2%	0.29
Total	**14.83**	**100.0%**	**0.48**	**4.30**	**2.0**	**100.0%**	

Source: KNBS; https://www.knbs.or.ke/download/urban-population-households-density-by-county/

LEAP data input for estimating GHG emission for municipal solid waste and residential liquid waste is summarised in Table 4-44, Table 4-45, and Table 4-46. The parameterisation considered assumptions made in the GHG inventory and NDC update reports. Other assumptions were derived from national surveys and county-level reports, such as those from Nairobi.

Table 4-44. General assumptions for municipal solid waste modelling

	Data input	Key assumptions
Population whose waste is collected	Demographic data * 0.48	An average fraction of 0.48 of waste is collected on a daily basis. Only urban population waste is collected considering the proportion of waste collected in all urban areas.
Per capita waste generation	0.290 tonnes/year	Updated NDC assumption
Fraction of Municipal solid waste disposed	0.69	Assumption based on updated NDC
Methane correction factor	0.6	IPCC default value
Fraction of organic material that degrades	77%	NDC and GHG inventory assumptions
Degradable organic carbon (Dissolved Organic Carbon [DOC] Fraction)		
Fraction of DOC dissimilated	50%	IPCC default
Fraction of CH4 in landfill	60%	Typical methane composition in biogas
CH4 recovered	0%	IPCC default
CH4 oxidised	0%	IPCC default

Table 4-45. Solid waste characterisation

Waste type	Percent composition
Food waste	62.4
Papers	14.0
Plastic	10.9
Glass	1.5
Others	11.2
Total	100

Source: NDC Update Report Assumptions

Table 4-46 presents domestic wastewater model input, as adopted from the Demographic and Health Survey Report.

Table 4-46. Domestic water emission classification

Model Inputs	Percent Population in 2014		Percent Population in 2019			
Treatment Type	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	
Latrine	46.2	66.3	59.3	51.3	85.7	
Septic Tank	30.4	15.1	20.3	21.4	1.8	
Anaerobic Reactor/Deep Lagoon	0.6	0.4	0.5	24.6	0.3	
Aerobic Treatment Plant	18.1	0.2	6.3	0.7	0.1	
Untreated Discharge (Open Defecation)	4.5	18	13.4	2	12.1	
	100	**100**	**100**	**100**	**100**	

Source: Demographic and Health survey 2014; Census report 2019

Table 4-47 details the data requirements and availability for industrial wastewater emission. Tier 1 methodology was used for industrial wastewater treatment, both for onsite and centralised treatment facilities. Due to the lack of actual data on wastewater generation in major agro-based industries, estimation was conducted using a production approach, which involved estimating wastewater production per tonne of finished product. Industrial wastewater was estimated by multiplying the production in tonnes by the water use intensity per tonne of production. This estimation was based on Chapter 5 of the IPCC guidelines, which provide waste generation estimates per tonne of production. In this case, the estimation was applied to four industries considered to be highly polluting, as illustrated in the following table.

Table 4-47. GHG emission estimation parametres for industrial wastewater from four main agri-food and pulp industries

Total Industrial Output	Unit	2015	2016	2017	2018	2019	2020	2021	2022
Beer	tonne/yr	474,000	391,000	507,000	549,000	569,000	576,000	583,000	571,000
Meatpacking	tonne/yr	568,000	612,000	724,000	675,000	733,000	649,000	565,000	603,000
Dairy products	tonne/yr	615,900	650,300	535,700	469,400	492,800	457,900	510,600	466,000

The total amount of organically degradable material in industrial wastewater is determined by multiplying the C***hemical Oxygen Demand*** (COD) for wastewater type *I* (kg COD/m^3 of wastewater) by the quantity of ***wastewater generated (m^3/year***). Table 4-48 outlines the essential IPCC parameters necessary for analysing industrial wastewater emissions.

Table 4-48. IPCC default parameters for Tier 1 emission estimation from wastewater

	Water Generation (m3/Mg) as per IPCC Guideline	Water Generation (m3/Mg) Adopted for Kenya Modelling	Kg COD/m^3 Wastewater
Beer and Malt	6.3	6.3	2.9
Meat and Poultry	13	13	4.1
Dairy Products	7	7	2.7
Pulp	162	58	9

4.5.3 Waste Sector Mitigation Targets and Achievements

The waste sector is estimated to have a potential GHG abatement of 0.1 MtCO2eq annually by 2030. This goal is outlined in strategic objective 5 of NCCAP 2018–2022, which aims to, among other things, improve solid waste management in urban areas. Key actions include promoting waste recycling and managing sanitary landfills. The NDC emission target for the waste sector was estimated at 0.39 MtCO2eq (NCCAP, 2018–2022). Priority actions outlined in NCCAP, 2018–2022 are summarised in Table 4-49.

Table 4-49. Summary of mitigation actions and implementation status in the waste sector

Smart climate action targets	Implementation status
Priority action 1. Promote recycling to divert waste from disposal sites	
Implement circular economy solid waste management approach in Nairobi to divert at least 90% of collected waste away from disposal sites toward various recycling practices.	• Kenya Private Sector Alliance's (KEPSA) Partnership for New Plastics Economy implemented waste segregation at the source for recycling in Nyayo Estate and the wider Alliance for Nairobi Metro Residents Association between 2020 and 2023. They recycled a total of 3,220 tonnes of plastics at source and processed 852 tonnes, along with about 268,000 tonnes of organic waste and 700 kgs of electronic waste.
Implement the Solid Waste NAMA to achieve 30% waste recovery (recycling, landfill, and composting) and 70% controlled dumping (tipping, compacting, and recovery) in at least one urban area in each of the selected 20 Counties by 2022.	• Establishment of Material Recovery Facility (MRF) in Kiambu County, which collected 86,600 tonnes of waste and recycled 2,310 tonnes. • Installation of 60 collection receptacles for waste segregation at source in Nyayo Estate and Nairobi County. • Safaricom's waste management programme diverted 786,893 kgs of solid waste from the dumpsite, with 913 tonnes of e-waste collected and recycled. • Sustainable Empty Pesticide Container Management collected 43.1 tonnes of empty pesticide plastic packaging from 340 collection centres operating in 8 counties, safely disposing of them through incineration in 2021 and 2022. • Awareness creation for proper disposal of hazardous empty pesticide plastic packaging and its relationship to climate change to more than 20,000 farmers.

Smart climate action targets	Implementation status
	• Successfully installation of medical waste non-burn technology in 10 beneficiary counties (hospitals), reducing air and environmental pollution as well as carcinogenic and health metals.
Priority action 2. Waste to energy	
Explore options for methane capture and power generation at landfill sites.	Installation of 920 biogas units in institutions and households by Flexi Biogas, with 80% in operation.
Establish waste-to-energy infrastructure in Nairobi, Mombasa, Kisumu, Nakuru, and other counties.	- Co- processing of waste by cement kilns, handling up to 20,000 tonnes per year.
Facilitate 800 MW of co-generation capacity from bagasse and agro-residues by 2022 and 1,200 MW by 2030.	

GHG emissions from waste have fluctuated due to changes in datasets and new knowledge. The updated NDC and second bi-annual report reported a significant contribution of industrial wastewater to the results, with solid waste contributing only 35% of the total GHG emissions. Differences and errors in the data were identified in the updated NDC, such as the quantity of milk production recorded as 5,090,000 tonnes in 2019, instead of 492,800 tonnes as reported in the Kenya Economic Survey report, 2022. Additionally, emissions from pulp processing were omitted from the emission estimation due to lack of sufficient data. Experts provided disclaimers regarding the lack industrial production data for pulp from 2015 to 2019, estimating the data based on 2010 as the base year with an annual growth rate of 4%. Since the major pulp industry in Kenya is no longer operational, this emission source was not modelled in the NCCAP. Municipal solid waste emerged as the highest source of waste sector emissions, accounting for 89% of the total GHG emissions. Industrial wastewater accounted for 6% of the total GHG emissions from the waste sector, while methane from domestic water and solid waste incineration contributed 3% and 2%, respectively, as illustrated in Figure 4-35.

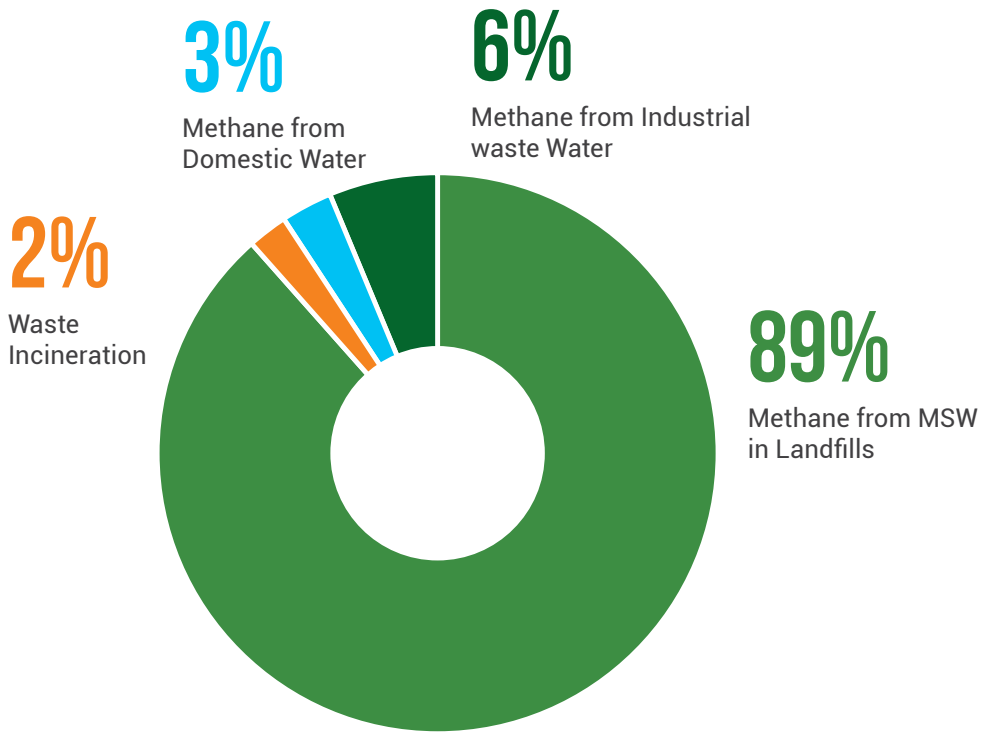


Figure 4-35. GHG emission from different waste streams

Box 3 Data Differences in Waste Sector

GHG emissions from waste have shown fluctuation due to changes in datasets and the transition in the GWP of methane from AR3 to AR5. The updated NDC report emphasised the significant contribution of industrial wastewater to the overall emissions, with solid waste accounting for only 35% of the total GHG emissions. Among the data differences and errors pointed out in the updated NDC, the quantity of milk production stood out, recorded as 5,090,000 tonnes in 2019, instead of the reported 492,800 tonnes in the Kenya Economic Survey report for 2022. In this NCCAP, emissions estimation omitted emissions from pulp processing due to insufficient data. Notably, experts provided disclaimers stating, "*Due to the unavailability of industrial production data for pulp from 2015 to 2019, the data has been estimated based on 2010 as the base year and an annual growth rate of 4%*". Given that Kenya's major pulp industry is no longer operational, this emission source was consequently not modelled in the NCCAP 2023–2027.

Impacts of Priority Mitigation Actions on GHG emissions

Table 4-50 presents the achievement of emission reductions achievement in the waste generation sector. The table shows positive progress toward reducing emissions in this sector, partly due to progress in waste segregation, collection, and recycling efforts. Additionally, differences in modelled parameters have contributed to the variations in emission levels.

Table 4-50. Status of GHG emission in the waste sector

	2010	2015	2020	2022
Baseline scenario emission (MtCO2eq) (GWP21)	2	2	3	3
Allowed GHG emissions considering NDC target (MtCO2eq) (GWP21)	2.0	2.0	2.8	2.8
Actual GHG emission (MtCO2eq) (GWP28)	2.0	2.1	2.5	2.7
Gap or deviation from allowed GHG emissions to NDC target	0.0	-0.1	0.3	0.1
Comment			Exceeded	Exceeded

4.5.4 Challenges Faced and Lessons Learnt in the Implementation Period

Key challenges identified included:



1. The absence of technology to treat used diapers and masks, contributing to our residual waste.
2. Limited awareness of segregation at the source and gaps in waste management, particularly regarding plastic carbon footprints.
3. Some farmers' resistance to using alternatives has led to limited coverage of sustainable empty pesticide container management in only a few counties.
4. Inadequate funding - Both funds and human resources for implementing climate change and health actions.
5. Lack of specific training on climate change and health for healthcare workers.
6. Lack of sector-specific climate change and health strategies and plans.
7. Priority areas intersecting between adaptation and mitigation efforts.

Lessons learnt

- Training on climate change and health is essential for effectively implementing policies, programmes, and actions.
- Identifying sector-specific priority areas is key for facilitating easy implementation.

4.6 Forestry

4.6.1 Overview of the Forestry Sector

The forestry sector has consistently been the largest emitter of GHG emissions (GoK, 2013), accounting for 30% of the total national emissions in 2010 (Ministry of Environment and Forestry, 2020). These emissions primarily originate from deforestation, where forests are cleared for fuelwood and charcoal production or to create agricultural land.

The Kenyan government has been actively working to increase the country's forest cover, with initiatives like the "Greening Kenya Campaign" aiming to plant millions of trees each year to combat deforestation and degradation. Initially targeting a 10% forest cover as part of the country's environmental conservation vision outlined in the Kenyan constitution (GoK, 2010), the Forest Service and other agencies have since revised this goal to achieve a 30% forest cover by 2032 (KIPPRA, 2023; Ministry of Environment and Forestry, 2021). According to the FRL report, the forest cover between 2015–2018 was measured to be 5.9% (MoEF, 2019). Indeed, it is considered the most accurate data and serves as the baseline for Kenya's forest sector development. Reforestation initiatives such as the National Forest Programme (NFP) aim to enhance forest and tree cover and reverse deforestation and forest degradation. Moreover, Kenya is a signatory to regional forest conservation agreements, including the development of forest policies and strategies within the EAC, the East African treaty on biodiversity, the EAC forest conservation and management bill 2015, and the development of a forest policy and strategy for the Intergovernmental Authority on Development (IGAD) region, and supports initiatives such as the IGAD climate centre, among others.

Despite efforts, the country has faced a persistent decline in forest cover. Figure 4-36 illustrates a time series of how Kenya forest cover has declined since 1990. Consequently, the country has taken bold and ambitious steps toward forest cover restoration. The new target is to achieve 30% forest cover, as elaborated in the REDD+ strategy, aiming to restore 10 million hectares of land and plant 15 billion trees by 2032 (*Enhancing Policy and Legislative Framework for Augmenting Forest Cover in Kenya–KIPPRA*, 2023).

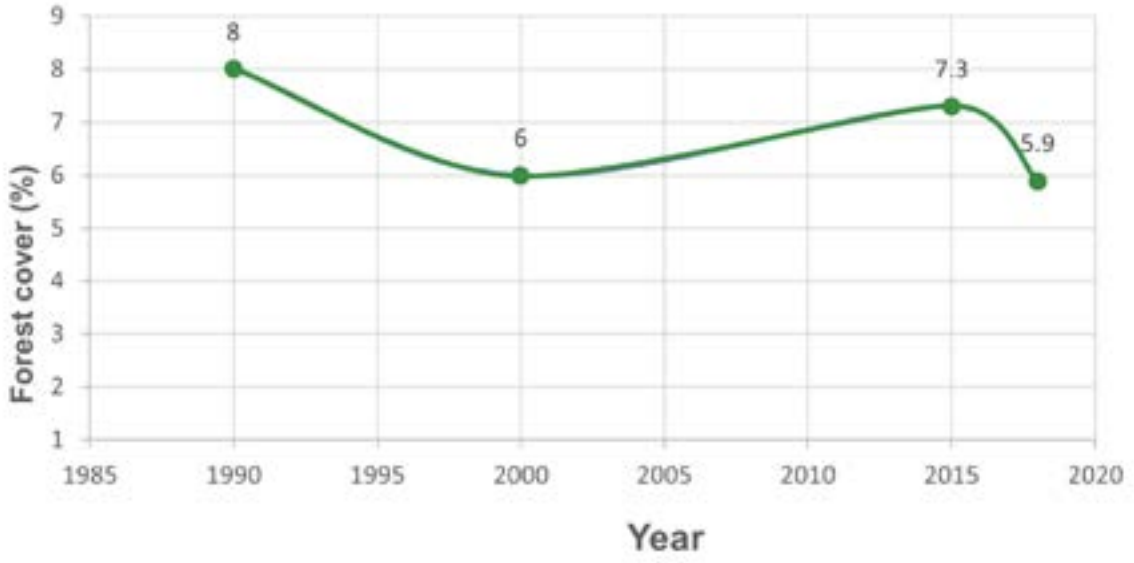


Figure 4-36. Kenya Forest Cover Trend for the period between 1990–2018

Source: KIPPRA, 2023

Kenya has been prioritising sustainable forest management practices to ensure the long-term health and productivity of its forests. This involves promoting responsible logging practices, as well as initiatives like reforestation, afforestation, and conservation efforts aimed at preserving biodiversity. Community-based forestry projects have been introduced to involve local communities in forest management and conservation, empowering them to participate in decision-making and benefit from sustainable use of forest resources. Kenya is home to diverse flora and fauna, some of which are unique to the country. Conservation efforts are aimed at protecting endangered species and ecosystems within forests while promoting biodiversity conservation. Moreover, the forestry sector significantly contributes to the economy through activities such as timber production, wood processing, and the manufacturing of various forest-based products. Emphasis is placed on sustainable harvesting practices and value addition to maximise economic benefits derived from forest resources.

The FRL analysis conducted between 2014–2018 reported a balance between forest land conservation and degradation. During this period, 1,086,615 hectares, 320,549 hectares, and 744,965 hectares of land were maintained as forest land in the montane/western, coastal and mangrove, and dryland forest categories respectively, across dense, moderate, and open classifications as illustrated in Table 4-51 (MoEF, 2019). However, about 1.25 million hectares of land were converted into forested areas. Specifically, 22% of land conversion was attributed to montane/western rain forests, 14% to coastal and mangrove forests, and 64% to dryland forests. Conversely, about 1.35 million hectares of forest land was converted into other land uses during the same period. Forest land conversion into cropland accounted for 11%, grassland for 88%, and wetland, settlement, and other land uses each accounting for 0.7%.

Table 4-51. Land conversion matrix in the period of 2014 - 2018

			2018												
			Montane Forest / Western Rain			Coastal Forest and Mangroves			Dryland Forest			Plantation	Cropland	Grassland	Wetland	Settlement and Other land
			Dense	Moderate	Open	Dense	Moderate	Open	Dense	Moderate	Open					
2014	Montane Forest / Western Rain Forest / Bamboo	Dense	854,362	49,209	19,714								88,835	91,840	416	821
		Moderate	80,248	83,235	12,899								11,406	53,825	78	33
		Open	9,843	10,524	16,260								6,435	51,566	10	25
	Coastal Forest and Mangroves	Dense				184,787	87,918	1,368					6,422	160,174	1,632	825
		Moderate				22,003	40,366	7,048					3,565	50,419	458	283
		Open				1,116	988	452					110	2,797	9	12
	Dryland Forest	Dense							334,982	97,928	42,170		24,559	455,918	3,874	2,307
		Moderate							37,877	60,223	33,164		4,769	127,932	1,229	1,018
		Open							21,221	20,812	66,904		4,012	185,783	1,445	4,274
	Plantation											56,315	17,880	7,263	26	23
	Cropland		78,641	8,156	6,568	1,689	2,567	438	21,204	9,163	10,163	3,684				
	Grassland		85,367	48,881	16,956	78,856	82,565	13,417	377,850	207,599	158,441	4,834				
	Wetland		287	176	12	343	316	34	1,648	1,053	1,877	14				
	Settlement and Other land		866	107	1,702	396	470	13	1,467	2,424	3,279	6				

Status of Emission from Land Conversion by Different Land Types

The analysis of historic emissions due to land conversion between 1990–2018 is illustrated in Figure 4-37 over five-year political regime periods. Examination of emissions from different types of land conversion, as illustrated in Figure 4-37a, indicates that the country has largely maintained emissions from land remaining forest land relatively constant. This is an indication that there is a balance between land conversion to other types and conversions from other types to forest land. Notably, Figure 4-37b indicates a decrease in emissions from forest land converted to grassland, while Figure 4-37c shows an upward trend in emissions resulting from forest land conversion to cropland, signalling continued agricultural use of forest land. Figure 4-38 further presents GHG emissions and sinks from various land conversion types, with GHG emission sinks reducing from 94 million tonnes of CO_2eq in 1990 to 77 million tonnes of CO_2eq in 2018.



Figure 4-37. Percent change in emission resulting from different land conversion types

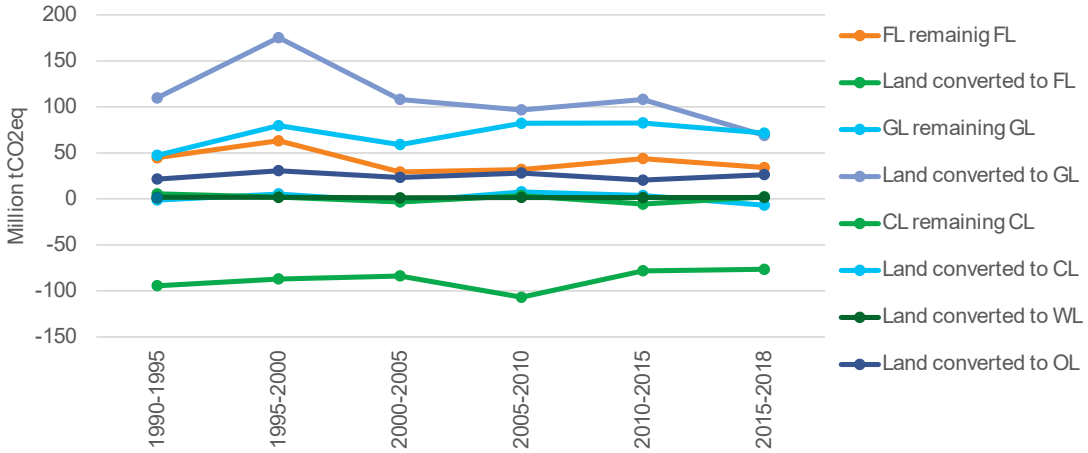


Figure 4-38. Total emission and sink from different land conversion types.

4.6.2 Data Inputs and Assumptions

The forestry sector, covering land use and land cover changes, is analysed for emissions, referred to as Land Use, Land-Use Change and Forestry (LULUCF). Forest emission or sink analysis relies on data from the national forest inventory of 2018, compiled using 30m x 30m satellite images that estimating forest cover at 5.9% in 2018. A survey conducted in 2021 using 0.5m x 0.5m satellite imagery indicated Kenya's forest cover in 2021 was 8.9%. However, this data is limited to a single point in time and cannot be used for forest cover change analysis in emission assessments. The analysis in NCCAP 2023–2027 relies on the FRL as of 2019.

The Kenyan Forest cover is described as montane and western, dryland, and mangrove coastal forests, as well as plantation forests. Other land cover types considered under LULUCF include grassland, cropland, plantations, wetlands, and settlements. The emission factors for the various land types are illustrated in Table 4-52.

Table 4-52. Emission factors used in land conversion GHG emission and sink analysis

		ABG	BGB	TOTAL		
Land Type	**Canopy Coverage Analysis.**	**Biomass Stock (Tonne/ha)**	**Biomass Stock (Tonne/ha) ****	**Biomass Stock (Tonne/ha)**	**Carbon Stock (Tonne/ha) *****	**CO_2 (Tonne/ha)******
Montane & Western Rain Forest	Dense	244.8	90.58	335.38	157.63	577.96
	Moderate	58.43	21.62	80.05	37.62	137.95
	Open	23.26	8.61	31.87	14.98	54.92
Coastal & Mangrove Forest	Dense	94.63	18.93	113.56	53.37	195.69
	Moderate	60.45	12.09	72.54	34.09	125.01
	Open	35.47	7.09	42.56	20.01	73.35
Dryland Forest	Dense	42.43	11.88	54.31	25.53	93.59
	Moderate	34.52	9.67	44.19	20.77	76.15
	Open	14.26	3.99	18.25	8.58	31.46
Plantation Forest	Plantation	289.97	78.29	368.26	173.08	634.64
Grassland	Wooded	6.351	2.349	8.70	4.09	14.99
	Open	3.1755	1.1745	4.35	2.04	7.50
Cropland	Perennial	40.88	15.12	56.00	26.32	96.51
	Annual	0	0	-	-	-
Wetlands	Vegetated	0	0	-	-	-
	Water bodies	0	0	-	-	-
Other Lands		0	0	-	-	-

Land use and forestry analysis aims to calculate GHG emissions from human activities which change the way land is used, such as clearing forests for agricultural use or engaging in open burning of clearing forest. These activities affect the amount of biomass in existing biomass stock (IPCC, 1996). These changes are accounted for in the way forest land is converted to other land types or vice versa, leading to the conversion of other land types to forest land. The land conversion categories defined by IPCC include forest land remaining forest land, land converted to forest land, grassland remaining grassland, land converted to grassland, cropland remaining cropland, land converted to cropland, wetland remaining wetland, land converted to wetland, and other land remaining other land, land converted to other land. The updated FRL over the period between 2014–2018 is presented in Table 4-53.

Table 4-53. Forest change matrix for the period 2014–2018 in hectares

Change matrix	Dryland	Coastal	Montane	Plantation
Dense Forest =>Dense Forest	344,985.21	164,282.04	834,861.96	52,712.73
Dense Forest =>Moderate Forest	97,928.28	87,917.67	49,209.21	1,217.70
Dense Forest =>Open Forest	42,170.40	1,363.23	19,734.30	597.51
Dense Forest =>Wooded Grassland	443,748.78	154,813.32	71,548.47	2,335.23
Dense Forest =>Open Grassland	12,168.72	5,360.67	20,291.94	4,326.21
Dense Forest =>Perennial Cropland	1,180.35	32.04	10,303.56	491.04
Dense Forest =>Annual Cropland	23,378.85	6,389.55	78,531.21	16,456.41
Dense Forest =>Vegetated Wetland	1,449.72	257.85	186.66	9.63
Dense Forest =>Water body	2,424.69	1,374.21	229.32	14.76
Dense Forest =>Other land	2,307.24	824.94	821.16	22.23
Moderate Forest =>Dense Forest	57,877.38	22,023.45	40,248.45	925.47
Moderate Forest =>Moderate Forest	60,223.23	40,366.26	83,234.88	277.83
Moderate Forest =>Open Forest	33,163.56	2,040.30	12,899.34	60.66
Moderate Forest =>Wooded Grassland	121,300.11	49,884.30	50,115.78	191.43
Moderate Forest =>Open Grassland	6,632.19	534.42	3,708.72	247.05
Moderate Forest =>Perennial Cropland	163.08	38.61	381.33	2.97
Moderate Forest =>Annual Cropland	4,599.63	3,526.38	11,024.64	670.23
Moderate Forest =>Vegetated Wetland	291.15	119.88	33.03	0.18

Change matrix	Dryland	Coastal	Montane	Plantation
Moderate Forest =>Water body	937.89	338.58	44.73	0.90
Moderate Forest =>Otherland	1,017.63	233.46	32.67	0.27
Open Forest =>Dense Forest	21,220.65	1,115.55	9,842.94	427.05
Open Forest =>Moderate Forest	20,412.18	989.19	10,323.90	26.82
Open Forest =>Open Forest	66,984.03	451.80	26,260.02	68.94
Open Forest =>Wooded Grassland	166,763.88	2,780.28	48,135.06	27.00
Open Forest =>Open Grassland	19,018.89	16.29	3,431.07	135.81
Open Forest =>Perennial Cropland	127.62	4.05	145.26	3.69
Open Forest =>Annual Cropland	3,884.67	106.11	6,289.74	255.78
Open Forest =>Vegetated Wetland	722.88	4.14	2.79	-
Open Forest =>Water body	722.07	5.31	7.29	0.18
Open Forest =>Otherland	4,274.10	11.52	25.29	0.09
Wooded Grassland =>Dense Forest	368,078.76	76,278.60	67,101.66	2,128.86
Wooded Grassland =>Moderate Forest	199,276.74	81,925.20	44,854.65	331.56
Wooded Grassland =>Open Forest	140,047.83	13,306.23	30,103.29	199.53
Wooded Grassland =>Wooded Grassland	23,270,072.04	1,298,675.88	1,406,979.90	3,735.81
Wooded Grassland =>Open Grassland	2,965,923.27	30,839.40	201,525.84	655.11
Wooded Grassland =>Perennial Cropland	6,369.03	5,257.71	3,826.35	53.73
Wooded Grassland =>Annual Cropland	723,609.45	123,358.86	390,735.81	4,710.06
Wooded Grassland =>Vegetated Wetland	9,367.65	2,261.79	486.09	6.66
Wooded Grassland =>Water body	12,725.46	4,661.19	626.22	1.08
Wooded Grassland =>Otherland	878,308.29	8,014.59	11,455.38	13.68

Change matrix	Dryland	Coastal	Montane	Plantation
Open Grassland =>Dense Forest	9,771.39	576.90	18,265.05	2,017.71
Open Grassland =>Moderate Forest	8,282.43	637.92	4,030.20	71.73
Open Grassland =>Open Forest	18,393.30	110.88	8,852.22	84.15
Open Grassland =>Wooded Grassland	2,892,027.24	16,707.24	259,491.96	1,040.49
Open Grassland =>Open Grassland	3,819,194.10	2,006.64	518,197.59	4,775.94
Open Grassland =>Perennial Cropland	1,564.20	23.40	2,389.77	88.65
Open Grassland =>Annual Cropland	125,779.59	1,823.40	344,893.23	9,454.59
Open Grassland =>Vegetated Wetland	3,256.02	100.71	69.03	0.27
Open Grassland =>Water body	4,465.98	215.64	212.76	0.63
Open Grassland =>Otherland	730,766.88	349.65	11,797.74	6.39
Perennial Cropland =>Dense Forest	3,731.40	57.96	27,389.43	357.57
Perennial Cropland =>Moderate Forest	975.15	43.47	694.08	4.68
Perennial Cropland =>Open Forest	91.89	4.23	146.52	3.51
Perennial Cropland =>Wooded Grassland	6,832.89	3,087.18	2,888.82	25.47
Perennial Cropland =>Open Grassland	1,318.59	62.82	1,891.08	42.30
Perennial Cropland =>Perennial Cropland	37,877.22	3,023.01	110,696.31	415.71
Perennial Cropland =>Annual Cropland	41,729.22	1,804.95	53,418.78	199.89
Perennial Cropland =>Vegetated Wetland	8.37	0.54	11.07	-
Perennial Cropland =>Water body	59.40	15.03	7.92	-
Perennial Cropland =>Otherland	676.26	14.49	118.35	0.09
Annual Cropland =>Dense Forest	17,472.51	1,631.07	51,251.22	3,253.50
Annual Cropland =>Moderate Forest	8,188.02	2,523.33	7,461.81	126.18
Annual Cropland =>Open Forest	10,071.09	433.89	6,421.77	140.85
Annual Cropland =>Wooded Grassland	654,159.87	70,391.34	232,389.99	1,468.80
Annual Cropland =>Open Grassland	124,875.00	3,154.32	121,045.68	2,885.94
Annual Cropland =>Perennial Cropland	35,518.23	651.51	62,835.30	169.38

Change matrix	Dryland	Coastal	Montane	Plantation
Annual Cropland =>Annual Cropland	2,373,282.45	24,721.47	2,037,794.94	16,818.66
Annual Cropland =>Vegetated Wetland	1,904.04	62.55	529.65	3.51
Annual Cropland =>Water body	3,662.37	316.26	657.72	3.24
Annual Cropland =>Otherland	13,904.37	905.94	8,432.55	25.20
Vegetated Wetland =>Dense Forest	401.58	85.14	82.26	2.97
Vegetated Wetland =>Moderate Forest	636.66	105.48	107.28	3.15
Vegetated Wetland =>Open Forest	1,169.64	7.20	4.77	0.54
Vegetated Wetland =>Wooded Grassland	8,298.45	649.98	392.13	16.11
Vegetated Wetland =>Open Grassland	824.49	1.80	403.56	1.35
Vegetated Wetland =>Perennial Cropland	300.60	-	8.46	-
Vegetated Wetland =>Annual Cropland	5,486.49	536.04	738.90	8.19
Vegetated Wetland =>Vegetated Wetland	13,296.96	683.37	608.40	-
Vegetated Wetland =>Water body	2,735.64	213.84	962.01	-
Vegetated Wetland =>Otherland	81.09	2.88	2.16	-
Water body =>Dense Forest	1,246.59	257.40	184.59	6.30
Water body =>Moderate Forest	445.86	210.42	68.94	1.26
Water body =>Open Forest	706.86	31.05	7.65	-
Water body =>Wooded Grassland	9,782.91	1,256.76	1,038.42	2.07
Water body =>Open Grassland	3,637.44	28.80	572.13	0.81
Water body =>Perennial Cropland	79.56	5.85	35.10	-
Water body =>Annual Cropland	4,002.21	675.99	1,572.75	1.80
Water body =>Vegetated Wetland	2,797.74	231.12	818.64	-
Water body =>Water body	1,154,076.48	4,556.79	24,139.26	3.24
Water body =>Otherland	10,610.64	184.50	220.05	-
Otherland =>Dense Forest	1,666.89	397.53	866.34	6.48
Otherland =>Moderate Forest	2,423.79	470.16	106.56	-
Otherland =>Open Forest	3,279.24	14.85	1,701.81	-

Change matrix	Dryland	Coastal	Montane	Plantation
Otherland =>Wooded Grassland	1,001,221.92	6,408.90	10,142.46	0.09
Otherland =>Open Grassland	1,088,501.85	2,430.90	9,862.02	2.25
Otherland =>Perennial Cropland	203.76	32.40	57.06	-
Otherland =>Annual Cropland	6,408.27	2,456.82	4,542.12	13.41
Otherland =>Vegetated Wetland	473.76	134.19	10.35	-
Otherland =>Water body	5,914.44	739.71	51.93	-
Otherland =>Other land	4,759,493.49	6,415.29	30,016.44	5.04
TOTAL	**49,175,902.35**	**2,356,467.75**	**7,533,207.00**	**136,901.97**

4.6.3 Mitigation Targets and Achievement in NCCAP II

Kenya is a country with low forest cover, and the FRL technically assessed by UNFCCC was reported at 5.9% of the total land area in 2018 (Ministry of Environment and Forestry, 2021). Strategic objective 4 aims to increase the forest cover to 10% of the total land area, including the rehabilitation of degraded land, including range land. A summary of priority actions and progress in implementation is detailed in Table 4-54.

Table 4-54. Summary action and implementation status for NCCAP 2018–2022

Smart climate action targets	Implementation status
Priority action 1. Afforestation and reforestation of degraded and deforested areas in Counties	
An additional 100,000 hectares of land (including agroforestry), afforested or reforested aiming to plant one million trees per County per year through initiatives including Annual National Tree Planting Day, Revived Green Schools Programme—10% of school land areas planted with trees etc.	**80% completed** • KEPSA, in a tripartite collaboration with the Ministry of Environment and Forestry and the United National Development Programme (UNDP- Kenya), mobilised the private sector to contribute to the national greening and forest restoration programme in 2022. • Total trees planted between 2018–2022 is 14.8 million, including contributions from Safaricom (1.3 million), Bolt Operations - Seedballs Kenya (11 million), Equity bank (1.8 million), Base Titanium (73,000), 610,000 seedlings from nurseries, and other private entities committed to the programme, as well as 10,000 trees of adopt a forest programmes by KAM among others. • Tree-growing app developed for collection of tree project-related data (species, number, location, and survival rate).

Smart climate action targets	Implementation status
Priority action 2. Reduce deforestation and forest degradation	
Deforestation and forest degradation reduced through enhanced protection of additional 100,000 million hectares of natural forests through initiatives such as, community/ participatory forestry management, limiting access to forests, Preventing disturbances through improved enforcement and monitoring.	66,459 hectares of forests established.
Priority action 3. Restore degraded forest landscapes (ASALs and rangelands)	
Restoration of up to 200,000 hectares of forest on degraded landscapes (ASALs, rangelands), through initiatives such as the GCF Dryland Resilience Project, focusing on enhanced natural generation of degraded lands through conservation and sustainable management.	**Estimated at 80% achieved** Agrochemicals Association of Kenya (AAK- GROW) adopted a 56-acre section of the Mau Forest in Likia, currently serviced on an annual basis.
Priority action 4. Promote sustainable timber production on privately-owned land	
Promote sustainable timber production on privately-owned land. Increase the area under private sector-based commercial and industrial plantations from 71,000 hectares to at least 121,000 hectares. •Standards and regulations for sustainable forestry management are being established, with a transition from voluntary to regulated practices,	**Estimated at 50% achieved** 5,500,000 planted in Kilifi, Kwale, Nyandarua, 80,000 hectares of commercial forest developed in partnership with 22,000 smallholder farmers by Komaza. Gatsby Africa, with the support of MECCF, launched the Geospatial Forestry Platform. The platform includes free Site Species Matching Tools (SSMT) as well as pay-to-use models for resource assessment based on satellite technology. SSMT maps are being downloaded for free by users across the country, including individuals, tree grower associations, and large-scale plantations.

Impact of Priority Mitigation Actions on GHG Emissions

The emission projection was based on the FRL between 1990–2018, as presented in Table 4-55. However, since there is no updated survey available besides the FRL report, the emission status in 2020 is based on the Long-term Low Emission Strategy for Kenya (Kenya LTS), with projections extended to 2022 (Launched in Africa Climate Summit). The historical trend-based projection took into consideration the actions aimed at achieving a 30% forest cover, though in a conservative manner, assuming only 15% forest cover is successfully achieved by 2030. Thus, the projection established that the emission as of 2022 to be 47.3 MtCO2eq, as illustrated in table 4-55. The significant difference between the reference scenario emission and actual emission is due to data changes resulting from more advanced studies, as discussed in box 4 below.

Table 4-55. Forestry sector emission status analysis

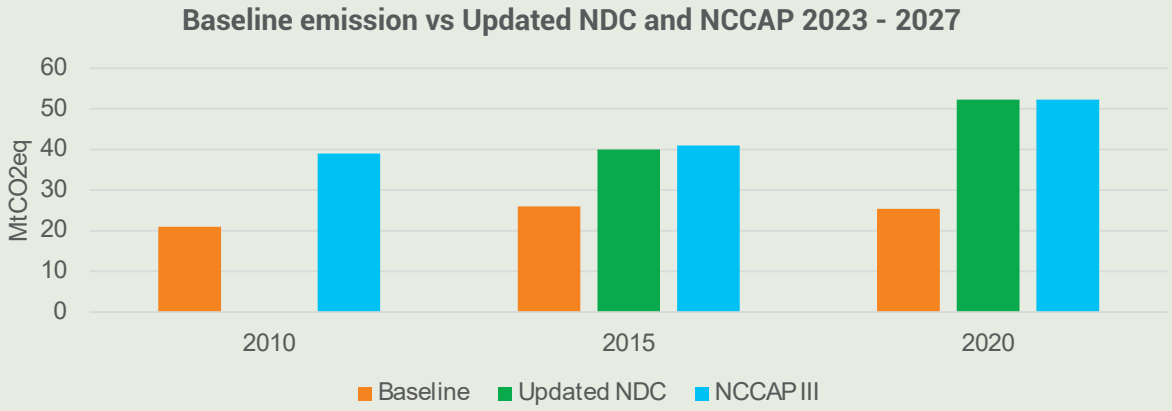
	2010	2015	2020	2022
Baseline scenario emission (MtCO2eq)	21.0	26.0	25.4	24.2
Allowed GHG emissions considering NDC target (MtCO2eq)	21.0	24.6	16.9	13.4
Actual GHG emission (MtCO2eq)	38.5	40.9	52.3	47.3
Gap or deviation from allowed GHG emissions NDC target	-17.5	-16.2	-35.4	-33.9
Comment (Shifting from NFI to FRL estimation)			Deficit	Deficit

Box 4 Data Differences in Forestry Sector

In line with efforts across various sectors, Kenya has been continually enhancing its GHG emissions data, deploying rigorous surveys and analysis to enhance evidence on its GHG emissions achievement especially in the implementation of REDD+.

Therefore, in 2013, Kenya launched the System for Land-Based Emission Estimation in Kenya (SLEEK) programme to support the National GHG inventory process. SLEEK did an extensive mapping using a semi-automated method and produced the Land Cover / Land Use Map for the years 1990, 1995, 2000, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, and 2018. These maps were based on imagery from LANDSAT 4, 5, 7, and 8 satellites, as elaborated in the National Forest Reference Level for REDD+ implementation (MoEF, 2019). The land cover maps have been the basis for developing the National Forest Reference Level for REDD+ Implementation (2019) and the National Forest Inventory (NIR) 3.

The forestry sector baseline emission under NCCAP 2013–2017 was estimated and projected to be 24.4 MtCO2eq in 2010 based on the NIR. It was projected to increase slightly to 26.1 MtCO2eq in 2015 and then gradually reduce to 22.1 MtCO2eq in 2030. However, with the new semi-automated Landsat imagery analysis of the REDD+ reference level, the forestry sector emission was determined to be 40.86 MtCO2eq in 2010 (About double the baseline estimation) and 52.26 MtCO2eq in 2015, with no change expected in the business-as-usual scenario. The figure below illustrates the difference between baseline emission, updated NDC, and NCCAP 2023–2027.



4.6.4 Mitigation Targets and Achievement in NCCAP II

Key challenges observed include:

1. Insufficient long-term monitoring due to limited resources (human and capital) and technology.
2. Inadequate capacity for monitoring and enforcing forest laws, resulting in lenient penalties for forest offenses.
3. Slow adoption of devolved forestry functions by counties.
4. Limited access to quality seeds and potting materials, leading to high costs of protecting planted seedlings and areas.
5. Inadequate financial resources for sustainable forest management.
6. Erratic weather conditions and uncontrolled grazing affect forest health and regeneration.
7. Inadequate monitoring capacity to address forest conservation and management issues.
8. Limited access to quality germplasm, coupled with high establishment costs and competition with other land uses.
9. Limited value addition opportunities, impacting the long-term return on investment in the forestry sector.

Lessons learnt

There is a need for continued monitoring, a standardised tool for monitoring, and a baseline for monitoring, along with the establishment of a coordination and reporting mechanism. Providing quality seedlings and ensuring species-site matching are essential aspects of the initiative. Awareness creation through NGOs and the inclusion of tree planting in performance contracts are also important.

To enhance community-based monitoring, it is vital to focus on non-timber forest products value chains and develop and implement grazing management plans. Timely implementation of silvicultural operations and the utilisation of fast-growing tree species, with proper species-site matching, are crucial elements. Additionally, fostering peer-to-peer learning and capacity building on value addition and technologies for value addition will further support the overall objectives.

4.7 Summary Progress on Emission Reduction in 2022

Kenya's GHG emissions are depicted to be rising beyond the reference (baseline projections) scenario projections. Indeed, GHG emission status as of 2022 was estimated at 128 $MtCO_2eq$, as illustrated in the area chart in Figure 4-39. The baseline projection to 2022 was estimated at 105.2 $MtCO_2eq$, and tracking the expected mitigation emission was 84.5 $MtCO_2eq$. The high emission growth is a result of forest sector emissions that were estimated using the FRL assessment, which estimated annual average GHG emission in the 2014–2018 period at 52.3 $MtCO_2eq$, about 2 times higher than the original reference level estimation of 25 $MtCO_2eq$. The second-highest contributor to the high growth, as illustrated in Figure 4-39, is the agricultural sector, also showing about 1.5 times more emissions compared to the reference (status of 49.6 $MtCO_2eq$ against a reference of 35 $MtCO_2eq$). This was due to two major reasons: a) adjusted IPCC global warming potential for methane from 21 times to 28 times that of CO_2 (IPCC, 2014), and b) actual growth of the stock of animals higher than projected stock in the reference scenario increasing the activity level data.

The energy sector has recorded generally impressive achievements, abating about 16 $MtCO_2eq$ in electricity generation and 0.2 $MtCO_2eq$ in energy demand. The reduced achievement in demand is also attributed to the inclusion of charcoal production emissions in the energy demand computation, as recommended by the IPCC (IPCC, 1996).

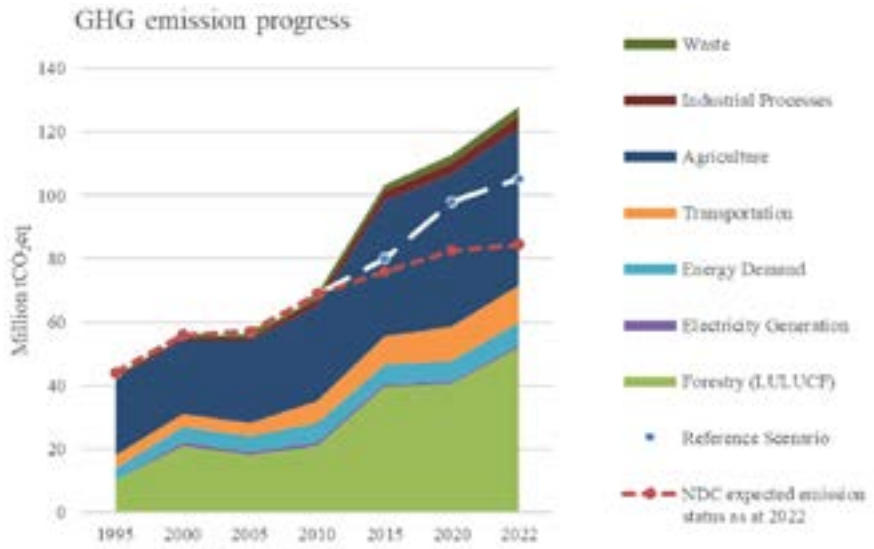
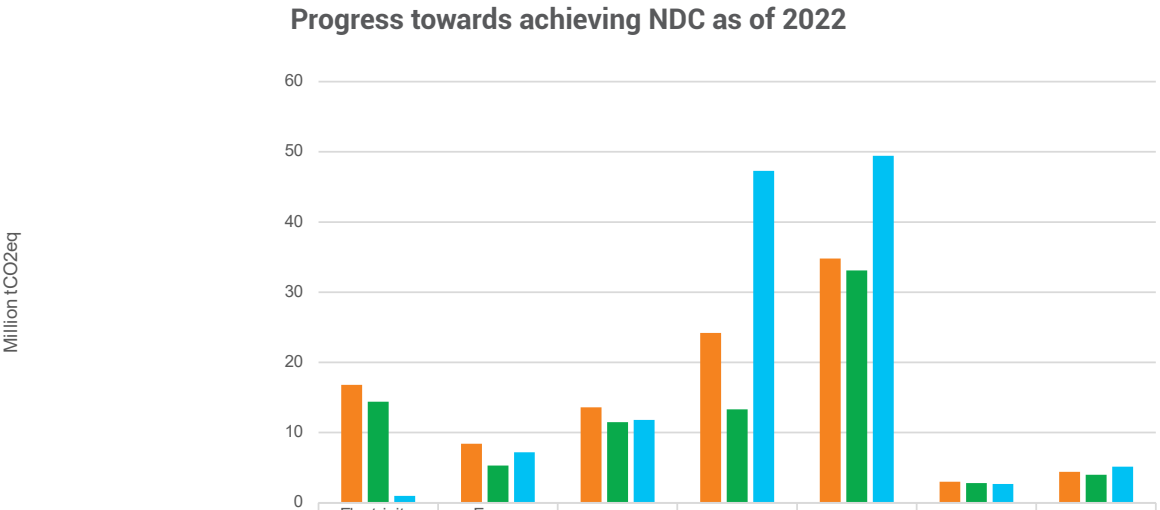


Figure 4-39. Summary of GHG emission evolution until 2022 against the reference projections

The transport sector has similarly shown significant achievement of emission reduction of 2.6 $MtCO_2eq$, while waste management achieved an emission reduction of 0.3 $MtCO_2eq$ compared to the reference scenario. Additionally, the IPPU sector realised an abatement of 0.2 $MtCO_2eq$, as illustrated in Figure 4-40.



	Electricity Generation	Energy Demand	Transport	Forestry	Agriculture***	Waste***	IPPU
Baseline emission (MtCO2eq)*	16.8	8.4	13.6	24.2	34.8	3	4.4
NDC target emission (MtCO2eq)*	14.4	5.3	11.5	13.3	33.1	2.8	4
Actual Emission by sector (MtCO2eq)**	0.97	7.2	11.8	47.3	49	2.7	5.15

Figure 4-40. Progress towards achievement of NDC in 2022

Note:

- * Reference emission and NDC projections were made using the IPCC ad-hoc working group report of 2010 (AR3), which specified that the GWP potential of methane was 21 times that of CO_2
- ** The emission status as of 2022 adopted the updated AR5 technical report GWP potential of methane as 28 times that of CO_2.
- *** The sectors whose emissions are greatly affected by the change in GWP potential are marked.





Chapter 05

Mitigation Actions for 2023–2027

This chapter details the priority actions in NCCAP 2023–2027 and GHG modelling on the expected emission reduction upon implementation of these priorities. Figure 5-1 summarises the emission abatement in NCCAP III against the BAU. "Business as Usual" in this section refers to inadequate policy implementation from 2022. It shows that in the absence of implementation actions, emissions will rise to 177 million tonnes of CO_2eq by 2027. Forestry will be the main source of abatement in this implementation period, expected to result in 37.3 $MtCO_2$eq, with electricity generation contributing 25 $MtCO_2$eq against the updated BAU scenario. In addition to the emissions reduction contributions from other sectors, the mitigation actions would result in a total abatement potential of 79 $MtCO_2$eq by 2027, realising a final emission of 98.1 $MtCO_2$eq.

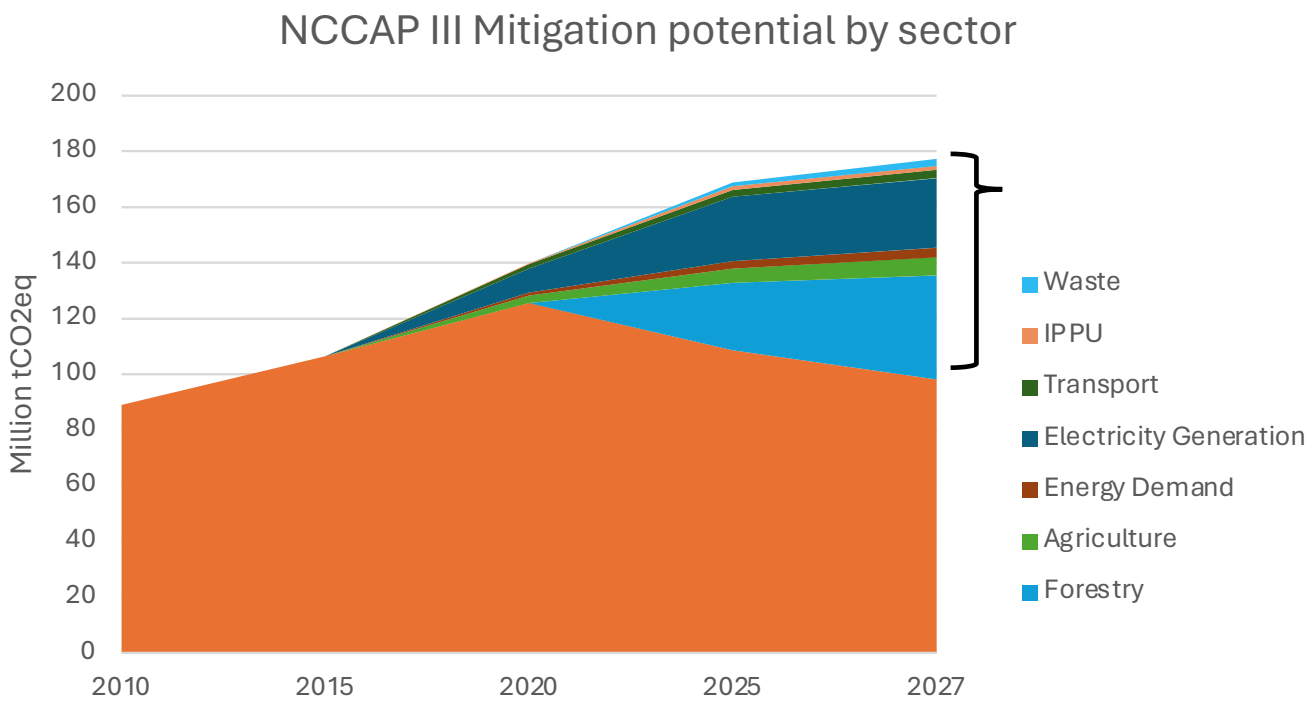


Figure 5-1. Overall GHG emission and abatement potential in NCCAP 2023–2027

5.1 Energy

The energy sector provides mitigation measures in three distinct sub-sectors: residential, commercial, and industrial energy demand.

Priority mitigation actions in the energy sector were derived from Medium Term Plan (IV) 2022–2027, the Kenya Bioenergy strategy, the National Cooling Strategy, and the implementation of minimum appliance standards. In NCCAP 2023–2027, the country will focus on three priority areas: increased access to clean and affordable energy, expansion of renewable electricity on the grid, and increased energy efficiency from generation, transmission, distribution, and use.

Table 5-1 provides a summary of the priority mitigation actions in the residential sector.

Figure 5-1. Overall GHG emission and abatement potential in NCCAP 2023–2027

Priority Mitigation Action	Smart Target	Reference / Remarks
Access to Clean and Affordable Energy: Enhancing power network expansion and improvement as well as electricity access in both on-grid and off-grid areas. Transition to clean cooking fuels and technologies	• Connection to electricity for 2.3 million additional customers and 30,000 public facilities. Installation and maximisation of 90,000 transformers; Installation of 150 mini-grids and 50,473 standalone systems; and installation of 75,000 lanterns under the Public Lighting Project. • About 75% of households adopting modern energy services (LPG, e-Cooking, biogas, and bioethanol) and the remaining 25% of households still relying on biomass transitioning to improved cooking technologies. • 3% and 25% adoption of green building for all new buildings. • Transition of institutions' energy use from biomass to LPG. Target 5,000 schools to transition to LPG by 2027. • Other initiatives like the Global e-Cooking Coalition (GECCO) intend to facilitate as a primary fuel for an additional 10% of the population of Kenya by 2030.	MTP IV (2022–2027); Bioenergy Strategy; Discussion with petroleum directorate; Minimum performance standards

Priority Mitigation Action	Smart Target	Reference / Remarks
Expansion and Sustained Use of Clean Energy: Promoting clean, affordable, and quality alternative renewable energy sources	• Expansion of Energy centres from 16 to 47 for increased dissemination of efficient charcoal kilns; Development of 195 energy-efficient charcoal kilns; Promotion of clean cooking solutions. • Development of 2 Biofuel Plants for ethanol value chain addition. • Promotion of Energy efficiency and conservation, including E-Mobility, green buildings, and reduction of GHGs; Electrification of institutions and community boreholes; Development of Kenya green hydrogen; and • Promotion of energy production from municipal waste 589 MW new renewables developed, including: • Geothermal (208 MW)– prioritised as baseload (Menengai - 105 MW, Uprating of Olkaria I – Additional Units 4 and 5 - 40 MW, Olkaria 1 rehabilitation - 63 MW); • Biomass / Cogeneration (11.44 MW); • Hydro (35 MW); • Solar (174 MW); and • Wind (161 MW).	MTP IV (2022–2027)/ LCPDP, 2022–2041
Promote Geothermal Energy for Alternative (Direct) Uses	• Commercialisation of the Menengai grain dryer - GDC • Use of Menengai geothermal brine heat in cement manufacturing - GDC • Supply of steam and brine to industries in the KenGen Green Energy Park	Sector consultation
Enhanced Electricity Access Toward Universal Access by 2030	Expansion of the electricity grid to connect populations that are either not connected to the grid or have unreliable supply of electricity. - Increase transmission grid by 2,930 km. - Increase connectivity by 1,450,000 new connections over the five-year period. - 200 solar-powered mini-grids developed in off-grid areas	Sector consultation

Priority Mitigation Action	Smart Target	Reference / Remarks
Enhanced Energy Efficiency for Conservation	- Losses in electricity transmission and distribution reduced from 23% to 16.5%. - Conduct an impact study on adoption and impact of Minimum Energy Performance Standards (MEPS) and target to increase adoption by an additional 20%. - Promote Energy efficiency and conservation in buildings in collaboration with the building sector stakeholders. - Promote energy auditing and process optimisation among designated facilities from the current estimated cumulative total of 2,000 companies to 3,000 industries and carry out 30 process optimisation audits. Kenya is estimated to have about 4000 estimated designated facilities - Improved implementation rates of audit recommendation from 50% to 75% of energy efficiency in the manufacturing sector. We need to do an impact study of the current implementation status. - Implementation of the Kenya National Energy Efficiency and Conservation Strategy (KNEECS)	Sector consultation
Integration of Renewable Energy in the Main Electricity Grid System by Individual or Companies	No. of integrated individuals/companies. Feed-in tariff policy.	Sector consultation
Expansion on Adaptation to Green Building Design and Construction	- Increase more buildings to be certified to green building standards, at least 30% of all projects to be certified.	Sector consultation
Private Sector-led Research and Development, and Piloting of Biofuels Production and Use in Kenya Aviation and Relevant Sectors	• International Oil Company (IOC) licensed to produce biofuels from castor seed, used cooking oil, and oil from inedible seed as well as second-generation biofuel from sugarcane bagasse. The expected products are biojet, bio-LPG, Biodiesel, and bio-Naptha. • Consolidating the feedstock for biofuels production • Target production of 250k tonnes of biofuels annually from 2025. • Additional trials for locally produced second-generation biofuels in Kenya aviation	Sector consultation

Source: Author's own compilation of stakeholders' input

Demographic dynamics will see more rural populations move to urban areas, significantly influencing their energy consumption habits. With the current trend of grid electrification, it is logical to assume that by 2024, close to all urban households will be connected to grid electricity. Maintaining such connections will require an additional 1.4 million households to be electrified in in urban areas over the next five years. To achieve a target of 2.3 million people, about 0.9 million households will need to be electrified by the year 2027. This will boost rural grid access to about 43%. Total modern electricity access in rural areas is expected to rise to 85% by 2027, with only 15% of the population lacking access to electricity, as illustrated in Figure 5-2.

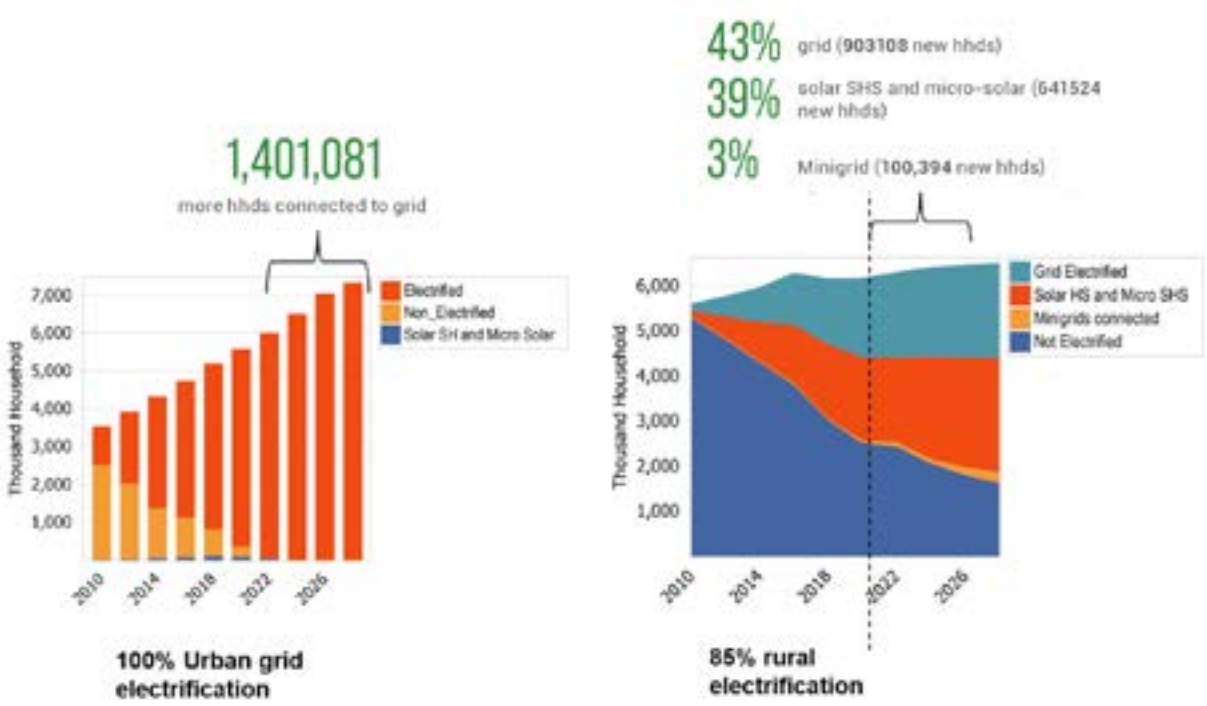


Figure 5-2. Evolution of electricity access in 2027

Source: Author's own from model results

Increasing access to clean and modern cooking technologies assumes that 75% of total household energy demand will result from increased adoption of LPG, ethanol, e-Cooking, and biogas. With the current rate of LPG adoption in urban areas standing at about 62%, we assume that future growth will be rather slow, reaching only about 70% due to product saturation. Even so, households using LPG in fuel stacking will still use about 40% of charcoal or other forms of traditional fuels. Only about 25% will use traditional biomass as the primary energy source. Moreover, e-Cooking will continue to grow but at a slow rate (from about 2% adoption in 2023 to 10% adoption in 2027). As e-Cooking becomes the preferred primary fuel, the intensity of LPG use will reduce.

Similarly, in rural areas, firewood will still supply 25% of household energy demand, while charcoal use will reduce by half to 4%. Ethanol and biogas use would rise to 25%, and LPG use will increase from 18% in 2022 to 50% in 2027. Like in urban areas, e-Cooking is still in its early stages in rural areas, and its use will increase marginally from 2% to 5% in 2027 (see Table 5-2).

There is limited information available on the adoption of improved kilns. According to the Kenya charcoal value chain study of 2013, only 10% adoption of improved charcoal kilns was reported. However, stakeholders indicated during consultations that there is an expected rollout of 195 improved kilns through the county energy centres. Therefore, in NCCAP 2023–2027, and in line with the targeted kilns, it is conservatively estimated that about 45% of the total charcoal produced will be from improved charcoal kilns facilitated through the 47 energy centres. MTP IV aims to increase the number of energy centres from 16 to 47 in all counties to enhance promotion, among other things, of efficient charcoal production (GoK, 2023a). `

Table 5-2. Residential sector modelling assumptions

Branch	Urban Cooking					Rural Cooking				
	2010	2015	2019	2022	2027	2010	2015	2019	2022	2027
Firewood	13	16	12	9	2	85	83	81	80	25
Charcoal	42	22	19	17	23	22	16	12	8	4
Twigs and Agri residues	1	1	-	0	-	1	2	2	1	0
Electricity	2	2	2	2	10	0	0	1	2	5
LPG	15	28	54	62	70	1	3	18	18	50
Biogas	0.0	0.3	0.1	0.1	0.1	0.0	0.2	0.2	0.2	21
Kerosene	42	30	28	9	-	3	2	3	1	0
Briquettes and Pellets	2	2	2	2	2	-	-	-	-	-
Other fossil	0	0	-	0	-	0	0	0	0	0
Ethanol fuel	-	-	0	13	25	-	-	-	-	21

Source: Author's own from technical committee inputs on scenarios

This transition would result in emission reduction of 1.1 million tonnes of CO_2eq, with the greatest emitter being LPG, accounting for 72% of the total residential sector GHG emissions. The rising population and increased adoption and use of LPG will continue to raise GHG emissions in the residential sector. However, the co-benefits of transition to LPG and biogas, including improved air quality and reduced deaths due to indoor air pollution, are unmeasurable.

GHG Abatement Potential in Residential Sector

Figure 5-3 illustrates the residential sector's emissions abatement upon the implementation of mitigation actions, especially in transitioning to cleaner cooking technologies. Figure 4-3 illustrates the general trend in emission abatement. The blue line represents the fifth IPCC global warming potential for methane, which is 28 times CO_2eq per tonne of methane, compared to 21 times CO_2eq in the AR3 IPCC estimation shown in the maroon line. Emissions rose and peaked in 2017, and emissions arising from residential fuel use are on a declining trend due to heightened implementation of national policies promoting clean cooking and increased adoption of LPG as the primary cooking fuel in urban areas in Kenya. The trend is expected to steadily drop to 1.9 $MtCO_2$eq by 2027. The residual emission of 1.9 MtCO2eq by 2027 is primarily due to the high adoption rate of LPG, with a small contribution from continued use of firewood, kerosene, and charcoal as illustrated. While LPG is a clean fuel with high thermal efficiency, it is a fossil fuel and emits CO_2 upon combustion. However, the level of emissions from LPG is much lower than the combustion and use of traditional biomass and kerosene. Thus, emission reduction of 1.3 $MtCO_2$eq is attributed to e-Cooking adoption, targeted at 10% of the urban population and 5% for the rural population, and the transition to LPG for cooking.

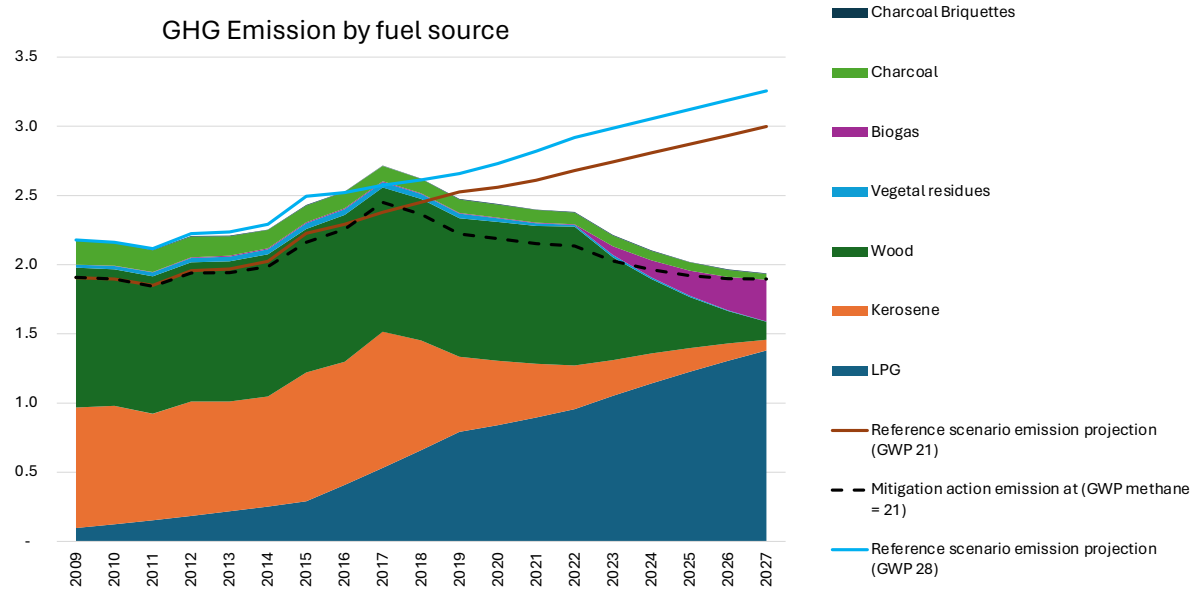


Figure 5-3. NCCAP 2023–2027 residential sector emission projection

Source: Author's own from model result

As illustrated in Table 5-3, the residential sector GHG emission reduction is expected to yield 1.3 $MtCO_2eq$ in 2027, based on 2015 as the first scenario year. About 70% of the remaining emissions will result from increased LPG use. However, in the planning period (2023–2027) with 2023 as the first scenario year, the residential sector is estimated to yield an emission reduction of 0.62 MtCO2eq in 2027, as illustrated in Figure 5-4

Table 5-3. Residential energy sector emission

	2010	2015	2020	2022	2025	2027
Baseline scenario emission (MtCO2eq)	2.16	2.50	2.73	2.92	3.12	3.26
Mitigation action emission (MtCO2eq)	2.16	2.43	2.44	2.38	2.02	1.94
GHG Emission reduction mitigation action against reference (MtCO2eq)			0.3	0.5	1.1	1.3

Source: Author's own from LEAP modelling

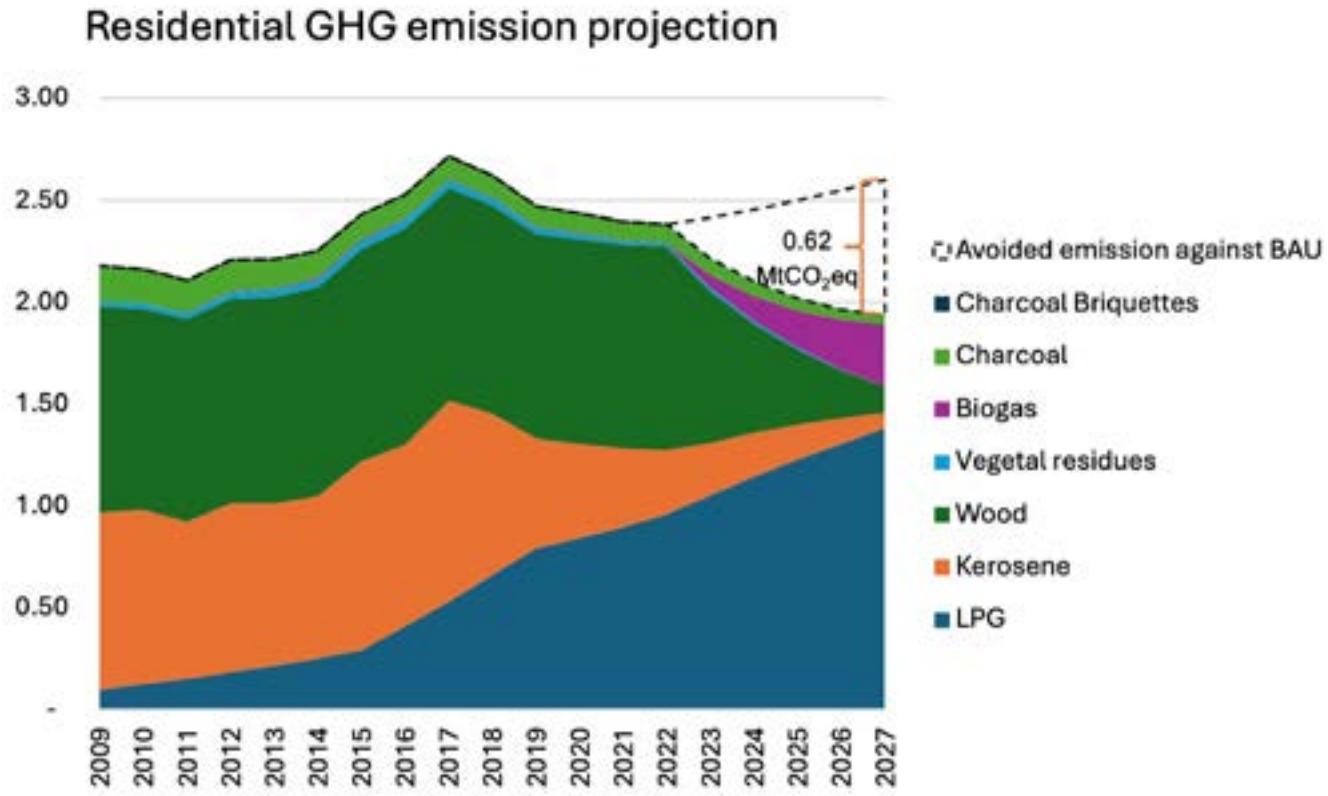


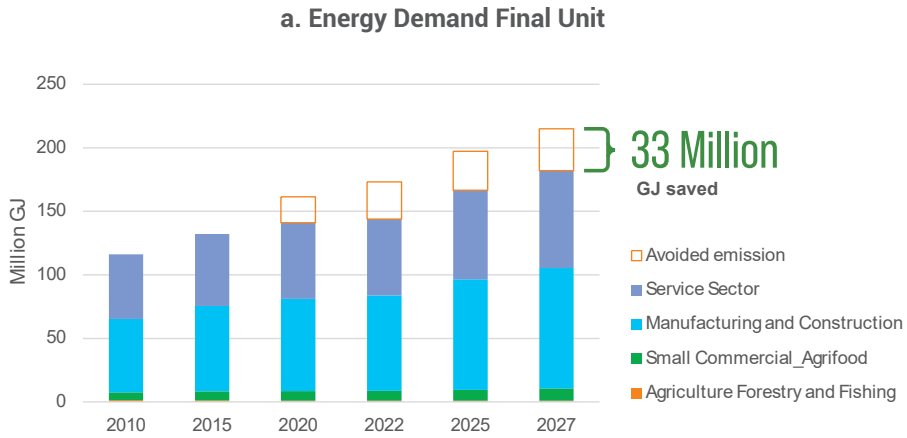
Figure 5-4. Emission abatement projection in residential sector with 2023 as the reference year.

GHG Abatement Potential in Commercial and Industrial Sectors

The mitigation efforts in the commercial and industrial sectors focus on enhancing energy efficiency. This includes increasing the number of energy audits conducted from the current 2,000 audits to at least 3,000 audits. Additionally, Energy Service Companies (ESCOs) will be established to improve the implementation rates of audit recommendations, aiming to raise the efficiency level from 50% to 75% in the designated facilities. Specifically, in the industrial sector energy efficiency included:

- Energy Audits Increased from 2,000 to at least 3,000 audits
  - By 2027, it is anticipated that 75% of medium and large industries will have undergone energy audits.
- Formation of ESCOs to enhance the implementation rates of audit recommendations in designated facilities, aiming to increase energy efficiency from 50% to 75%.
  - By 2027, it is projected that 75% of these industries will be implementing the audit recommendations.
  - After every three years of implementation, a 7.5% improvement in efficiency is achieved.
  - The maximum achievable energy consumption reduction is 15%, and it is optimised within a five-years timeframe.
  - **Harmonising the 15% efficiency achievement across all industrial sector results in an 11.5% efficiency achievement by 2027.**
  - Also, the implementation of Minimum Energy Performance standards (MEPS) in the commercial and industrial sector is integrated into the implementation of energy audit recommendations, hence no further gains are expected.

The energy conservation measure results in saving up to 33 million GJ of energy and reduces emissions by 2 $MtCO_2eq$ compared to the business as usual scenario, as illustrated in Figure 5-5a. Additionally, the emission reduction against the baseline (reference scenario) was estimated and 2 $MtCO_2eq$, against the reference projection as illustrated in Table 5-4.



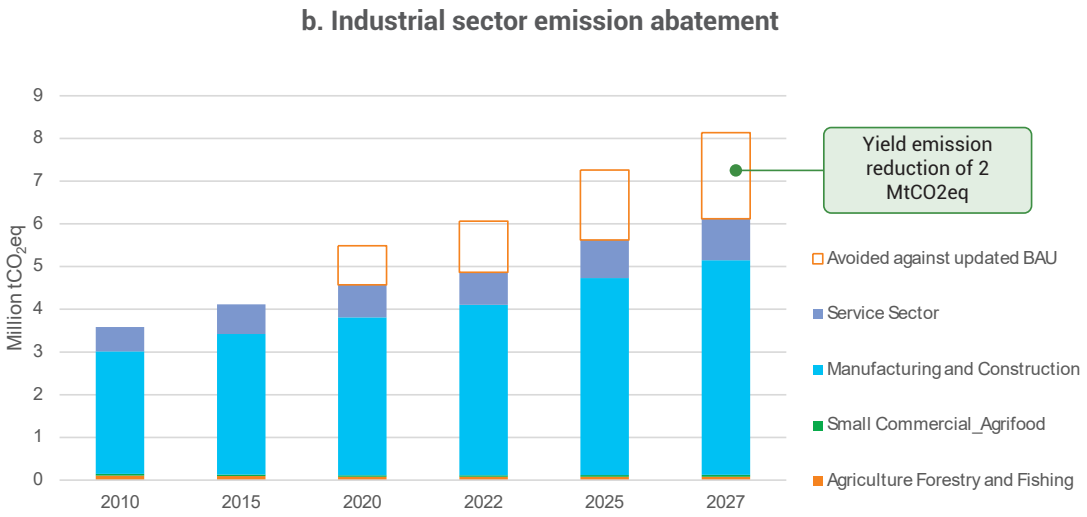


Figure 5 5. Commercial sector energy efficiency benefits and GHG emission abatement co-benefits

Source: Author's own from model results

Table 5-4. Potential emission reduction from the commercial and industrial sector GHG emissions

	2010	2015	2020	2022	2024	2027
Baseline scenario emission (MtCO2eq)	3.59	4.11	5.49	6.06	7.26	8.13
Mitigation action scenario (MtCO2eq)	3.59	4.11	4.57	4.87	5.62	6.12
Emission reduction (MtCO2eq)			0.9	1.2	1.6	2.0

Source: Author's own from model results

GHG Emission Abatement Potential in Electricity Generation

The reference scenario for electricity generation heavily relied on fossil fuels. However, Kenya has significantly increased its renewable electricity mix on the grid, achieving over 90% renewable energy from 2018–2022. In NCCAP 2023–2027, the country aims to further enhance its renewable electricity capacity by adding 589 MW from renewable sources. Additionally, battery energy storage systems will be adopted to better support the integration of variable renewable electricity, such as solar and wind technologies.

With a strong commitment to renewable electricity, only a residual emission of 0.3 $MtCO_2eq$ is anticipated in 2027. However, with a more ambitious approach, achieving 100% renewable energy is feasible as the country adopts battery storage, pump hydropower storage, and hydropower as ramping and peaking technologies. This approach could result in a GHG abatement of 24.9 $MtCO_2eq$ in 2027 from electricity generation compared to the baseline scenario, as illustrated in Figure 5-6 and Table 5-5.

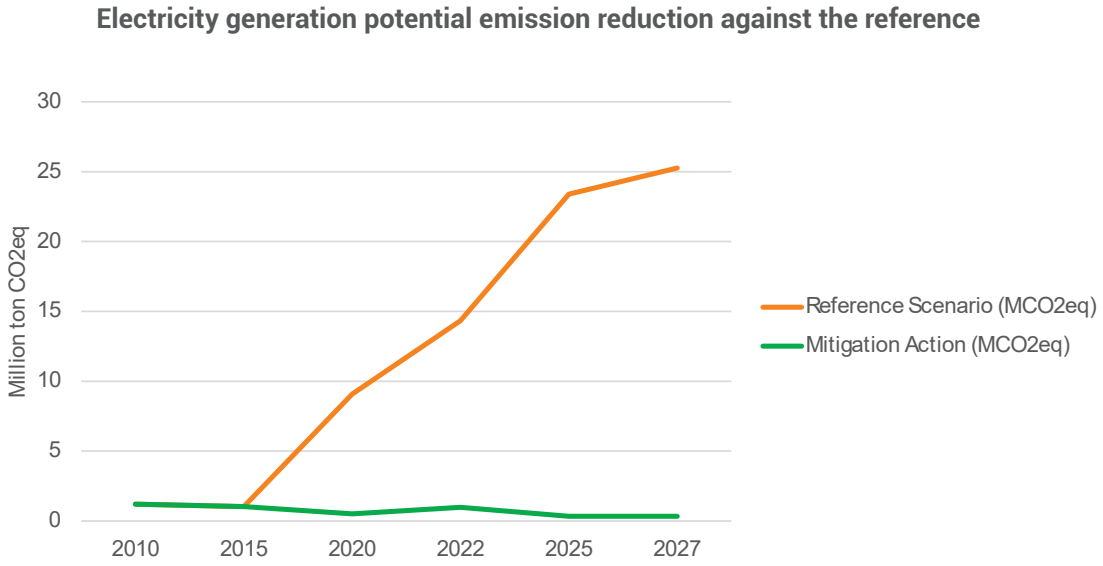


Figure 5-6. Projected Emission reduction from electricity generation

In the NCCAP III period, Kenya has made remarkable strides in reducing emissions in the electricity sector. By 2020, the Kenyan grid was comprised of over 90% renewable sources, resulting in low emission levels. If the country maintains the current proportion of renewable electricity in the grid, it will continue to experience low levels of GHG emissions. Improving grid efficiency, which remains a primary challenge in grid electricity, will further contribute to additional emission reduction, as illustrated in Table 5-5.

Table 5-5. Emission reduction potential in electricity generation

	2010	2015	2020	2022	2025	2027
Baseline emission (MtCO2eq)	1.21	1.04	9.09	14.34	23.40	25.26
Mitigation action emission (MtCO2eq)	1.21	1.04	0.51	0.98	0.34	0.34
GHG emission reduction (MtCO2eq)	-	-	8.6	13.4	23.1	24.9

5.2 Transport

The transport sector is recognised as a challenging area for decarbonisation in Kenya. The majority of vehicles and other automobiles primarily rely on fossil fuels. However, there has been a recent emergence of low-carbon technologies and low-emission engines (Tier 4) in the market. Efforts within the transport sector are being directed towards climate change mitigation through the adoption of actions aimed at transitioning to low-carbon pathways. These actions include promoting of e-mobility, expanding the use of gas-fuelled vehicles, implementing mass rapid transport systems, and encouraging non-motorised transportation alternatives.

The strategic objective of NCCAP 2023–2027 is to establish efficient, sustainable, greener, low-carbon, world-class transport systems, and logistics services capable of withstanding projected impacts of climate change. Key sectoral challenges include operational inefficiency, technological limitations, heavy traffic congestion, and high fossil fuel consumption, resulting in elevated levels of carbon emissions. There is a pressing need for resilient and adaptive transport infrastructure to reduce vulnerability to extreme weather conditions. In light of this, NCCAP III assumes that in order to achieve the priorities there will be supportive policy, legal, fiscal, and regulatory frameworks.

Table 5-6. lists the various mitigation priorities that will be undertaken to ensure low carbon pathways in the transport sector.

Table 5-6. Priority mitigation actions in the transport sector

Priority Mitigation Action	Smart Target	Reference / Remarks
From piloting to commercialisation of e-mobility through PPP approach	• E-mobility policy is developed and adopted by 2024 • 50 e-mobility charging infrastructure developed, each year targeting 10 charging points. • Commissioning of local manufacturing of electric motors. • The private sector seeks to invest in another 1,000 electric bus fleets by 2027. • There are reported about 30 two-wheelers organisations in the country. • Deploy electric vehicles (150 electric buses, 50 GoK passenger cars). • Implement / Provide appropriate incentives to increase uptake. • Develop and implement Standards for electric/hybrid vehicles in Kenya.	Sector consultation

Priority Mitigation Action	Smart Target	Reference / Remarks
Reduce traffic congestion in major cities	Design and implementation of Intelligent Transport Systems (ITS) including Traffic Management Centre (TMC). Construction of 70 km of the Bus Rapid Transit (BRT) for Nairobi Metropolitan Area (BRT Design, Infrastructure, Equipping, and Operation). Shifting freight from road to rail to 30%.	Sector consultation
Enhancing efficiency in public transport operation	Improved intermodal connectivity for rail, road, air, and NMT. This includes improved transportation to and from airports and rail stations, e.g., BRT and rail line to JKIA, BRT connection to the commuter rail, Commuter rail line to JKIA. Expansion of the Commuter rail in cities (including in Nairobi and Mombasa). Improving matatu operations/public transport operations, upgrading of fleet.	Sector consultation
Development and improvement of Non-Motorised Transport	Build 500 km of non-motorised walkways and cycling lanes in major cities	Sector consultation
Enhancing cargo to rail transition	Extension of SGR from Naivasha–Kisumu–Malaba: (Naivasha–Kisumu 2B (262 km), Kisumu–Malaba 2C (107 km) Construction of 20 stations in Nairobi Development of integrated climate-resilient rail cities (Eldoret and Nairobi) Modernisation, Upgrading, and rehabilitation of the meter gauge railway system. Modernisation of railway fleet: Locomotives, Wagons, Diesel Multiple Units (DMUs) Cool logistics for movement of fresh produce through railway and sea	Sector consultation
Promote alternative technologies and fuels	Development of sustainable fuels including green hydrogen, SAFs, LPG, marine fuels. Construction of modern terminal buildings with natural light, smart lighting, more parking spaces for aircraft, solar panels, fixed electric ground power units at JKIA. Upgrading of JKIA runway to reduce runway occupancy time. To reduce fuel burnt for arriving and departing aircraft. Development of a 2nd runway to reduce fuel burn, due to simultaneous take-offs and landings. Installation of solar power plants at JKIA and other major airports to reduce energy demand.	Sector consultation

Other opportunities exist within the maritime sector. These include:

- Increasing the number of water buses as a means of transport where feasible.
- Domesticating the annex (International Convention for the Prevention of Pollution from Ships [MARPOL] Annex 6).
- Implementing shore power (cold ironing).
- Developing solar and wind power at the port under review.

GHG Abatement Potential

The transport sector offers the potential to abate up to 3.1 $MtCO_2eq$ by 2027, as illustrated in Table 5-7.

Table 5-7. GHG emission mitigation potential in the transport sector

	2010	2015	2020	2022	2025	2027
Business as Usual Emission (MtCO2eq)	6.17	8.81	12.29	13.32	15.30	16.95
Mitigation Action Emission (MtCO2eq)	6.15	8.76	10.76	11.75	12.89	13.90
GHG Emission Reduction (MtCO2eq)	-	-	1.5	1.6	2.4	3.1

5.3 Industrial Process and Product Use

Industrial processes and product use are particularly challenging to decarbonise. They entail significant transformations in products or fundamental changes to manufacturing processes. For example, in cement production, reducing process emissions would require substantial alterations, such as shifting to alternative raw materials for cement production. Currently, the main process involves heating calcium carbonate to produce calcium oxide, a step that releases carbon dioxide as an intermediate raw material for clinker manufacture.

Similarly, product emissions are mainly attributed to the use of refrigerants, during the repair process or at the end of the refrigerator's life cycle, HFCs are released into the atmosphere. The Kigali Amendment requires countries to completely shift from HFC refrigerators to hydrocarbon refrigerators, and Kenya is aiming to comply by signing the agreement.

The trends in production processes with significant implications for GHG emissions are shown in Table 5-8, while the trend of the use of high-global warming potential HFCs is illustrated in Table 5-9.

Table 5-8. Emission trend in mineral and chemical processes

	2010	2015	2020	2022	2025	2027
Minerals	**1,669**	**2,784**	**3,301**	**4,071**	**5,011**	**5,694**
Cement	1,620	2,731	3,247	4,018	4,945	5,619
Lime	39	43	43	43	53	60
Glass	11	11	11	11	14	15
Chemicals	**62**	**44**	**35**	**39**	**48**	**55**
Soda Ash	62	44	35	39	48	55
Total	**1,731**	**2,828**	**3,336**	**4,111**	**5,059**	**5,749**

Table 5-9.Trend in GHG emission in refrigeration and air conditioning

	2010	2015	2020	2022	2025	2027
HFC-125	15.5	29.5	34.9	34.9	118.3	167.8
HFC-134A	56.3	62.6	63.0	63.0	213.6	303.0
HFC-143A	14.4	14.4	16.7	16.7	56.8	80.5
Total	**86.2**	**106.5**	**114.7**	**114.7**	**388.7**	**551.3**

Table 5-10 presents priority mitigation actions for the 2023–2027 period. The focus is on reducing consumption, exploring alternative production methods such as non-motorised transportation and brick construction, and conducting a feasibility study on carbon capture and storage.

Table 5-10. Priority mitigation actions under IPPU

Priority Mitigation Action	Smart Target	Reference / Remarks
Promotion of sustainable cooling and adopting low carbon refrigerants	Better servicing and reduction of HFC by 50% in 2027. The report assumes about 50% of the emissions comes from Refrigeration, Air Conditioning and Heat Pumps (RACHP) during servicing.	Kenya LTS; Sustainable cooling strategy
	Implementation of 10% adoption of low GWP hydrocarbon refrigerants in 2027.	
Alternative construction materials	Reducing brick and mortar by adopting innovative building technologies including laminated timber panels, interlocking bricks and composite materials. Targeting halving cement use in new buildings by 2027.	Kenya LTS
Advancing state of the art technologies in carbon sequestration	Carrying out feasibility studies and case studies for carbon capture and storage in Kenya. Piloting a small-scale CCS technology in one of the cement factories for data collection policy advice.	Kenya LTS
Energy transition and increased adoption of efficient charcoal kilns	Distribution of 195 efficient charcoal kilns in charcoal hotspots in Kenya.	Consultation with sector leads

GHG Abatement Potential in Charcoal Production

Specific assumptions and targets included in sustainable charcoal production included the dissemination of 195 kilns. In the NCCAP 2023–2027, it was further assumed that the kilns will be distributed in the major charcoal hotspots—Narok, Kitui, and Makueni (accounting for 75% of the market share). These kilns would serve as a conservative estimate of 60% of charcoal production from the hotspots. Hence, overall, 45% of charcoal produced would be from efficient kilns nationally. GHG abatement from charcoal includes a reduction in charcoal consumption, thereby organically reducing demand and production, and energy-efficient kilns reducing the number of biomass conversions. Both direct mitigation from the deployment of efficient kilns and indirect mitigation from reduced charcoal demand would result in 0.5 million tonnes of CO_2eq reduction.

GHG Abatement Potential

By implementing the priorities in charcoal production efficiency, alternative building materials, and low-carbon refrigerants, a total abatement reduction of 1.8 $MtCO_2$eq is predicted, as illustrated in Table 5-11.

Table 5-11. GHG emission in IPPU

	2010	2015	2020	2022	2025	2027
Business as Usual Emission (MtCO2eq)	3.2	4.1	4.5	5.2	6.6	7.5
Mitigation Action Emission (MtCO2eq)	3.2	4.1	4.5	5.2	5.4	6.1
GHG Emission Reduction (MtCO2eq)	-	-	-	-	1.1	1.4

5.4 Agriculture

Proposed Mitigation Actions for the 2023–2027 Period

The priority mitigation actions were crafted based on the fourth medium-term plan (MTP IV). The MTP IV considers seven value chains as priority for strategic focus for national development, including livestock consisting of meat, leather, and dairy, and crops consisting of tea, edible oils, rice, textile, and apparel. The government is looking into such activities as feedlots and feed production zones, modernisation of milk, meat, and honey processing plants, construction of food processing hubs, and mechanisation. All these activities have varied carbon footprints. The sector's growth projection as articulated in MTP IV is shown in Table 5-12 Growth projection in key agricultural sectors in accordance with MTP IV.

Table 5-12. Growth projection in key agricultural sectors in accordance with MTP IV

S/No.	Priority	2022	2027
	Milk production	5,280 million litres	6,739 million litres
	Leather production	9,084 MT	18,900 Mt
	Jobs from leather value chain	17,000	100,000
	Maize production	34.3 million bags	50 million bags
	Rice production	192,292 MT	400,000 MT
	Irish potato production	1,800,000 MT	4,000,000 MT
	Production of clean coffee	51,900 MT	150,000 MT
	Tea production	535,000 MT	745,000 MT
	Production of edible oils	80,000MT	400,000 MT
	Cotton production	5,486 MT	200,000 MT
	Share of manufacturing contribution to GDP	7.8 per cent	15 per cent
	Value of wholesale and retail trade	KES 1,042 billion	KES 1,267 billion
	Value of export earning	KES 873.1 billion	KES 1,115 billion

Source: Medium Term Plan IV, 2023–2027

As such, the agricultural sector's proposed priority mitigation actions in the NCCAP 2023–2027 for crop production include upscaling adoption and sustained implementation of sustainable land management practices, agroforestry initiatives, and fruit and tree planting to contribute to the increase of national tree cover. Additionally, measures such as low carbon rice production, dairy intensification, and the adoption of sustainable alternative energy sources and energy efficiency practices throughout the agricultural value chain are emphasised. Numerous public and private-led initiatives have been identified to ensure that the sector achieves its proposed actions and meets the specified targets.

Some of the private-led activities include, among others, the farm Africa Integrated Carbon Sequestration in the Regenerative Agriculture project, which integrates the Acorn methodology supported by the Rabobank Foundation. This initiative began implementation in 2023 with the goal of facilitating 50,000 farmers engaged in agroforestry to benefit from the sale of carbon credits based on the carbon sequestered from the trees they have planted. Two carbon farming programs under the OCP-Kenya[11] Limited programme are in the initial stages, with key activities focusing on identifying partners. Additionally, baseline study has been conducted on carbon farming in Kenya through individual interviews and focus groups. Other publicly-led activities are supported by the National Agricultural and Rural Inclusive Growth Project (NARIGP) and the Agricultural Sector Development Support Programme (ASDSP), which transitions to the Kenya Agricultural Business Development Project (KABDP). Specific priority mitigation actions are listed in Table 5-13.

Table 5-13. Agricultural sector mitigation actions

Priority Mitigation Action	Smart Target	Reference / Remarks
Upscale the promotion and adoption of sustainable land management	Promote sustainable land management through the National Land Policy and the Sustainable Land Management Policy, to conserve, stabilise, and strengthen the resilience of water catchments, including in rangelands.	Sector consultation
	a) Increase area under integrated soil nutrient management by 2,500,000 hectares	Sector consultation
	b) Support for increased rehabilitation of degraded land from 50,000 hectares to 150,000 hectares	Sector consultation
	c) Farm area under conservation agriculture to be increased from 53,200 hectares to 100,000 hectares incorporating minimum/no tillage	Sector consultation
Scale up area under farm forestry/trees for food and fodder	Increase the total area under agroforestry/farm forestry, fruit, and fodder trees at the farm level by 200,000 hectares	Sector consultation

[11] OCP is a global corporation in agricultural production. In Africa, the corporation seeks to improve fertility and productivity, fertilizers, and value chain development. https://www.ocpafrica.com/en/kenya

Priority Mitigation Action	Smart Target	Reference / Remarks
Increased rice production acreage under intermittent irrigation	Increase production of rainfed rice (from 44,255 hectares to 140,677 hectares, reduce emissions from paddy rice production systems. Increase production of intermittent irrigation from 25,000 hectares to 140,677 hectares	Sector consultation
Energy efficiency in agricultural value chain	The sector will work towards enhancing energy efficiency and alternative, renewable energies in the areas of: - Promotion of solar-powered irrigation system, - Promotion of bioenergy powered from agricultural waste for farm operations such as biogas from plant biomass i.e., kitchen waste and livestock waste - Enhanced energy efficiency in food preparation and alternative renewable energy improved *jikos*, solar cookers, latent heat (fire cookers) of 500 households per County - Sustainable cooling technologies as detailed in the dairy NAMA - Enhanced energy efficiency in farm machineries - 2 million farmers adopt climate-smart post-harvest technologies (e.g., green energy-powered cold storages, solar crop dryers, etc.	Sector consultation
Reduced livestock emission through climate-smart animal husbandry and manure management on-farm	- Manure management for biogas generation and bio-slurry - Rangeland management through ring-fencing and pasture land rehabilitation - Intensification of animal productivity through artificial insemination, embryo technology, and improving feeds to enhance high production while maintaining low population of cattle	Sector consultation
Manure management	80,000 livestock households supported to adopt improved manure management systems (composting, anaerobic digesters technology, etc.)	Sector consultation

The sector growth plan is tied to the government's ambition to improve and grow the agricultural sector and strategic targets. In areas where there are no actual targets identified, the growth trend shall adopt the progressive growth on agricultural GDP contribution. The mitigation actions are thus built upon the priority actions described in Table 5-13. Specifically targeting manure management through aerobic digestion for dairy farmers while aligning with the energy sector priorities. In the energy sector, about 21% of the total population in rural areas will be using biogas for cooking. This is about 1.3 million households adopting biogas technology. Thus, the 80,000 farmers who will be supported to adopt improved manure management systems, including biodigester, would synergise with the energy sector. Moreover, under sustainable land management, the agricultural sector

aims for 2.5 million hectares under soil nutrient management. Bio-slurry (a byproduct of biodigester and biogas capture) is rich in nutrients and with 1.3 million families adopting biogas production and using bio-slurry on their farms would contribute to the key performance indicators of the priority area on sustainable land management.

Moreover, under the sustainable land management practices, one contributing factor to nitrous oxide emissions is the disturbance of soil and fertiliser application. The priority action targets to increase the area under minimum/zero tillage from 53,200 hectares to 100,000 hectares, which represents only about 4% of the total cultivated area. Ordinarily, the IPCC default value for direct nitrous oxide emission in tropical regions is 10 kg N_2O-N ha $^{-1}$ y^{-1} and an indirect emission factor of 6.3 kg N_2O-N ha $^{-1}$ y^{-1}(IPCC, 2006). In this case, the consideration of emission factors under zero tillage is only associated with indirect nitrous oxide emission.

Rice production, as one of the key pillars of ensuring food security in Kenya, is expected to increase from 2 tonnes to 2.8 tonnes per acre. Also, the crop land for rice production is projected to rise from 44,255 hectares in 2021 to 140,677 hectares in 2027. The production is categorised into rainfed upland, rainfed lowland, and irrigated farms, accounting for 15%, 18%, and 67% respectively of the total rice production area. While maintaining projecting the total land coverage for rice production at 140,677 hectares in 2027, in the same percentage proportions, irrigated land fields will be 94,254 hectares. In a low-carbon pathway, the country will focus on transitioning 100% from irrigated to intermittent irrigation of the irrigated rice fields, as illustrated in Figure 5-7.

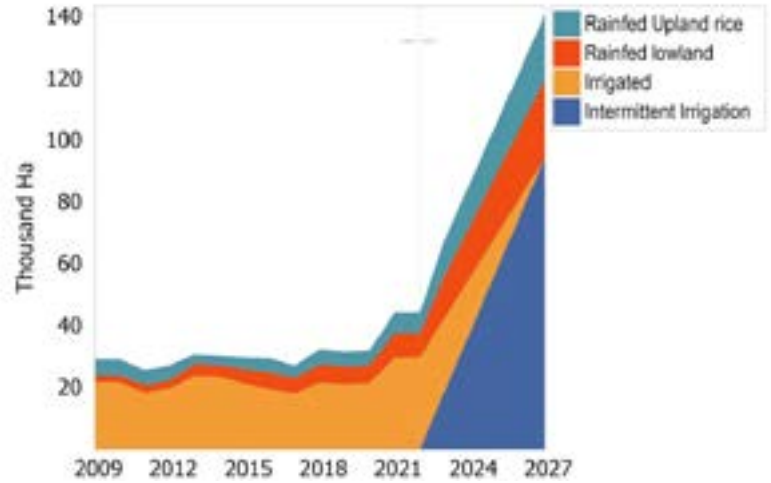


Figure 5-7. Evolution of rice production in the intensified rice production scenario

The high-growth projection in the agricultural sector, which targets biotechnology in cotton production, increased rice production, development of the edible oil value chain, enhancement of the tea value chain, and distribution of low-cost fertilisers, would lead to a significant increase in fertiliser use in Kenya. It is anticipated that fertiliser use will double from approximately 0.75 million metric tonnes annually to about 1.4 million metric tonnes.

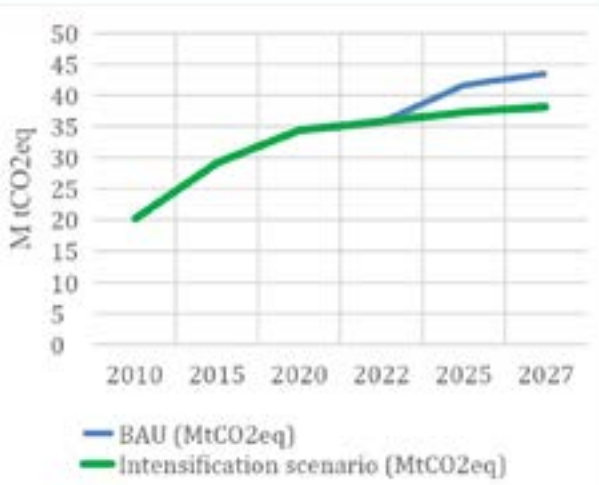
Finally, while it has been observed that the population of animals has doubled in 10 years leading to an increase in enteric fermentation, the livestock production sector is aiming to stabilise

the growth rate of animals, especially dairy and free-range cattle, while increasing productivity through various measures such as artificial insemination, embryo technology, and feed enhancement, among others. As such, in the next five years, a conservative annual growth rate of dairy cattle was assumed to be 0.1%, and that of free-range cattle at 0.5%.

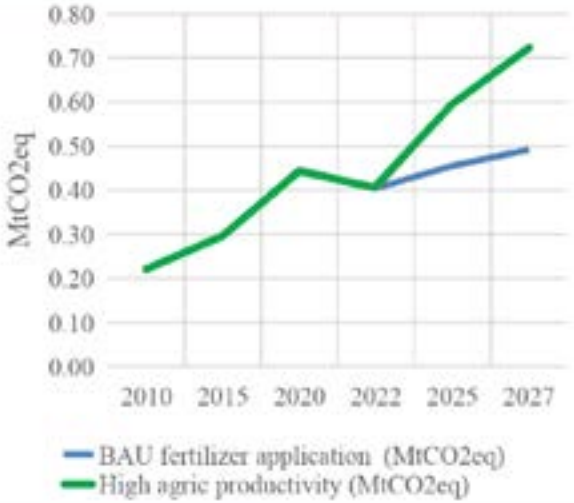
GHG Abatement Potential

The total abatement potential against business as usual is 6.6 $MtCO_2eq$, as illustrated in Figure 5-8e and Table 5-14. Yet, the emission under mitigation action is still projected to be much higher in 2027 compared to the projected reference, due to the reasons mentioned in the previous chapter. In respect to BAU, intensification of livestock production, aiming to reduce the growth rate of large ruminants while maintaining productivity to meet the needs of the Kenyan population, will contribute to the highest emission reduction of 5.31 $MtCO_2eq$ avoided from enteric fermentation in cattle, as shown in Figure 5-8a. MTP IV. However, the MTP IV seeks to increase agricultural productivity by increasing fertiliser application. In this respect, there is projected higher emission against the BAU by 0.23 MtCO2eq, as illustrated in Figure 5-8b. Sustainable land management practices such as minimal and zero tillage agriculture are still in the initial stages. The target of 100,000 hectares of land set for 2027 represents a small proportion (less than 2.5%) compared to the total crop land; hence, its impact on reducing GHG emissions is minimal. Intermittent irrigation of rice farms is expected to reduce up to close to 57% of BAU emissions, equivalent to 0.85 $MtCO_2eq$. Finally, production of biogas from animal dung is expected to reduce very minimal emission, as depicted in Figure 5-8d, as it only targets dairy cattle, which is a small proportion compared to the livestock population. Moreover, in the entire computation, manure management would only constitute less than 10% GHG emission in livestock enteric fermentation and manure management emissions.

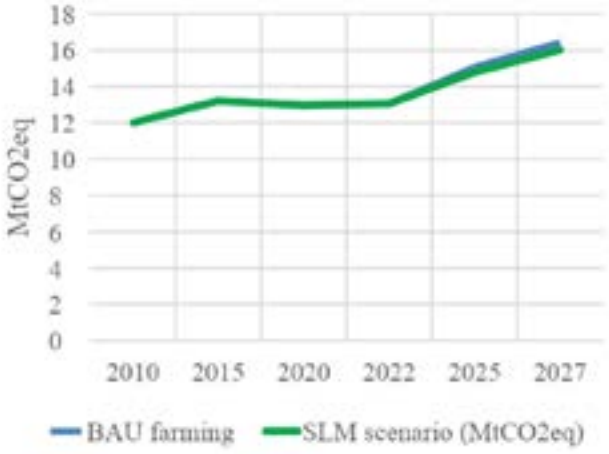
a) Intensified livestock production



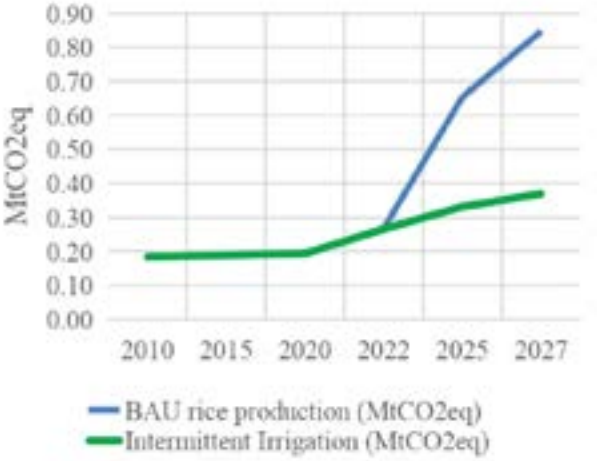
b) High agricultural productivity



c) Sustainable land management



d) Intermittent rice irrigation



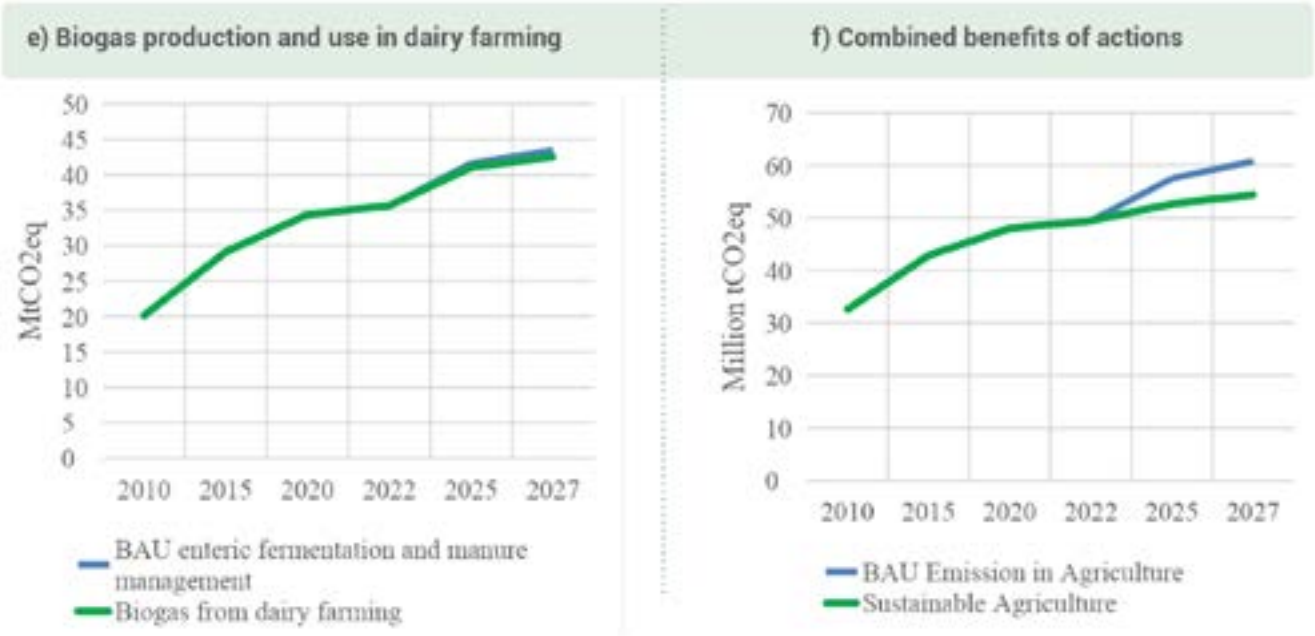


Figure 5-8. GHG emission in different modelled scenarios against the BAU

Table 5-14. Summary of emission reduction

	2010	2015	2020	2022	2025	2027
Business as Usual Emission (MtCO2eq)	33.1	43.1	50.7	53.5	57.7	60.6
Mitigation Action Emission (MtCO2eq)	32.6	43.0	48.1	49.5	52.5	54.0
GHG Emission Reduction (MtCO2eq)	-	-	2.6	4.0	5.3	6.6

5.5 Waste

The waste sector emission abatement outlined in the NCCAP 2023–2027 comprises two main activities aimed at reducing waste generation and managing residual waste in a sustainable manner. The first intervention focuses on waste prevention and reduction at the source, along with minimising waste reaching landfills. This involves integrating waste reduction into production processes, using eco-friendly inputs and packaging, better designing of products for enhanced durability, reusability, and recyclability, implementing better segregation at the source, reducing excessive packaging, promoting efficient resource use, adopting green procurement practices, and extending product lifecycles. The goal is to divert about 90% of waste from landfill sites.

Secondly, biodegradable materials, including organic and kitchen waste, waste generated in agriculture due to poor post-harvest management, unsold produce from marketplaces, fresh and rotten vegetable waste, expired grain products, and agricultural waste at the farm level, which are biodegradable under controlled aerobic conditions, will be managed through sanitary landfills. It is anticipated that 80% of the total biodegradable waste will undergo composting, while the remaining 20% will be directed to landfills for waste-to-energy recovery.

The county governments are primarily responsible for the implementation of waste management, including refuse removal, refuse dumps, and solid waste disposal. Table 5-15 summarises the priority actions in the waste sector.

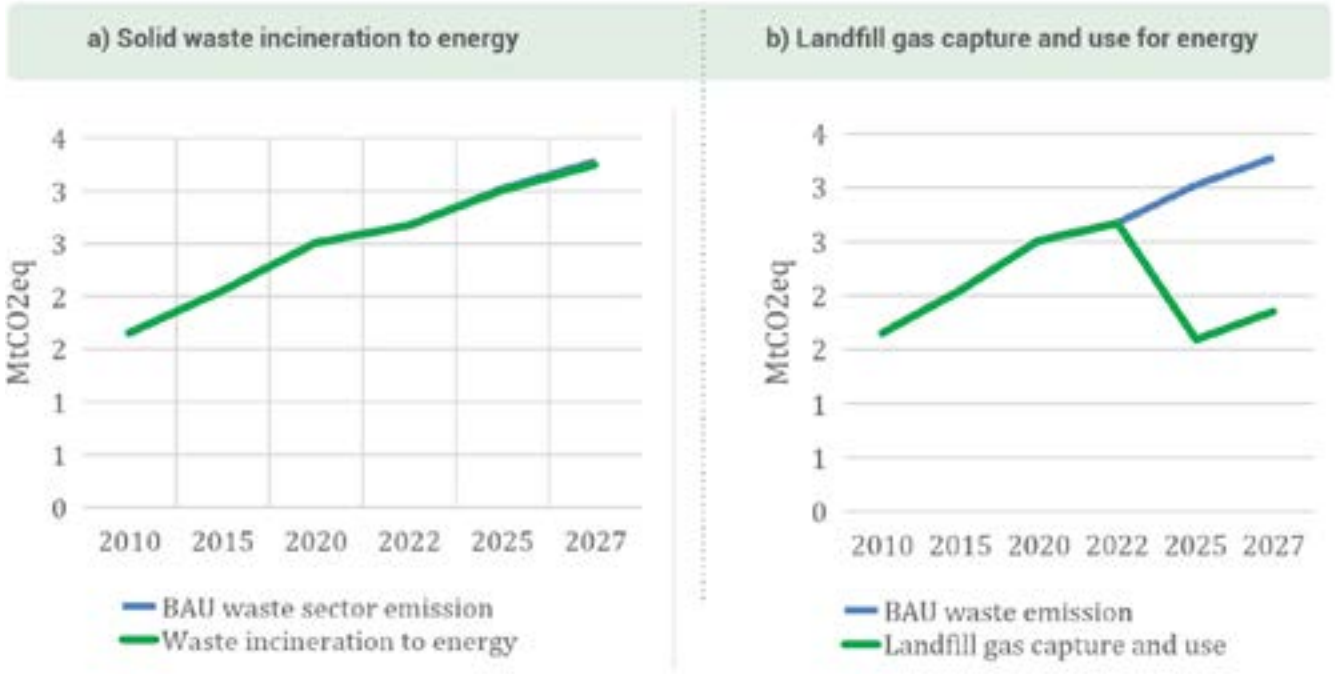
Table 5-15. Summary of priority mitigation actions in waste sector

Priority Mitigation Action	Smart Target	Reference / Remarks
Expansion of non-burn technologies for hospital waste treatment	Installation of clinical waste microwave equipment and non-burn technology in all 47 counties aims to increase the coverage of non-burn technology. This initiative enables counties to manage medical waste management through a pooled system among health facilities.	Sector consultation
Expansion of implementation of waste recycling, composting and waste-to-energy and managed landfill	- 90% waste diversion from disposal sites by promoting recycling, re-use, and industrial symbiosis in Nairobi. - Implement Extended Producer Responsibility (EPR) for all producers. - Attain 80% waste recovery through composting and 20% for waste-to-energy in sanitary landfills. - At least one material recovery facility in each of the 47 counties, targeting 95% of all post-consumer materials to undergo full lifecycle by 2025. - A Circular Economy Solid Waste Management Approach for urban areas.	Sustainable Waste, Management Policy 2021/ Sustainable Waste Management Act, 2022

Priority Mitigation Action	Smart Target	Reference / Remarks
Managed landfills	80% controlled dumping, including tipping, compacting, and recovery, in at least one urban area in 20 counties.	Updated NDC, 2020

GHG Emission Abatement Potential

The waste sector has shown positive gains in emission reductions compared to the reference. The overall GHG emission abatement is 2.5 $MtCO_2eq$ against the baseline (reference), as illustrated in Table 5-16 and Figure 5-9c. The amount of solid waste incinerated is much less than solid waste disposed of in dumpsites and liquid waste. Implementing managed landfills by 2025 will reduce about 50% of GHG emissions from dumpsites. However, if the population continues to grow without expanding sanitary landfills, the GHG emission trajectory will start to rise again, as illustrated in Figure 5-9b. The greatest achievement is obtained by reducing the waste that reaches the dumpsite and using managed landfills with gas capture, which will reduce emissions by about 78%, as illustrated in Figure 5-9c.



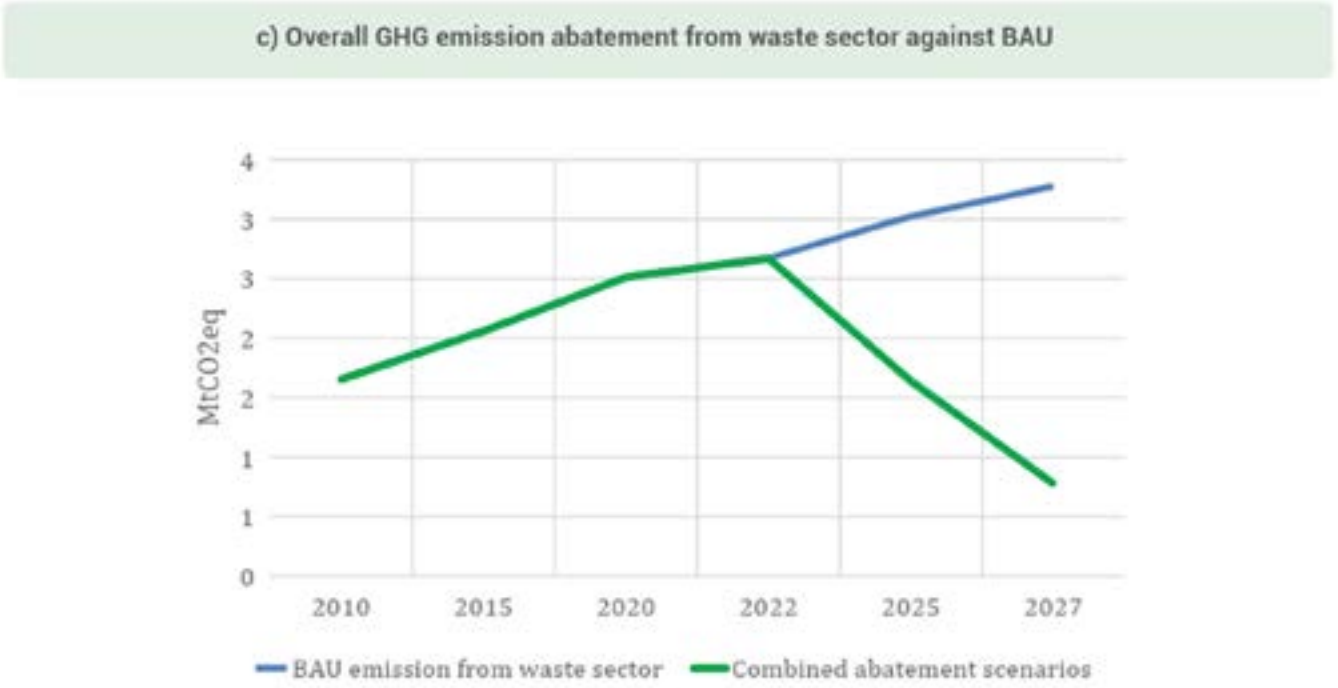


Figure 5-9. Summary emission projection in different scenarios

Table 5-16. Summary emission abatement potential

	2010	2015	2020	2022	2025	2027
Business as Usual Emission (MtCO2eq)	1.7	2.1	2.5	2.7	3.0	3.3
Mitigation Action Emission (MtCO2eq)	1.7	2.1	2.5	2.7	1.6	0.8
GHG Emission Reduction (MtCO2eq)	-	-	-	0.0	1.4	2.5

5.6 Forestry

Table 5-17 lists and details priority actions for NCCAP 2023–2027. The country has an ambitious target of achieving 30% forest cover by 2032 (GoK, 2023b). An assessment recently conducted by KFS indicated a forest cover of 8.83% in 2021 (GoK, 2023b), compared to 5.9% in 2018 (MoEF, 2019), and a tree cover of 12.1% in 2021. Among other key strategies to be used includes the 15 billion trees drive.

Some of the key assumptions towards the implementation of forest sector priorities include:

- Relevant and accurate data will be available to track the emission targets.
- Availability of requisite resources.
- There will be enhanced ambition towards tree growing, improved capacity and monitoring technology, increasing interest in tree growing.
- National Strategy for Achievement of 30% tree cover by 2032 approved and funds allocated for implementation, favorable weather conditions expected for tree growing, increased human capacity at the county level, integrating tree growing into CIDP.
- There are existing best practices on restoration and participatory forest management can be upscaled. Several partners are providing technical and financial support, and well-coordinated efforts among them can achieve desired targets.
- Unsecured and unmarked forest boundaries may pose challenges, especially with adjacent communities misinformed about the actual boundaries.
- Availability of resources, integration of restoration efforts into CIDPs is crucial, conservancy management plans implementation, favorable weather conditions.

Table 5-17. Priority actions for NCCAP III

Priority Mitigation Action	Smart Target	Reference / Remarks
1. Reduce emissions from deforestation through: • An additional 1% of existing forest cover afforested or reforested, including via agroforestry. • Planting of trees in counties annually through initiatives such as: Annual National Tree Planting Day; Tree planting drives in institutions including faith-based institutions; Involving youth and youth-led enterprises in tree planting. • Expanding and protecting mangrove forest cover, including implementing the National Mangrove Ecosystem Management Plan (2017-2027).	Reduce deforestation by rehabilitating and protecting an additional 100,000 hectares of natural forests (including mangroves) by 2028 via: • Community participation in forest management; • Limiting access to forests; • Preventing disturbances through improved enforcement and monitoring; • Developing alternative technologies to reduce demand for biomass (e.g., clean cooking, efficient charcoal production, briquetting); • Carbon stock enhancement (tree planting) in existing forests; • Financial innovations, including payments through REDD+ / carbon markets.	National REDD+ Strategy, 2021; Draft strategy for landscape and ecosystem restoration; MTP IV (2023–2027)

Priority Mitigation Action	Smart Target	Reference / Remarks
2. Reduce emissions from forest degradation through: • Securing forest boundaries; Counties to develop spatial plans with clear forest opportunities identified. • Social fencing (Community/participatory forestry management). • Preventing forest disturbances through improved enforcement and monitoring, limiting access to forests, and controlled livestock grazing. • Carbon stock enhancement in existing forests to support biodiversity. • Promote adoption of efficient energy technologies to reduce demand for wood biomass. • Promote alternative technologies to reduce demand for biomass. • Improve processing efficiency of forest materials, including increasing recovery rates from 30%. • Expand the accounting for carbon from sequestration to storage and material substitution in forests and forest products.	Reduce Forest degradation by rehabilitating and protecting an additional 100,000 hectares of natural forests (including mangroves) by 2028 via: • Community participation in forest management; • Limiting access to forests; • Preventing disturbances through improved enforcement and monitoring; • Developing alternative technologies to reduce demand for biomass (e.g., clean cooking, efficient charcoal production, briquetting); • Carbon stock enhancement (tree planting) in existing forests; • Promote the adoption and use of efficient charcoal kilns; • Considering the high proportion of renewable biomass used to produce charcoal (between 90% and 95%), these measures could lead to 5.7 million m3 Round Wood Equivalent (RWE) of non-renewable biomass savings per year from dry forests; • Improving harvesting techniques has the potential to cut logging waste from harvesting volumes by 5%.	National REDD+ Strategy, 2021; Draft strategy for landscape and ecosystem restoration; MTP IV (2023–2027)

Priority Mitigation Action	Smart Target	Reference / Remarks
3. Reduce emissions from land degradation outside forest through: • Monitor and quantify emissions reduced from restored degraded rangelands, farmlands, wetlands, and riparian ecosystems based on targeted acreage in the national forest-based initiatives (Forest and Landscape Restoration Implementation Plan [FOLAREP], 30% strategy etc.). • Enhanced restoration of degraded landscapes through the promotion of innovative and climate-resilient practices such as agroforestry, drought-tolerant tree species, value addition in non-timber products, ecotourism, among others. • Validate and upscale sustainable land management practices such as promoting improved fallows, building soil organic matter, and soil organic carbon.	Restoration of up to 1,000,000 hectares of forest on degraded landscapes (ASALs, rangelands)	National REDD+ Strategy, 2021; Draft strategy for landscape and ecosystem restoration; MTP IV (2023–2027)
4. Incentivise tree growing value chain enterprises through: • Promote establishment of woodlots on private land. • Incentivise and create an enabling environment for commercial forestry enterprises across the value chain. • Promoting the use of sustainable timber in the furniture and construction industry, including the use of mass timber technologies. • Developing a framework for forest long-term forest leases of public industrial plantations for greater productivity. • Linking tree growing initiatives to carbon market incentives. • Incentivise production of tree seedlings at scale, including by the private sector (women, youth, Community Forest Associations [CFAs], nurseries).	- Establish 5 million acres (20,000 km2) agroforestry woodlots in drylands; - Scale-up the Forest Stewardship Council (FSC) certification on KFS pilot sites to the entire 150k hectares of plantation forests and Tree Grower Associations and Outgrower models; - At least 20% of public industrial plantations under long-term lease agreements with the private sector; - Establish 75,000 hectares of private commercial forest plantations.	National REDD+ Strategy, 2021; Draft strategy for landscape and ecosystem restoration; MTP IV (2023–2027) BETA Agenda, 2023

GHG Abatement Potential

Kenya's forests serve as a significant carbon sink, contributing to Kenya's aim of achieving net-zero GHG emissions by mid-century. The projection for the forest sector was conservative, aiming for a 15% forest cover by 2050, which could result in a carbon sink of up to 41 $MtCO_2eq$ by 2050. During the planning period, the projection showed an abatement of 37.3 $MtCO_2eq$ compared to the BAU and 7.6 $MtCO_2eq$ against the reference projection in the first NDC. However, as mentioned earlier and illustrated in Table 5-18, the FRL forest emission modelling showed much higher values in all years compared to the emission analysis based on the national forest inventory.

Table 5-18. Summary forest sector GHG abatement

	2010	2015	2020	2022	2025	2027
Baseline emission based on FRL analysis (MtCO2e)	38.5	40.9	52.3	52.3	52.3	52.3
NCCAP III mitigation scenario (MtCO2e)	38.5	40.9	52.3	52.3	28.1	15.0
Emission reduction potential against the BAU (MtCO2e)			0.0	0.0	24.2	37.3

Some of the identified risks and ways to mitigate them in the implementation of priority actions in the forestry sector are listed in Table 519.

Table 5-19. Risks and mitigation measures in implementing forestry sector actions.

Identified risk	Classification/category of risk	Ways to mitigate the risk
Inadequate requisite resources (Human and financial)	Economic risk, Level: High	Leverage partnerships and collaborations
Uncoordinated mangrove conservation and restoration actions	Social risk, Level: High	Streamline actions and reporting mechanisms through Kenya Forest Service with advice from the National Mangrove Management Committee
Litigation by citizenry on violated rights	Social risk, Level: Moderate	Compliance with laws and regulations; Undertake Stakeholder Consultations
Weak information sharing and management	Social risk, Level: Low	Build capacity for sharing and management





Chapter 06

Implementation Plan

During the implementation period of the NCCAP 2023–2027, climate change efforts will primarily focus on prioritised measures for both mitigation and adaptation. The potential of mitigation actions has been extensively studied in Chapter 4 of this MTAR, while the analysis of adaptation potential and broader benefits was conducted in ATAR 2023–2027. These technical reports are integral parts of the NCCAP 2023–2027. This chapter outlines the implementation of prioritised mitigation actions outlined in the MTAR, including progress measurement, reporting, and verification. Detailed plans will be created at both sectoral and county levels.

6.1 Overview of Implementation Plan

The Implementation Plan outlines the strategic steps, actions, and timelines required to achieve the goals and targets set in the plan. Serving as a roadmap, it guides the systematic and efficient implementation of climate change mitigation measures across various sectors. This plan is a critical tool to ensure that the objectives of the NCCAP are translated into actionable steps that result in meaningful change.

Key elements described in the Implementation Plan include:



1. **Issues and Problem Statement:** These are the outstanding issues affecting the sector that need to be addressed through national development plans in a low carbon pathway.
2. **Sectoral Priorities and Targets:** The plan identifies specific sectors and sub-sectors that need attention and outlines their corresponding mitigation goals. These sectors include energy, agriculture, forestry, transportation, waste management, and agriculture as outlined in the MTAR.
3. **Action Items and Measures:** The plan outlines concrete actions and measures required to achieve the set targets within each sector. These actions include policy development, capacity building, technological adoption, infrastructure development, awareness campaigns, and other relevant initiatives.
4. **Timelines and Phases:** The plan provides a clear timeline for the implementation of each action. In this MTAR, all plans are targeted for the next five years, and no phasing has been done to identify what should be implemented in the short or long term.
5. **Responsibilities and Partnerships:** It specifies the responsible government agencies, institutions, and stakeholders for each action. Effective partnerships between government bodies, civil society, the private sector, academia, and international organisations are crucial for successful implementation.
6. **Resource Mobilisation:** The plan outlines the financial and technical resources required for each action. It identifies potential sources of funding, such as government budgets, international grants, private sector investments, and climate finance mechanisms.
7. **Monitoring and Evaluation:** The plan incorporates a robust system for monitoring and evaluating progress. In this MTAR, we have identified key indicators and expected outcomes of each action that would be used to measure their impact on climate change mitigation.

8. **Adaptive Management:** The plan acknowledges that flexibility and adaptability are essential as circumstances change. It includes provisions for reviewing and updating actions based on emerging information, new technologies, and changing priorities.

6.2 Implementation Approach

Sector: Energy Demand
Issue Problem: Energy demand issues are two-pronged: overreliance on biomass fuel for domestic use and energy inefficiency in industrial sectors. Continued use of biomass fuel has not only resulted in indirect forest emissions but has also compromised the health and well-being of the Kenyan people, while simultaneously contributing to the destruction of biodiversity and the Kenyan heritage. On the other hand, inefficiency in the manufacturing sector has increased the demand for fossil-based fuels exacerbating the burning of coal and heavy diesel oil for industrial production and further increasing national GHG emissions.
Strategic Objectives: • Promote energy and resource efficiency in the manufacturing sector. • Promote clean and affordable alternative energy sources. • Encourage the transition to clean cooking to reduce the demand for fuelwood. • Expand green building design and adoption.
Assumptions: • Priority mitigation actions will be initiated early, with a flexible and scalable approach. • Quick wins and big wins will be emphasised. • Resources, including finances, staff, and training, will be allocated for efficient implementation. • Risk assessments will be ongoing to address implementation challenges related to behaviour change.

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Enhanced energy efficiency	1. Implementation of MEPS. 2. Six (6) devices put under MEPS. Study report on the adoption and impact of MEPS. 3. Increase energy audits from the current 2,000 to at least 3,000. 4. Conduct at least 50 audits for cleaner production process optimisation. 5. 100 companies supported to map out their carbon footprint. 6. ESCOs approved for increased implementation rates of audits.	Reduced GHG emissions resulting from Energy conservation	• No of MEPS adopted. • No. of energy audits. • No. of process audits. • No. of companies' carbon footprint assessments done. • No. of ESCOs.	MoEP, EPRA, KAM, Kenya National Cleaner Production Centre (KNCPC), KEPSA, ESCOs.	5 years	2.4 billion
Expansion on green building design and construction	1. At least 30% of all new buildings certified as green buildings.		• No. of new buildings / percentage of new buildings certified as green buildings.	Ministry of Lands, Public Works, Housing and Urban Development, county governments, Kenya Green Building Society (KGBS).	5 years	

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Promote clean, affordable, and high-quality alternative renewable energy sources, including clean cooking technologies	1. Energy centres increased from 16 to 47 to enhance the dissemination of renewable energy technologies. 2. Increased promotion of alternative energy technologies including, biogas digesters, small hydro plants, and other clean cooking solutions. Selected targets include: • Develop 195 energy-efficient charcoal kilns. • 50% adoption of biogas and ethanol technologies. • 10% adoption of e-Cooking. • 75% adoption of biogas. • Transition 5,000 institutions to LPG. 3. Establishment of biofuel plants, including ethanol and biodiesel production technologies. 4. Enhanced data monitoring through the establishment of wind masts and data loggers.	Improved health through the adoption of clean cooking technologies	• No. of additional energy centres in counties. • No. of technologies promoted. • No. of biofuel plants established. • Capacity of biofuels produced in the plants. • No. of employees at the energy centres. • Type of data and frequency of collection and logging.	MoEP, REREC, county governments, private sector actors, academia/ research institutions.	5 Years	238 billion
Optimisation of geothermal energy for industrial productivity through direct heating	1. Waste heat recovery and use – Using waste heat form Menengai geothermal brine for manufacturing. 2. Steam and brine supplied to industries in the KenGen Green Energy Park. 3. The Menengai grain dryer is commercialised.	Optimise waste heat recovery from geothermal sources	Qty of heat recovered (GJ). Qty of steam supplied (GJ / cubic metre). No. of industries benefiting.	GDC, private sector industries.	5 years	11 billion

Sector: Electricity Generation						
Issue Problem: Kenya is on a positive pathway towards achieving 100% renewable electricity in the grid. However, the country faces challenges in successfully attaining 100% clean electricity. These include transmission and distribution losses, as well as inadequate transmission infrastructure to support the integration of variable renewable electricity into the grid.						
Strategic Objective: Ensure an electricity supply mix that is primarily based mainly on renewable energy, is resilient to climate change, and promotes energy efficiency.						
Priority Actions	**Expected Output**	**Expected Outcome**	**Key Performance Indicator**	**Responsible Agencies**	**Time Frame**	**Estimated Budget**
Intensification and optimisation of renewable electricity integration into the grid	1. **589 MW** of new renewables developed, including: Geothermal - 208 MW, Solar - 174 MW, Wind - 161 MW, and small hydropower.	A more environmentally friendly mix of electricity on the grid	• Capacity of renewable electricity commissioned in MW • Quantity of RE dispatched to the grid in GWh.	MoEP, KENGEN, REREC, Kenya Power, and private sector developers.	5 years	88 billion
Enhance power network expansion and improvement, as well as last-mile electricity access in both on-grid and off-grid areas	1. 2.3 million additional customers to the grid, including 30,000 public facilities. 2. 90,000 transformers installed and maximised. 3. 75,000 lanterns installed under the Public Lighting Project. 4. 200 solar-powered mini-grids developed in off-grid areas. 5. 50,473 standalone systems installed. 6. Transmission grid expanded by 2,930 km.	Towards universal access to modern and clean energy to achieve SDG 7	• No. of new customers connected to grid. • No. of public facilities connected to grid. • No. of transformers installed. • No. of solar lanterns installed and operational. • No. of mini-grids installed. • No. of customers connected to mini-grid. • No. of kilometres covered by new transmission and distribution lines.	Kenya Power, REREC, county governments, MoEP, private sector (Mini-grid developers), solar PV installers.	5 years	854 billion
Reduction of grid transmission and distribution losses	Losses in electricity transmission and distribution reduced from 23% to 16.5%.	Reduced indirect emission resulting from system losses	• Percentage of transmission and distribution losses recorded.	Kenya Power	5 years	0.5 billion

Sector: Transport						
Issue Problem: The transport sector is identified as one of the "hard to decarbonise" sectors in Kenya. Similar to other developing countries, road transport is predominant, with a large population of cars and public transport, leading to high GHG emissions. Rail transport and other mass rapid transit systems are underdeveloped. Moreover, despite having a non-motorised policy, cyclists face challenges due to the condition of non-motorised road tracks and their inadequate availability**.**						
Strategic Objective: Establish efficient, sustainable, world-class transport systems and logistics services that can withstand the projected impacts of climate change.						
Priority Actions	**Expected Output**	**Expected Outcome**	**Key Performance Indicator**	**Responsible Agencies**	**Time Frame**	**Estimated Budget (KES)**
Adoption of a mass transport system	1. 70 km of the BRT operational in the Nairobi Metropolitan Area. 2. Expansion of commuter rail in Nairobi and Mombasa, with an additional 52 km. 3. Promote a modal shift of passengers from road to rail.	A more sustainable transport system in Nairobi decongesting the city	• No. of km constructed. • No. of BRT buses operational. • No. of kilometres of MGR expanded. • No. of passengers using rail transport	Nairobi Metropolitan Area Transport Authority (NaMATA), State Department for **Transport** (SDoT), private bus operators, KRC.	5 years	42 billion
Promotion of Non-motorised Transportation Systems	500 km of NMT (walkways, cycle lanes) designed, constructed, and maintained.	Reduced GHG emissions due to more people opting for walking and cycling	• No. of km of NMT tracks.	KURA, KeRRA, KeNHA, and counties	5 years	5 billion

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Transition to e-mobility	1. Increased electric vehicle use, with expected targets including: • Deployment of more than 1,000 electric buses. • Adoption of e-cars by the government. • Adoption of electric 2–3 wheelers by the private sector. 2. Deployment of electric vehicle charging infrastructure. 3. Local manufacturing and use of electric vehicles including 2- and 3-wheelers. 4. Standards for electric/hybrid vehicles in Kenya developed and implemented. 5. E-Mobility Policy and requisite frameworks developed and implemented.	Reduced GHG emissions and enhanced air quality through the adoption of clean transportation	• No. of e-buses. • No. of E-GK. • No. public charging stations. • No. of assembly plants. • No. of standards.	Ministry of Roads and Transport (MoRT), Ministry of Investment, Trade and Industry (MITI), private sector, MoEP, county governments, NaMATA	5 years	27 billion
Expansion and greening of rail transport for reduced GHG emissions	1. Extension of SGR from Naivasha–Kisumu–Malaba: • Naivasha–Kisumu 2B (262 km). • Kisumu–Malaba 2C (107 km). 2. Ensuring 30% of freight shifted from road to rail 3. Increase in long-distance passenger shift to rail 4. Modernisation, upgrading, and rehabilitation of the meter gauge railway system. 5. Construction of 20 stations in Nairobi. 6. Modernisation of railway fleet: locomotives, wagons, DMUs. 7. Development of cooling logistics for the movement of fresh produce through railway and sea. 8. Greening rail corridors.	Reduced emissions through rail system expansion	• No. of kilometres. • Percentage of freight. • No. of Passengers. • No. of rail cities. • No. of stations. • No. of rolling stock. • No. of cold stores/centres/facilities. • No. plug in points at all Inland Container Depots (ICDs). • No. of wagons with cold facilities. • Area of greened rail corridors.	SDoT, KRA, KRC Kenya Ports Authority (KPA), cargo operators, county governments, private sector, KEPSA	5 years	554 billion

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Improve maritime transport and Explore alternative propulsion technologies	1. Promote adoption of energy-efficient technologies. 2. Uptake of low carbon fuels for vessels operating in Kenya waters e.g., green hydrogen, nitrogen, and ammonia. 3. Increase the number of water buses as a means of transport. 4. Domestication implementation of annexes 6 of the International Convention for the Prevention of Pollution from Ships. 5. Installation of shore power at the Port of Mombasa, including determining whether to use solar or wind power (berth 1).	Reduction in emissions from Kenya's marine sector	• No. of vessels using alternate fuels. • No. of water buses. • Annex 6 Domesticated. • Percentage of Annex 6 framework implementation. • E-mobility policy completed.	KMA, private sector, MoEP, MoRT, Maritime Agencies SDoT, KPA	5 years	1.3 billion
Improve air sector contribution to environmental sustainability and climate change resilience	1. Replace inefficient aircraft with more fuel-efficient engines. 2. Implementing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and report to International Civil Aviation Organization (ICAO). 3. Developing SAFs with lower life cycle CO2 emissions.	Reduced emissions from domestic air transportation	• No. of modern aircraft. • Percentage of implementation of carbon offsetting activities. • Type of alternative fuels adopted. • Qty of alternative fuels used annually in aircraft.	ALS Limited[12], Kenya Airports Authority (KAA), Kenya Civil Aviation Authority (KCAA), Air Navigation Service Providers (ANSP), Kenya Airways (KQ), Astral Aviation, MoEP, MoRT, Treasury, Kenya Pipeline Company (KPC), EPRA, Oil Marketing Companies (OMCs), Air carriers.	5 years	32 billion

[12] ASL limited is a chattered air craft operating at Wilson airport providing specialized aviation solutions. https://als.co.ke/about-us/

Sector: Industrial Processes and Product use

Issue Problem: Industrial processes such as cement production and the use of refrigerants remain challenging to decarbonise. However,, with climate change, increasing food security needs, and urbanisation, demand for these materials persists. A complete transition to alternative building materials and low GWP refrigerants is urgently required.

Strategic Objective:
To transition to low GWP refrigerants
To transition to alternative building materials

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Promotion of sustainable cooling and adopting low-carbon refrigerants	1. Improved servicing and 50% reduction of HFC emissions by 2027.		• Percentage of HFCs reduced.	Ministry of Investment, Trade and Industry, NEMA, private sector, KAM, KEPSA.	5 years	
	1. Implementation of 10% adoption of low GWP hydrocarbon refrigerants by 2027.		• Proportion of GWP refrigerants used in Kenya.			
Alternative construction materials	Reducing the use of brick and mortar by adopting innovative building technologies, including laminated timber panels, interlocking bricks, and composite materials. Targeting a halving of cement use in new buildings by 2027.		• No. of institutions trained on climate change. • No. of institutions conducting voluntary carbon footprint assessments. • No. of green technologies adopted. • No. of stakeholders adopting green technologies.			

Sector: Agriculture						
Issue Problem: Agriculture serves as a backbone of the Kenyan economy and is the highest foreign exchange earner. However, it also stands as one of the largest contributors to GHG emissions, primarily from enteric fermentation and the mineralisation of soil organic matter. The agricultural system in Kenya is predominantly characterised by traditional practices, with crop farming mainly reliant on rainfed methods and livestock rearing conducted extensively. To improve sustainability while simultaneously boosting productivity, Kenya must take deliberate steps to promote climate-smart agriculture.						
Strategic Objective: Enhance food and nutrition security by increasing the productivity and resilience of the agricultural sector while minimising carbon emissions.						
Priority Actions	**Expected Output**	**Expected Outcome**	**Key Performance Indicator**	**Responsible Agencies**	**Time Frame**	**Estimated Budget (KES)**
Improve livestock sector productivity through the implementation of CSA interventions	1. 1,000 Farmer facing SMEs supported to install milk coolers and meat chilling facilities. 2. Support 80,000 livestock households to adopting improved manure management systems such as composting and anaerobic digesters technology. 3. Increase the area under rehabilitated rangelands with good soil health to 5,000,000 hectares by implementing range planning, improvement, and reseeding activities covering 2,400,000 hectares in 23 ASAL Counties.	Improved livestock productivity while maintaining the current stock of animals	• Acreage (Ha) of rangeland reseeded with adoptable pasture species for use by farmers and pastoralists. • No. of pastoralist counties that undertake rangeland reseeding. • No. of households that have adopted anaerobic digesters for improved manure management. • No. of dairy farming households, categorised by gender.	SDLD, Ministry of Agriculture and Livestock	5 years	5 billion

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Promotion of sustainable land management practices	1. Increase the acreage under sustainable land management to 1,000,000 hectares: a) Increase area under integrated soil nutrient management by 2,500,000 hectares. b) Support increased rehabilitation of degraded land from 50,000 hectares to 150,000 hectares. c) Increase farm area under conservation agriculture from 53,200 hectares to 100,000 hectares, incorporating minimum/no tillage. f. Increase the total area under agroforestry/ farm forest at farm level by 200,000 hectares. g. Increase production of rainfed rice from 44,255 hectares to 140,677 hectares to reduce emissions from paddy rice production systems. Increase production of intermittent irrigation from 25,000 hectares to 140,677 hectares 2. 2 million farmers adopt climate-smart post-harvest technologies (e.g., green energy-powered cold storages, solar crop dryers, etc.).		• Dairy farmers adopting modern technologies. • No. of Cooperatives/ Community-Based Organisations (CBOs) with installed milk coolers and milk chilling equipment. • Percentage of reduction in post-harvest losses of livestock products (Milk and meat) • No. of pastoral households adopting Livestock Identification and Traceability System (LITS) • No. of Tropical Livestock Units (TLUs) registered under the LITS • No. of Counties implementing LITS	KALRO, private sector, farmers	5 years	7 billion

Sector: Waste						
Issue Problem: As Kenya's economy and cities experience rapid growth, the country's waste management challenges have increased in parallel with urbanisation and population expansion. The poor state of waste management poses significant concerns for public health and the environmental exacerbating pollution and emissions.						
Strategic Objective: To effectively address the waste challenge by implementing sustainable waste management practices that prioritise waste minimisation and contribute to a circular economy.						
Priority Actions	**Expected Output**	**Expected Outcome**	**Key Performance Indicator**	**Responsible Agencies**	**Time Frame**	**Estimated Budget (KES)**
Promote resource use efficiency and the circular economy in industrial processes	1. Implementation of EPR and formation of Producer Responsibility Organisations (PROs). 2. Implementation of cleaner production mechanisms in industries. 3. Promote industrial symbiosis in three Special Economic Zones.	Sustainable waste management	• No. of PROs formed. • No. of green industrial parks/ clusters. • No. of SEZ implementing industrial symbiosis. •	KAM, KEPSA, KNCPC, KIRDI, county governments	5 years	5 billion
Reduced emission from the incineration of medical waste	1. Installation of clinical waste microwave equipment (non-burn technology) for medical waste management in 37 counties.	Sustainable management of medical solid waste	• No. of medical waste microwaves procured, installed, and commissioned.	Ministry of Health (MOH), Ministry of Environment, Climate Change and Forestry (MOECCF) county governments, partners, NEMA.	5 years	3 billion

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Expansion and implementation of waste recycling, composting, waste-to-energy, and managed landfill	1. Diverting waste from disposal sites through recycling, re-use, and industrial symbiosis. 2. Promotion of waste recovery through composting and waste-to-energy in a sanitary landfill. 3. Establishing at least one material recovery facility in each county. 4. Implementation of mandatory EPR for producers. 5. Developing engineered sanitary landfills in at least five counties.	Turning waste into an economic resource	• Qty. of waste diverted from dump sites. • No. of material recovery centres established and commissioned. • No. of composting facilities established across the counties. • No. of private sector actors investing in waste recovery and reuse. • No. of producer responsibility organisations.	County governments, NEMA, Ministry of Environment, private sector; KEPSA, KAM	5 years	7 billion

Sector: LULUCF						
Issue Problem: Overreliance on biomass for fuelwood, logging, and expansion of agricultural land are three main causes of forest degradation and deforestation in Kenya. The government is seeking to avert these trends through deliberate and heightened promotion of farm forestry, agroforestry, and agricultural intensification.						
Strategic Objective: Increase forest cover to 30% of the total land area; rehabilitate degraded lands, including rangelands; and increase resilience in the wildlife and tourism sector						
Priority Actions	**Expected Output**	**Expected Outcome**	**Key Performance Indicator**	**Responsible Agencies**	**Time Frame**	**Estimated Budget (KES)**
Reduce emissions from deforestation and forest degradation	1. National Tree Growing and Restoration Campaigns targeting: 15 billion trees by 2032. 290 new tree nurseries. Rehabilitation of 5,000 hectares of public forest. Rehabilitation of 1,400 hectares of mangroves. 2. Restoration of 35,000 hectares of degraded public forest.	32% tree cover by 2032	• No. of trees planted and grown. • No. of new tree nurseries and their capacity. • Area of degraded public forest restored.	KFS, Kenya Forestry Research Institute (KEFRI) county governments, CFA, Kenya Plant Health Inspectorate Service (KEPHIS), Kenya Water Towers Agency (KWTA).	5 years	8.1 billion
Reduce emissions from land degradation outside forests	1. Scaling up sustainable land management practices in 35,000 hectares, such as improved fallows, building soil organic matter, and carbon on private and community land.	Enhanced productive ecosystem	• Sustainable land management reports. • Area of land under SLM.	KEFRI, KFS, Ministry of Agriculture and Livestock, county governments, development partners.	5 years	0.11 billion
Incentivise tree growing value chain enterprises	1. An Enabling environment for Bamboo value chain actors 2. Financial or non-financial incentives provided for commercial forestry.	A vibrant forest product value chain for sustainable economic growth	No. of hectares of bamboo commercial forest established. No. of hectares of commercial forest plantation established.	Private sector, KEFRI, KFS, county government, CBOs and NGOs	5 years	2.6 billion

Priority Actions	Expected Output	Expected Outcome	Key Performance Indicator	Responsible Agencies	Time Frame	Estimated Budget (KES)
Enhanced forest-based climate change research and technological development	1. Access to high-quality tree germplasm for the changing agroecological zones and end-market needs is improved. 2. Breeding drought-tolerant tree species. 3. Tracking and reporting on REDD+ implementation.	Resilient forests in ASAL regions	No. of tree species approved for dryland areas. Percentage implementation of REDD+.	KEFRI, KFS, county governments, and CFAs	5 years	0.12 billion

6.3 Overview of Implementation Plan

The enablers for the implementation of NCCAP III have been categorised into the following areas: policy, research, technology, and innovation; partnerships and collaborations; financial support; policy and institutional frameworks. These enablers are described as follows.

Policy, Regulation, and Strategies

- Encouraging increased energy efficiency and optimised resource usage through incentivisation strategies.
- Establishing a foundational energy efficiency benchmark for motors and lighting systems.
- Introducing a certification and labeling framework for charcoal products.
- Establishing 47 energy centres at the county level to actively promote the adoption of renewable energy sources.
- Continuing the ongoing development of the Kenya e-Cooking strategy, a pivotal tool for realising set objectives.
- Advancing the ongoing development of wayleave regulations.
- The State Department for Petroleum is actively working towards launching the Wananchi gas initiative. In its initial phase in Nairobi and its environs, this effort will provide a subsidised package including a 6kg cylinder, burner, and gas filling, all at a cost of KES 1,950 for users.
- Finalise the development of the E-Mobility policy.
- Nearing the finalisation of the Integrated National Transport Policy.
- Concluding the formulation of Kenya Civil Aviation Regulations (KCARs) within the framework of CORSIA.
- Reaching the final stages of the regulatory framework for preventing air pollution from shipping as per the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78).
- Updating and implementing urban planning and building control regulations to actively encourage compact development, mixed-use spaces, and a reduction in parking provision near MRT stations.

- Recognising the positive sentiment and opportunity among stakeholders for boosting the growth of 2-3-wheeler e-cycles, driven by the government's supportive stance.
- Implementing the Sustainable Waste Management Policy of 2021.
- Enforcing the provisions of the Sustainable Waste Management Act in 2022.
- Enforcing a ban on single-use plastics, including carrier bags.
- Ensuring the prohibition of single-use plastics within protected areas, an initiative enacted in 2019.
- Approaching the finalisation and rollout of extended producer responsibility regulations, designed to stimulate re-use, recycling, and the diversion of waste from the environment.
- Development of a national waste management public partnerships framework: County-based waste management plans and regulations that are consistent with the National Waste Management Strategy (NWMS) and other relevant policies developed.
- PPP Framework objective: a tool to guide Public-Private Engagements in well-structured investments and the delivery of public health services. Strategically and professionally manage the Healthcare Waste (HCW) arising from the healthcare services.
- Commencing the implementation of the Forest Tree Seed Regulations and the Kenya Commercial Tree Improvement Strategy.
- Undertaking the operationalisation of forest policies, regulations, and standards responsive to climate change, including:
  - Implementing the REDD+ Strategy and Forestry Policy.
  - Addressing the recommendations from the legal review of the National Forest Programme and the MECCF Strategic Plan.
  - Reviewing the Benefit Sharing Bill to accurately reflect the investment, risks, and returns inherent in the forestry sector.
  - Executing the legal review recommendations outlined in the National Forest Programme and the MECCF Strategic Plan.

Collaboration and Partnerships

Strengthened collaborations would results in better achievement of the priority actions. The action plan aims to strengthen existing collaborations while seeking new and strategic partners to deliver priority actions across sectors. Notably, the following networks and collaborations will be sought.

- The Kenya Industrial Research and Development Institute (KIRDI) has established fully equipped laboratories to facilitate research in renewable energy technologies and energy efficiency. These facilities include a comprehensive bioenergy laboratory for biogas research and the standardisation and optimisation of bio-slurry. Additionally, a Light Photo Spectrometry laboratory is available for testing lighting appliances, along with a motor testing dynamometer and a stove testing and research laboratory for assessing the performance of improved cookstoves and other energy-efficient measurement equipment. This institution is well-equipped with various tools and facilities conducive to supporting industrial development and rapid prototyping.
- The Strathmore Energy Research and Centre (SERC) has been actively involved in testing and training solar PV systems over the years. It has also played a role in incubating numerous entrepreneurs, particularly in the field of e-bike technologies for productive applications.

- Currently, there are around 30 private sector entities in Kenya engaged in e-mobility initiatives. These actors are collectively promoting the adoption of electric buses, cars, as well as two and three-wheeled vehicles.
- A priority is the establishment of effective methods for community engagement in the forestry sector, particularly concerning safeguards and benefit-sharing arrangements.

Capacity Building

- Providing training and raising public awareness about climate change adaptation and mitigation strategies.
- Facilitating Geothermal Development Capacity Building, training 60 participants annually through collaboration between KenGen, GDC, and other partners.
- Coordinating the training of 1,000 participants every year in renewable energy technologies through REREC.
- Organising training for 100 participants each year on renewable energy technologies by Kenya Power's Institute of Energy Studies and Research.
- Establishing a Public Information Centre on Nuclear Energy, Science and Technology aimed at promoting awareness of nuclear electricity generation.
- Providing capacity building for the construction and operation of nuclear power plants, focusing on nuclear scientists and engineers.
- Delivering annual training to 500 industry representatives covering climate change, circular economy, carbon footprint, and emerging climate change topics, in collaboration with the KAM.
- Engaging stakeholders and raising awareness about the interconnectedness of the climate change and energy sectors.

Technology and Infrastructure

- Compiled an inventory of efficient charcoal kilns across Kenya.
- As of June 2021, the total transmission network (400 kV, 220 kV, 132 kV) spanned 7,676 kilometres (according to the LCPDP 2022–2041). Additionally, plans are underway for further expansion of the transmission network, and the capacity of transmission substations reached 5,455 MVA, as outlined in the LCDP 2022–2041.
- A baseline study report on green hydrogen within the NCCAP 2018–2022 timeframe has been compiled.
- Plans are underway to enhance gas importation storage in Mombasa. Currently, privately-operated storage stands at 20,000 metric tonnes. The Petroleum Directorate aims to expand this capacity to 30,000 metric tonnes in the short term and an additional 15,000 metric tonnes in the medium term, creating a total of 45,000 metric tonnes of LPG storage. This expansion aims to lower storage costs and ultimately reduce the cost of LPG.

- By 2026, the goal is to establish natural gas infrastructure for importing LNG from Tanzania to Kenya. The initial agreement focuses on supplying LNG for power generation, including the Dongo Kundu LNG plant, as well as industrial applications.
- The Directorate of Petroleum plans to install LPG infrastructure, including storage tanks and piping, in public secondary schools. This initiative will also involve distributing gas burners to the participating schools.
- Establishing observatories to monitor the impacts of climate change within the forest sector.

Knowledge Management

- Enhancing the reliability and accountability of climate change emission mitigation by aligning private sector reporting with the national reporting framework.
- Conducting a survey on charcoal production and distribution in Kenya during the first year of the action plan implementation to guide the execution of the plan.
- Integrating climate change considerations within the private sector's institutional framework.
- Initiating natural gas exploration in Isiolo, with the expected commencement by 2027. The potential reserves in Isiolo County are estimated at 1.8 trillion Cubic Feet (TCF). An initial study on Natural Liquid Gas (NLG) in the shallow offshore areas is set to begin by the end of 2023, led by the State Department of Petroleum.
- KIPPRA will initiate a study to identify urban individuals living in poverty who can participate in the pilot phase of the Wananchi gas programme.

Finance

- **Avenues of Funding and Initiatives with Development Partners:** Kenya has access to a diverse range of funding avenues and collaborative initiatives with prominent development partners. These partnerships encompass organisations such as GIZ-Endev, UNDP, GCF, and ABC. These funding sources and partnerships play a pivotal role in supporting various projects and programmes aimed at addressing climate change challenges, fostering sustainable development, and promoting innovative solutions. Through these collaborations, Kenya can secure financial resources, technical expertise, and knowledge sharing to drive impactful initiatives across multiple sectors.
- **BasiGo Partnership with KCB Bank and Family Bank:** The BasiGo partnership marks a pioneering collaboration between KCB Bank, Family Bank, and stakeholders in the electric bus sector. This innovative partnership is structured to facilitate asset finance for prospective electric bus owners, enabling them to procure e-buses upfront. By providing asset finance, the partnership addresses the initial cost barrier associated with adopting electric buses. This initiative not only promotes the transition to eco-friendly transportation solutions but also stimulates the growth of the electric bus market. KCB Bank and Family Bank's involvement signify their commitment to advancing sustainable mobility and

supporting the reduction of greenhouse gas emissions in Kenya's transportation sector.

- **Accreditation of Kenya Commercial Bank (KCB) by GCF:** The accreditation of KCB by the GCF signifies a significant achievement for Kenya's financial landscape. GCF accreditation acknowledges KCB's capability to channel climate finance to projects and programmes that contribute to climate change mitigation and adaptation efforts. This accreditation enhances KCB's role as a financial intermediary, allowing it to directly manage and disburse GCF funds for initiatives aligned with climate goals. This partnership empowers KCB to play a more direct role in supporting climate-resilient and low-carbon projects, leveraging its financial expertise to drive sustainable development in Kenya.

Research and Innovation

1. **Climate Change Resilient Technologies:** Research in climate change resilient technologies focuses on identifying, developing, and promoting innovative solutions that can mitigate the impacts of climate change. Modern coolers and scrubbers are examples of such technologies. Modern coolers utilise advanced techniques to optimise cooling processes while minimising energy consumption, contributing to energy efficiency and reduced carbon emissions. Scrubbers are devices used to remove pollutants from exhaust gases, enhancing air quality and reducing the emission of harmful substances. Research in these areas aims to enhance the resilience of industries and processes to the effects of climate change while minimising their environmental footprint.
2. **Research on Emerging Energy Technologies:** Ongoing research explores novel energy technologies with the potential to significantly reduce greenhouse gas (GHG) emissions in the energy sector. Examples include Small Modular Reactors (SMRs) in Nuclear Technology, Power-to-X processes, and Green Hydrogen production. SMRs offer compact and scalable nuclear power solutions with enhanced safety features, contributing to a low-carbon energy mix. Power-to-X technologies convert surplus renewable energy into useful products such as hydrogen or synthetic fuels, enabling energy storage and reducing dependence on fossil fuels. Green Hydrogen production utilises renewable sources to generate hydrogen gas, offering a clean energy carrier. Additionally, research in SF6-free Gas Insulated Switchgear aims to develop alternatives to sulfur hexafluoride (SF6), a potent greenhouse gas commonly used in electrical equipment.
3. **Baseline Study on SF6 in the Power Sector:** Conducting a baseline study on the use of SF6 in the power sector involves assessing the current use of SF6 as an insulating gas in various electrical applications. This research helps establish a clear understanding of SF6 emissions, its environmental impact, and the potential for alternative solutions. The findings inform strategies to reduce SF6 emissions and transition to more environmentally friendly alternatives.
4. **Enhanced Forest-Based Climate Change Research and Technological Development:** This research area concentrates on advancing forest-based solutions to address climate change. It involves improving access to high-quality tree germplasm, including both indigenous and fast-growing exotic species. The aim is to cater to changing agroecological zones and market demands. Developing drought-tolerant tree species contributes to adapting forests to changing climate conditions. Additionally, this research generates essential data on phenology (the study of plant life cycle events), species migration patterns, and matching tree species to suitable sites. These insights guide sustainable forest management practices and support climate-resilient reforestation efforts.

6.4 Monitoring, Reporting and Verification (MRV) System

A comprehensive approach to monitoring, reporting, and verification (MRV) is essential to ensure the effective implementation of climate change mitigation actions. This approach will incorporate multi-agency collaboration and participatory engagement. The MRV framework follows a three-tiered structure, encompassing monitoring, verification, and reporting, each contributing to the assessment of progress towards stated goals.

Monitoring activities will primarily occur within the purview of implementing agencies. They will be responsible for daily, weekly, or monthly data collection, aligned with the indicators established in NCCAP III. These key performance indicators will serve as guideposts for agencies to systematically capture and store data pertinent to their interventions.

On a national level, public interventions will be closely monitored in terms of resource allocation and utilisation. Budgetary allocations for specific activities will be tracked to gauge resource utilisation. This insight will highlight instances of underutilisation or inefficiency, prompting a reevaluation of actions. Additionally, the completion status of strategies, policies, and implementation reports will be utilised as indicators of progress.

To ensure an impartial assessment, an external independent agency will be commissioned annually to undertake the verification process. This verification will involve site visits to selected projects, allowing firsthand observation of progress and the documentation of noteworthy case studies. Collaborating closely with the implementing agencies, the independent verifier will access the necessary data and information. Subsequently, the agency will submit a report to the national climate change steering committee and the climate change directorate. This report will outline successful strategies, identify areas requiring improvement, and recommend potential adjustments.

The proposed MRV framework will foster transparency, accountability, and continuous improvement in climate change mitigation efforts. By integrating multi-agency collaboration, data-driven monitoring, and external verification, this approach contributes to a robust and reliable assessment of the journey towards a low-carbon development trajectory.





Chapter 07

Cross-cutting Issues/ Actions

This chapter presents cross-cutting issues that need to be addressed to ensure the successful implementation of mitigation actions. Specifically, we provide a high-level overview and potential inclusion of the following in the implementation of the NCCAP: carbon markets, gender mainstreaming, and non-market approaches.

7.1 Carbon Markets

Carbon markets in Kenya have emerged as a critical component of the nation's efforts to combat climate change and promote sustainable development. These markets facilitate the trading of carbon credits, allowing entities to buy and sell emission reduction units as a means of achieving climate goals. Kenya's engagement with carbon markets is rooted in its commitment to the Paris Agreement and its NDCs, which outline the country's targets for mitigating greenhouse gas emissions and adapting to the impacts of climate change.

Recognising the potential of carbon markets to drive both environmental and economic benefits, Kenya has embarked on initiatives to mainstream carbon crediting into its climate strategies. The strategic objectives encompass integrating carbon crediting into mitigation and adaptation efforts, providing alternative financing for NDC implementation, enhancing NDC execution through carbon markets, and adhering to international obligations by developing compliant carbon market systems.

To achieve these objectives, Kenya has been working to establish robust infrastructure, policies, and regulations necessary for effective carbon trading. The focus is on sectors such as energy, forestry, transportation, agriculture, and industry, each with specific emission reduction targets. The country's carbon trading endeavors aim to incentivise emission reductions, promote sustainable practices, and attract investments in low-carbon technologies and projects.

As part of its carbon market development, Kenya is fostering collaboration among government agencies, private sector entities, non-governmental organisations, and international partners. This collaboration aims to address challenges such as data accuracy, legal frameworks, capacity building, and stakeholder engagement. By enhancing transparency, accountability, and environmental stewardship, Kenya's journey into carbon markets represents a proactive approach to climate action, fostering a transition to a greener and more sustainable future.

Strategic Objectives:

1. Incorporate Carbon Crediting into Climate Change Efforts: The primary goal is to seamlessly integrate carbon crediting into Kenya's strategies for mitigating and adapting to climate change.
2. Alternative Financing for NDC Implementation: Carbon trading offers an alternate source of funding to support the implementation of Kenya's NDCs.
3. Enhance NDC Implementation through Carbon Markets: Carbon markets play a pivotal role in strengthening the execution of NDC goals and actions.
4. Compliant Carbon Market Development: Kenya aims to establish and manage carbon markets that align with international obligations.

Key Assumptions:

1. Abundant Carbon Stocks: Kenya is presumed to possess adequate carbon stocks to facilitate trading and meet NDC commitments.
2. Adequate Carbon Market Infrastructure: It is assumed that the necessary infrastructure for carbon trading is in place or will be established.
3. Clarity on Carbon Rights: A clear understanding and delineation of carbon rights are essential for effective carbon trading.
4. Stable Carbon Market Prices: The assumption is that carbon market prices will remain consistent and favorable for trading activities.

Trading Opportunities and Targets:

1. Baseline Emission: The starting point is a baseline of 143 MtCO2eq in 2030.
2. Reduction Target: Kenya aims to reduce emissions by 32% (46 MtCO2eq) by 2030.
3. Trading Potential: Over the course of NCCAP III, a reduction of 86 MtCO2eq is targeted, with 40 MtCO2eq available for trading.
4. Sectoral Targets: Different sectors are assigned targets: Forestry (20.8%), Energy (48.1%), Transport (4.7%), Agriculture (9.7%), Industry (2.4%), Waste (0.8%), totaling 86.5%.

Delivery Infrastructure:

Responsible agencies include ministries, departments, institutions, county governments, and non-state actors. These entities collaborate to oversee carbon trading across sectors.

Implementation Strategies:

1. Carbon Budget Assessment: Evaluating the mitigation potential through a carbon budget assessment.
2. Carbon Registry Development: Creating a carbon registry for accurate accounting and verification.
3. REDD+ Registry: Establishing a registry specific to REDD+ initiatives.
4. Policy and Regulatory Frameworks: Finalising policies and regulations to institutionalise carbon markets.
5. Readiness Assessment: Conducting assessments to ensure preparedness for carbon trading.
6. Infrastructure Development: Developing the necessary infrastructure to facilitate carbon trading activities.
7. ESG Reporting Guideline: Developing guidelines for Environmental, Social, and Governance (ESG) reporting.
8. Capacity Building: Enhancing knowledge and skills related to carbon trading among stakeholders.
9. Environmental and Social Safeguard Framework: Establishing safeguards to protect environmental and social interests throughout carbon trading activities.
10. Transitioning CDM Projects: Moving eligible Clean Development Mechanism (CDM) projects into the article VI framework to ensure their continuity and alignment with evolving carbon market mechanisms.

Resources Required:

Financial resources, technical expertise, operationalisation of the Climate Change Fund, and finances from local and international partners are needed to support various aspects of carbon trading. Additionally, investments in infrastructure development, capacity building initiatives, and the establishment of regulatory frameworks are essential for the successful implementation of carbon market mechanisms.

Risks and Mitigation:

Risks associated with carbon trading include inadequate capacity, policy gaps, double counting, under and over-reporting, lack of benefit-sharing frameworks, price fluctuations, verification irregularities, marginalised communities, and segmented engagements. These risks can be mitigated through various measures, including resource mobilisation, research and development initiatives, capacity building programmes, policy formulation, stakeholder coordination, multi-sectoral engagements, prioritisation of projects, and maintaining a chain of custody to ensure transparency and accountability throughout the trading process.

Kenya's commitment to carbon trading underscores its dedication to sustainable development, climate action, and the alignment of economic growth with environmental stewardship. Through strategic planning, collaborative efforts, and effective risk management, the nation aims to make tangible progress in its carbon trading initiatives.

7.3 Non-Market Approaches

Gender mainstreaming in Kenya demonstrates the nation's commitment to promoting equal opportunities and outcomes for all genders in various sectors. It acknowledges that addressing gender disparities is essential for achieving sustainable development and social justice. It acknowledges historical imbalances that have marginalised women and integrates gender perspectives into policies, programmes, and projects to empower women and enhance their participation and leadership.

Kenya's Constitution upholds principles of gender equality and prohibits discrimination. In line with this, the government has instituted frameworks and organisations, such as the National Gender and Equality Commission (NGEC), to promote gender mainstreaming. National development plans like Vision 2030 and the BETA prioritise gender-responsive strategies to drive inclusive growth and development.

Efforts span across various areas, covering education, health, economic empowerment, and political representation. Programmes aim to increase girls' access to education, improve maternal healthcare, support women's entrepreneurship, and promote participation in decision-making bodies. Gender-responsive budgeting, policies, and advocacy campaigns serve to reinforce the influence of gender mainstreaming.

Despite progress, challenges persist, including entrenched traditional norms, inequalities in resource access, and gender-based violence. To address these, Kenya consistently engages in community sensitisation, strengthens legal frameworks, and advocates for gender-responsive data collection and analysis.

Gender mainstreaming in Kenya signifies a comprehensive approach to achieving gender equality, uplifting marginalised voices, and fostering a society where all individuals can contribute and thrive on equal footing.

Mainstreaming Gender in Climate Change Mitigation

Mainstreaming gender in the six climate change mitigation sectors in Kenya (Energy, Electricity Generation, Transport, Waste Management, Agriculture, and Manufacturing) requires a comprehensive and targeted approach. Here's how gender mainstreaming can be achieved in each sector:

1. **Energy:**
   - Develop and implement policies that promote equal participation of women in decision-making and leadership roles within the energy sector.
   - Design energy programmes considering the specific needs and preferences of women, such as clean cooking solutions and off-grid energy access for rural communities.
   - Provide training and capacity-building opportunities for women to engage in the design, installation, and maintenance of renewable energy systems.
2. **Electricity Generation:**
   - Encourage women's participation in traditionally male-dominated fields such as engineering, construction, and maintenance of power generation infrastructure.
   - Ensure equal access to job opportunities, training, and professional development for women in the electricity generation sector.
   - Promote gender-sensitive workplace policies that address the unique challenges faced by women in the industry.
3. **Transport:**
   - Develop transportation systems considering women's safety, accessibility, and travel patterns.
   - Invest in gender-responsive public transportation infrastructure, including well-lit and secure transit stops, and consider women's mobility needs in urban planning.
   - Encourage women's participation in decision-making processes related to transport planning and policy development.

4. **Waste Management:**
   - Encourage women's involvement in waste management initiatives, including recycling and waste reduction programmes.
   - Ensure that waste collection and disposal sites are safe and accessible for women, particularly those in informal settlements.
   - Raise awareness about the importance of waste management in reducing health hazards and enhancing the overall well-being of communities, with a focus on women's roles.

5. **Agriculture:**
   - Provide women farmers with access to credit, training, and technology to enhance their agricultural productivity and income.
   - Recognise and support women's contributions along the entire agricultural value chain, from production to processing and marketing.
   - Promote sustainable agricultural practices that address gender-specific challenges, such as time constraints and limited access to resources.

6. **Manufacturing:**
   - Encourage the recruitment and advancement of women in manufacturing industries, including through targeted training and apprenticeship programmes.
   - Implement workplace policies that promote gender equality, such as equal pay for equal work and measures to prevent gender-based discrimination and harassment.
   - Provide mentorship and leadership development opportunities for women in the manufacturing sector.

In all these sectors, comprehensive data collection and analysis that considers gender differences are crucial to identify gender-specific challenges and opportunities. Collaborative efforts between government, civil society, private sector, and international organisations will be essential to ensure effective gender mainstreaming and the achievement of climate change mitigation goals.

7.3 Non-Market Approaches

Non-market approaches to climate change mitigation in Kenya involve strategies that do not rely solely on traditional market mechanisms like carbon trading. These approaches focus on addressing climate challenges through a combination of policy, technology, and community-based actions. Here's a brief overview of non-market approaches in climate change mitigation in Kenya:

1. These include the NCCAP, which outlines specific actions and targets across sectors. Additionally, Kenya's GESIP integrates climate resilience and low-carbon development into key economic sectors.
2. **Renewable Energy Promotion:** Kenya has made significant strides in promoting renewable energy sources such as geothermal, wind, and solar power. The country's ambitious renewable energy targets aim to increase the share of renewable energy in the national energy mix. Initiatives like the Feed-in Tariff (FiT) programme encourage private investment in renewable energy projects.
3. **Afforestation and Reforestation:** Afforestation and reforestation efforts in Kenya play a vital role in carbon sequestration and biodiversity conservation. The government, in collaboration with non-governmental organisations and communities, undertakes tree planting and ecosystem restoration initiatives to enhance carbon sinks.
4. **Community-Based Climate Adaptation:** Climate-resilient practices at the community level contribute to mitigation efforts. Sustainable land management, agroforestry, and water conservation practices are adopted to enhance agricultural productivity while reducing emissions and enhancing resilience to climate impacts.
5. **Waste Management and Circular Economy:** Kenya has taken steps to improve waste management practices and promote a circular economy. Initiatives include waste separation, recycling, and composting programmes. These efforts reduce greenhouse gas emissions from landfills and promote resource efficiency.
6. **Climate-Smart Agriculture:** Promoting climate-smart agricultural practices aims to increase productivity while minimising emissions. Techniques like agroecology, improved irrigation methods, and drought-resistant crop varieties contribute to sustainable agricultural systems.
7. **Capacity Building and Public Awareness:** Non-market approaches also include capacity-building programmes and public awareness campaigns. These efforts educate communities, businesses, and institutions about climate change impacts and mitigation strategies.
8. **Climate Finance and International Collaboration:** Kenya seeks climate finance through international agreements, such as the GCF, and climate-related initiatives by development partners. These funds support projects that enhance climate resilience, deploy renewable energy, and promote sustainable development.

In conclusion, non-market approaches to climate change mitigation in Kenya represent a holistic strategy for addressing climate challenges. By combining policy, technology, and community engagement, these approaches aim to achieve sustainable development and build resilience in response to climate change.





References

Kenya Forest Service. (2020). State of Kenya's Forests Report 2020. [Link: https://www.kenyaforestservice.org/images/SOFR/SOFR%202020%20Final.pdf]

United Nations Environment Programme (UNEP). (2021). Towards Greening Kenya's Economy: A Rapid Assessment of Kenya's Green Economy Policies. [Link: https://www.unep.org/resources/report/towards-greening-kenyas-economy]

Kenya Forestry Research Institute (KEFRI). (2021). Annual Report 2020/2021. [Link: http://kefri.org/wp-content/uploads/2021/08/KEFRI-ANNUAL-REPORT-2020-21.pdf]

ASCU. (2012). *National Horticulture Policy*. *[Link:* https://www.kenyamarkets.org/wp-content/uploads/2016/06/National-Horticulture-Policy-2012.pdf]

Climate Bond Initiative. (2019, October 2). *First Green Bond from Kenya: Acorn USD40m - Climate Bonds Certified, financing green buildings*. Climate Bonds Initiative. *[Link:* https://www.climatebonds.net/2019/10/first-green-bond-kenya-acorn-usd40m-climate-bonds-certified-financing-green-buildings]

Climate Policy Initiative. (2021). *The landscape of climate finance in Kenya: On the road to implementing Kenya NDC*. *[Link:* https://www.climatepolicyinitiative.org/wp-content/uploads/2021/03/The-Landscape-of-Climate-Finance-in-Kenya.pdf]

German Embassy. (2022). *Road Map to E-mobility in Kenya*. *[Link:* https://eedadvisory.com/wp-content/uploads/2022/01/RoadMap-to-e-Mobility-in-Kenya.pdf]

GIZ, PIK, & KFW. (n.d.). *Climate Risk Profile: Kenya*. Retrieved August 31, 2023, from *[Link:* https://www.pik-potsdam.de/en/institute/departments/climate-resilience/projects/project-pages/agrica/giz_climate-risk-profile-kenya_en_final]

GoK. (2007). *Kenya Vision 2030*. Government Press, Kenya. *[Link:* https://www.researchictafrica.net/countries/kenya/Kenya_Vision_2030_-_2007.pdf]

GoK. (2013). *National Climate Change Action Plan 2013—2017*. Government of Kenya (GoK) Vision 2030. [Link: https://unfccc.int/files/bodies/awg/application/pdf/03_kenya_omedi_moses_jura_2.pdf]

GoK. (2022). *State of the Climate Kenya, 2022*. Kenya Meteorological Department (KMD). [Link: https://meteo.go.ke/sites/default/files/downloads/State%20of%20the%20Climate%20Kenya%202022_1.pdf]

GoK. (2023a). *Medium Term Development Plan 2023—2027 (MTP IV)*. [Link: https://www.planning.go.ke/wp-content/uploads/2024/03/MTP-IV-2023-2027.pdf]

GoK. (2023b). *National Landscape and Ecosystem Restoration strategy (Draft Report)*. [Link: https://regreeningafrica.org/wp-content/uploads/2022/11/The_Kenya_National_Landscape_Restoration_Scaling_Conference_2022.pdf]

Government of Kenya (Ed.). (2015). *Kenya: Second National Communication to the United Nations Framework Convention on Climate Change*. National Environment Management Authority (NEMA-Kenya). *[Link:* http://unfccc.int/resource/docs/natc/kennc2.pdf]

IPCC. (1996). *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (Workbook Volume 2; p. 63). *[Link:* https://www.ipcc-nggip.iges.or.jp/public/gl/invs5c.html]

IPCC. (2006). *2006 IPCC guidelines for national greenhouse gas inventories* (Eggleston H.S., Buendia L., Miwa K., Ngara T., & Tanabe K., Eds.). IGES, Japan. *[Link:* https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html]

IPCC. (2014). *Climate Change 2014 Synthesis Report*. *[Link:* https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf]

IUCN, & IKI. (2016). *Kenya | Bonchallenge*. *[Link:* https://www.bonnchallenge.org/pledges/kenya]

Kenya Dairy Board. (n.d.). Kenya Dairy Value at a glance. *Kenya Dairy Board*. Retrieved March 29, 2021, from *[Link:* https://www.kdb.go.ke/]

KNBS. (2018). *2015/2016 Integrated household budget survey (KIHBS)*. [Link: https://www.knbs.or.ke/download/highlights-201516-kenya-integrated-household-budget-survey-kihbs-reports/]

KNBS. (2020). *2019 Kenya Population and Housing Census Volume I: Population by County and Sub-County* [Census report]. KNBS. *[Link:* https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county]

KNBS. (2023). *Economic Survey 2023*. Kenya National Bureau of Statistics. *[Link:* https://www.knbs.or.ke/download/economic-survey-2023/]

Ministry of Environment and Forestry. (2020). *Kenya Updated Nationally Determined Contribution (NDC)*. *[Link:* https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya%27s%20First%20%20NDC%20(updated%20version).pdf]

Ministry of Environment and Forestry. (2021). *National REDD+ strategy*. *[Link:* https://www.un-redd.org/sites/default/files/2022-05/NATIONAL%20REDD%2B%20STRATEGY%202022.pdf]

Ministry of Environment, Climate Change and Forestry. (2022). *National Cooling Action Plan for Kenya* [Action Plan]. *[Link:* https://www.environment.go.ke/wp-content/uploads/2023/06/230607_NCAP-for-Kenya22high.pdf]

Ministry of Environment, Water and Natural Resources. (2015). *Kenya's Intended Nationally Determined Contribution (INDC)*. [*Link:* *https://thecvf.org/wp-content/uploads/2020/10/Kenya_INDC_20150723.pdf*]

MoE. (2004). *SESSIONAL PAPER NO. 4 ON ENERGY*. *[*Link: https://renewableenergy.go.ke/downloads/policy-docs/sessional_paper_4_on_energy_2004.pdf]

MoE. (2019, March 7). *Sector Study on Clean Cooking in Kenya*. https://rise.esmap.org/data/files/library/kenya/Electricity%20Access/Kenya_MoE-Kenya%20Cooking%20Sector%20Study_2019.pdf

MoEF. (2019). *The National Forest Reference Level for REDD+ Implementation*. [Link: https://redd.unfccc.int/media/national_frl_report_for_redd__in_kenya.pdf]

Munguti, J. M., Kim, J.-D., & Ogello, E. O. (2014). An Overview of Kenyan Aquaculture: Current Status, Challenges, and Opportunities for Future Development. *Fisheries and Aquatic Sciences*, *17*(1), 1–11. *[Link:* https://doi.org/10.5657/FAS.2014.0001]

UNEP Copenhagen. (n.d.). *CDM Pipeline*. UNEP-CCC. Retrieved July 14, 2023, from *[Link:* https://unepccc.org/cdm-ji-pipeline/]

World Bank. (2021). *Climate Risk Country Profile: Kenya*. *[Link:* https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15724-WB_Kenya%20Country%20Profile-WEB.pdf]







NATIONAL CLIMATE CHANGE ACTION
PLAN (NCCAP) III 2023-2027 - VOLUME III

MITIGATION TECHNICAL ANALYSIS REPORT (MTAR)

www.environment.go.ke